New Entries to IPNI Library as References

Hardwick S. R., R. Toumi, M. Pfeifer, E. C. Turner, R. Nilus, and R. M. Ewers. 2015. The relationship between leaf area index and microclimate in tropical forest and oil palm plantation: Forest disturbance drives changes in microclimate. Agricultural and Forest Meteorology, 201:187-195.
Reference ID: 21198
Notes: #21198e
Abstract: Land use change is a major threat to biodiversity. One mechanism by which land use change influences biodiversity and ecological processes is through changes in the local climate. Here, the relationships between leaf area index and five climate variables air temperature, relative humidity, vapour pressure deficit, specific humidity and soil temperature are investigated across a range of land use types in Borneo, including primary tropical forest, logged forest and oil palm plantation. Strong correlations with the leaf area index are found for the mean daily maximum air and soil temperatures, the mean daily maximum vapour pressure deficit and the mean daily minimum relative humidity. Air beneath canopies with high leaf area index is cooler and has higher relative humidity during the day. Forest microclimate is also found to be less variable for sites with higher leaf area indices. Primary forest is found to be up to 2.5 degrees C cooler than logged forest and up to 6.5 degrees C cooler than oil palm plantations. Our results indicate that leaf area index is a useful parameter for predicting the effects of vegetation upon microclimate, which could be used to make small scale climate predictions based on remotely sensed data.

Ajambang W., S. W. Ardie, H. Volkaert, M. Galdima, and S. Sudarsono. 2015. Huge carbohydrate assimilates delay response to complete defoliation stress in oil palm (Elaeis guineensis Jacq.). Emirates Journal of Food and Agriculture, 27:126-137.
Reference ID: 21199
Notes: #21199e
Abstract: Understanding how and when crops cope with and respond to stress during reproductive development may be able to forecast total crop production under abrupt climate change. We studied the effect of complete defoliation under time-specific climate-related conditions on inflorescence sex differentiation in oil palm. A total of 162 pisifera oil palm trees were completely defoliated at the rate of three trees per month between July 2007 and December 2011. Complete defoliation significantly increased male inflorescence induction by 104% when compared with control without defoliation. Acute soil water deficit (SWD) of 16.8 mm between the 30th and 60th day after complete defoliation (DAD) had an additional positive effect on male inflorescence production. A regression analysis on 18 time-specific, climate-related research and two inflorescence-related variables resulted in high regression coefficients for the time period 30th to 60th DAD. This is an indication that oil palm responds to complete defoliation stress after a 30-day delaying period. Total soluble sugars measured at 45 DAD showed a depletion of 55% in the leaves and 21% in inflorescence of defoliated trees compared to control trees without defoliation. Preferential sex differentiation in oil palm towards maleness is an acclimation response to the depletion of total soluble sugar inflected by mechanical and soil

water deficit stresses. These results shall permit the simulation of male inflorescence induction and yield forecasting in other geographical locations.

Cracknell A. P., K. D. Kanniah, K. P. Tan, and L. Wang. 2015. Towards the development of a regional version of MOD17 for the determination of gross and net primary productivity of oil palm trees. International Journal of Remote Sensing, 36:262-289.
Reference ID: 21200
Notes: #21200e
Abstract: Conducting quantitative studies on the carbon balance or productivity of oil palm is important for understanding the role of this ecosystem in global climate change. The MOD17 algorithm is used for processing data from the Moderate Resolution Imaging Spectroradiometer (MODIS) to generate the values of gross primary productivity (GPP) and net primary productivity for input to global carbon cycle modelling. In view of the increasing importance of data on carbon sequestration at regional and national levels, we have studied one important factor affecting the accuracy of the implementation of MOD17 at the sub-global level, namely the database of MODIS land cover (MOD12Q1) used by MOD17. By using a study area of approximately 7 km x 7 km (49 MODIS pixels) in semi-rural Johor in Peninsular Malaysia and using Google Earth 0.75 m resolution images as ground data, we found that the land-cover type for only 16 of these 49 MODIS pixels was correctly identified by MOD12Q1 using its 1 km resolution land-cover database. This leads to errors of 24% to 50% in the maximum light use efficiency, leading to corresponding errors of 24% to 50% in the GPP. We show that by using the Finer Resolution Observation and Monitoring - Global Land Cover (FROM-GLC) land-cover database developed by Gong et al., this particular error can be essentially eliminated, but at the cost of using extra computing resources.

Anderman T. L., R. Remans, S. A. Wood, K. DeRosa, and R. S. DeFries. 2014. Synergies and tradeoffs between cash crop production and food security: a case study in rural Ghana. Food Security, 6:541-554.
Reference ID: 21201
Notes: #21201e
Abstract: Despite dramatic improvements in global crop yields over the past half-century, chronic food insecurity persists in many parts of the world. Farming crops for sale (cash cropping) has been recommended as a way to increase income that can, in turn, improve food security for smallholder farmers. Despite long-term efforts by development agencies and government to promote cash cropping, there is limited evidence documenting a relationship between these crops and the food security of households cultivating them. We used a mixed methods approach to build a case study to assess these relationships by collecting quantitative and qualitative data from cacao and oil palm farmers in the Ashanti region of Ghana. Three dimensions of food security were considered: food availability, measured by the months in a year households reported inadequate food; food access, indicated by the coping strategies they employed to secure sufficient food; and food utilization, gauged by the diversity of household diets and anthropometric measurements of child nutritional status. We found significant negative relationships between each of these pillars of food security and a household's intensity of cash crop production, measured by both quantity and area. A qualitative assessment indicated community perception of these tradeoffs and identified potential mechanisms, including increasing food prices and competing activities for land use, as underlying causes. The adverse relationship

between cash crop production and household food security observed in this paper calls for caution; results suggest that positive relationships cannot be assumed, and that further empirical evidence is needed to better understand these tradeoffs.

Hunsberger C., S. Bolwig, E. Corbera, and F. Creutzig. 2014. Livelihood impacts of biofuel crop production: Implications for governance. Geoforum, 54:248-260.
Reference ID: 21202
Notes: #21202e
Abstract: While much attention has focused on the climate change mitigation potential of biofuels, research from the social sciences increasingly highlights the social and livelihood impacts of their expanded production. Policy and governance measures aimed at improving the social effects of biofuels have proliferated but questions remain about their effectiveness across the value chain. This paper performs three tasks building on emerging insights from social science research on the deployment of biofuel crops. First, we identify livelihood dimensions that are particularly likely to be affected by their cultivation in the global South - income, food security, access to land-based resources, and social assets - revealing that distributional effects are crucial to evaluating the outcomes of biofuel production across these dimensions. Second, we ask how well selected biofuel governance mechanisms address livelihood and equity concerns. Third, we draw insights from literature on non-energy agricultural value chains to provide one set of ideas for improving livelihood outcomes. Our analysis demonstrates that biofuel policies treat livelihoods as a second-degree problem, specifying livelihoods as an afterthought to other goals. We suggest integrating livelihoods into a multi-criteria policy framework from the start - one that prioritizes equity issues as well as overall outcomes. We also show that the instruments with strongest provisions for safeguarding livelihoods and equity appear least likely to be implemented. Together, shifting both the priorities and the relative hierarchy of biofuel governance instruments could help produce strategies that more effectively address livelihood and equity concerns.

Persson U. M., S. Henders, and C. Cederberg. 2014. A method for calculating a land-use change carbon footprint (LUC-CFP) for agricultural commodities-applications to Brazilian beef and soy, Indonesian palm oil. Global Change Biology, 20:3482-3491.
Reference ID: 21203
Notes: #21203e
Abstract: The world's agricultural system has come under increasing scrutiny recently as an important driver of global climate change, creating a demand for indicators that estimate the climatic impacts of agricultural commodities. Such carbon footprints, however, have in most cases excluded emissions from land-use change and the proposed methodologies for including this significant emissions source suffer from different shortcomings. Here, we propose a new methodology for calculating land-use change carbon footprints for agricultural commodities and illustrate this methodology by applying it to three of the most prominent agricultural commodities driving tropical deforestation: Brazilian beef and soybeans, and Indonesian palm oil. We estimate land-use change carbon footprints in 2010 to be 66 tCO2/t meat (carcass weight) for Brazilian beef, 0.89 tCO2/t for Brazilian soybeans, and 7.5 tCO2/t for Indonesian palm oil, using a 10 year amortization period. The main advantage of the proposed methodology is its flexibility: it can be applied in a tiered approach, using detailed data where it is available while still allowing for estimation of footprints for a broad set of countries and agricultural commodities; it

can be applied at different scales, estimating both national and subnational footprints; it can be adopted to account both for direct (proximate) and indirect drivers of land-use change. It is argued that with an increasing commercialization and globalization of the drivers of land-use change, the proposed carbon footprint methodology could help leverage the power needed to alter environmentally destructive land-use practices within the global agricultural system by providing a tool for assessing the environmental impacts of production, thereby informing consumers about the impacts of consumption and incentivizing producers to become more environmentally responsible.

Zhang N., X. He, J. Zhang, W. Raza, X. M. Yang, Y. Z. Ruan, Q. R. Shen, and Q. W. Huang. 2014. Suppression of Fusarium Wilt of Banana with Application of Bio-Organic Fertilizers. Pedosphere, 24:613-624.
Reference ID: 21204
Notes: #21204e
Abstract: Fusarium wilt is one of the most serious diseases of banana plants caused by soil-borne pathogen Fusarium, oxysporum, f.sp. cubense (FOC). In this study a pot experiment was conducted to evaluate the effects of different bio-organic fertilizers (BIOs) on Fusarium wilt of banana, including the investigations of disease incidence, chitinase and beta-1,3-glucanase activities of banana plants, and FOC populations as well as soil rhizosphere microbial community. Five fertilization treatments were considered, including chemical fertilizer containing the same N, P and K concentrations as the BIO (control), and matured compost mixed with antagonists Paenibacillus polymyxa SQR-21 and Trichoderma harzianum T37 (BIO1), Bacillus amyloliquefaciens N6 (BIO2), Bacillus subtilis N11 (BIO3), and the combination of N6 and Nil (BI04). The results indicated that the application of BIOs significantly decreased the incidence rate of Fusarium wilt by up to 80% compared with the control. BIOs also significantly promoted plant growth, and increased chitinase and beta-1,3-glucanase activities by 55%-65% and 17.3%-120.1%, respectively, in the banana roots. The population of FOG in the rhizosphere soil was decreased significantly to about 104 colony forming units g(-1) with treatment of BIOs. Serial dilution plating and denaturing gradient gel electrophoresis analysis revealed that the application of BIOs increased the densities of bacteria 4nd actinomycetes but decreased the number of fungi in the rhizosphere soil. In general, the application of BIOs revealed a great potential for the control of Fusarium wilt disease of banana plants.

Francisco M. S., R. D. Araujo, E. P. dos Santos, F. F. B. Gomes, and G. R. B. da Cruz. 2014. Effect of Management Conditions on the Sensory Characteristics of Banana (Musa Spp.) Cv. Pacovan: Efeito das condições de manejo nas características sensoriais de banana (*Musa* spp.) cv. Pacovan. Revista Brasileira De Fruticultura, 36:313-317.
Reference ID: 21205
Notes: #21205e
Abstract: The effect of four management conditions on the acceptance of 'Pacovan' banana was assessed. The fruits were harvested at ideal physiological maturity for storage in four farms in the municipality of Bananeiras - PB, according to a fully randomized design. Treatments were identified as P1: Irrigation + chemical and organic fertilization + chemical control of weeds; P2: manual control of weeds; P3: irrigation + chemical fertilization + manual control of weeds; P4: manual and chemical control of weeds. Five bunches of bananas were harvested in each farm

and submitted to cooling with calcium carbide for 12 hours for uniform ripening. After this period, fruits were kept at room temperature until full maturation. The sensory panel was composed of 62 untrained judges, with mean age of 18 years. Attributes of aroma, flavor, texture and pulp color were assessed through acceptance test using a 9-point hedonic scale. The purchase intention test used a 5-point structured scale. The samples were presented to panelists in the form of slices with thickness of approximately 1.5 cm. Results were submitted to analysis of variance (ANOVA) and means were compared by the Tukey test at 5% probability. For all attributes, values ranged from 7.34 to 7.68, in the hedonic scale between terms 'liked moderately' and 'liked very much'. As for the purchase intention, acceptance percentages were 74.19, 72.58, 72.58 and 70.97% respectively for P1, P2, P3 and P4. The management condition did not influence the acceptance of 'Pacovan' banana, and the fruits were considered by the judges as a product of good acceptance.

dos Santos J. G. R., R. Andrade, P. O. Galdino, A. S. F. Linhares, P. M. E. Maia, and A. S. de Lima. 2014. Quality of production of banana Nanicao under different biofertilizers: Qualidade da produção da bananeira Nanicão em função do uso de biofertilizantes. Revista Brasileira De Engenharia Agricola e Ambiental, 18:387-393.
Reference ID: 21206
Notes: #21206e
Abstract: The objective of this research was to study the effects of 5 doses of 4 different types of biofertilizer in production of banana Nanicao in 3 successive cycles. The experiment was conducted under field conditions at Escola Agrotecnica of the Cajueiro in the municipality of Catole do Rocha, in the state of Paraiba, Brazil. The soil in the area is classified as Entisol with sandy loam texture. The experiment was conducted during June 2008 to June 2011. The experimental design was a randomized block design with 20 treatments in a 5x4 factorial scheme (doses x types) of biofertilizers with four replications. The results show that the types of biofertilizers did not affect the production quality, the length and diameter of fruit increased with increasing dose of biofertilizer to optimum limits, the length of the fruit of the second cycle was more than that of plants of first and third cycles, the diameter of the fruit of the second cycle of the crop was higher than the first and third cycles and values of Brix and pH of the pulp of the fruit were not affected by biofertilizer doses.

Alvarez V. H. V., A. F. Santos, G. L. A. A. Santos, and P. M. Matta. 2014. Fertilization of ornamental plants: requirement-supply method: Fertilização de plantas ornamentais pelo método requerimento-suprimento: proposição de técnica experimental. Revista Brasileira De Ciencia Do Solo, 38:532-543.
Reference ID: 21207
Notes: #21207e
Abstract: The recommendation of a fertilizer dose for a crop depends on nutrient gain-loss balance in the agricultural system (Restitution Law). At the Federal University of Viçosa (UFV), this balance has been modeled for liming and fertilizer recommendations for eucalyptus (NUTRICALC), pineapple, cotton, rice, banana, coffee, sugarcane, coconut, orange, melon, maize, pastures, soybean, tomato (FERTICALC), and for teak (FERTI - UFV). Fertilization and nutrition of tropical ornamental plants is based on the knowledge of growers and fertilizer manufacturers. This study was developed to establish an experimental technique for determining: recovery rates of available forms of macro and micronutrients by

extractors; nutrient demand and recovery rates of ornamental plants; as well as nutrient doses and contents in fertilizer which supplies plant requirements. The modeling focused on two modules. Plant module, in which nutrient demand and requirement for a given yield are obtained; and substrate module, that allows to calculate nutrient supply from the pot or bed used for cultivation. Modeling enabled to outline a new research method for lime and fertilizer recommendations of crops with insufficient information, particularly for tropical ornamental plants. The requirement - supply method allows to determine nutrient dose and content of supply fertilizer (SF) that meets plant requirement. The method is iterative and was developed in three approaches. The first one considered the production of orchid seedlings. In the second, growth curves with SF were determined for violets cultivated in pots containing substrate. In the last, criteria to define nutrient recovery rates in plants and substrate chemical extraction were determined. Finally, the proposed experimental technique is presented.

Soares T. L., E. H. de Souza, M. A. P. D. Costa, S. D. E. Silva, and J. A. dos Santos-Serejo. 2014. In vivo fertilization of banana. Ciência Rural, 44:37-42.
Reference ID: 21208
Notes: #21208e
Abstract: The aim of this research was to study the in vivo fertilization process of banana cultivars. The diploid hybrid (AA) 091087-01 was the male progenitor. Flower samples were checked for fertilization from the first to the twentieth day after pollination. The size of the diploid ovules increased gradually at the beginning of the seed formation process. On the other hand, in the AAA triploids (Cavendish subgroup), the not fertilized ovules were aborted. In the AAB triploids (Prata subgroup) some ovules were fertilized. The flowers of Grand Naine, Nanicao and 'Pacovan' cultivars presented necrosis in the distal part of the ovary on the first day after pollination. Necrosis can hinder pollen tube growth towards the ovule, which might be related to the low seed yield in 'Pacovan' cultivars and to the absence of seeds in the Cavendish subgroup cultivars.

da Silva J. T. A. and M. G. V. Rodrigues. 2013. Nutricional Evaluation, Production and Incidence Panama Disease in Banana "Prata Ana" Fertilized with K, on the 4th cycle: Avaliação nutricional, produção e incidência do mal-do-panamá em bananeira 'Prata-Anã' (AAB) adubada com K, no quarto ciclo. Revista Brasileira De Fruticultura, 35:1170-1177.
Reference ID: 21209
Notes: #21209e
Abstract: The objective of the present study were to estimate the rates of K to obtain the maximum physical and economic efficiency, determine the critical level of leaf K and to relate the nutritional balance of banana 'Prata Ana' with the incidence of plants with Panama disease in the 4th cycle. The experiment was conducted in an oxisol, medium texture, in the semi-arid region in the northern of the State of Minas Gerais, Brazil. The treatments consisted of four rates of K (0, 400, 800 and 1200 kg ha(-1) yr(-1) of K2O.) These were distributed in randomized blocks with five replications. Fertilization with K increased the production of banana in the 4th cycle. The maximum physical efficiency (31.0 Mg ha(-1)) and economic (30.5 Mg ha(-1)) were obtained with the application of 969 and 707 kg ha(-1) yr(-1) of K2O, respectively. The critical levels of leaf K obtained were 29.5 and 27.1g kg(-1) for the maximum physical efficiency and economic, respectively. The increase in rates of K

provided a better nutritional balance in the banana and reduced the percentage of plants infested with Panama disease.

Aular J. and W. Natale. 2013. Mineral Nutrition and Fruit Quality of Some Tropical Fruit: Guava, Mango, Banana, and Papaya: Nutrição mineral e qualidade do fruto de algumas frutíferas tropicais: goiabeira, mangueira,bananeira e mamoeiro. Revista Brasileira De Fruticultura, 35:1214-1231.
Reference ID: 21210
Notes: #21210e
Abstract: Fruit quality is the result of the action of several factors, in particular the individual and combined effect of mineral nutrients. The proper evaluation of mineral nutritional requirements causes that fruit plants can express all their genetic potential. Thus, a research has been conducted in tropical fruit, for evaluating the influence of mineral nutrients on fruit quality; however, they appear dispersed. The objective of this review was to compile and report the effects of mineral nutrients on fruit quality of guava, mango, banana and papaya. Consequently, information about the influence of the essential elements in color, flavor, shape, size, appearance, penetration resistance, physiological disturbs disease incidence, physicochemical characteristics and lifetime of post - harvest fruit are presented.

Acon-Ho J., C. Cervantes-Umana, and R. WingChing-Jones. 2013. Recovery of 15N in the banana plant within sediment origin soil: Recuperación del 15n en la planta de banano y en el suelo de áreas con origen sedimentario. Agronomia Mesoamericana, 24:71-81.
Reference ID: 21211
Notes: #21211e
Abstract: Between October, 2003 to February, 2004 at the Finca Venecia, located in Matina in Limón, mobility in soil and recovery of banana plant nitrogen was determined, using the direct method with 15N isotopic method. Three sources enriched with 15N: urea (U), ammonium nitrate (NA) and ammonium sulfate (SA) were evaluated, at a dosage of 424 kg N per hectare per year and "monitored" through profile at four depths: 10, 30, 60 and 90 cm of soil and four growth stages (start, F10, Fm, flowering and harvest) of banana cultivation. Forms of N available from the SA was determined in greater quantity in the soil and in lesser amounts in tissues of the plant, indicating a lower tendency to be lost or absorbed from the system than the other sources. Urea is the nitrogen source that produces the greatest accumulation of N in the fruit and positively affects the plant dry weight, compared with other nitrogen sources tested (NA and SA). The use of SA appears to have a negative effect on the growth of the mother and offspring rhizome so its use as the sole source of N fertilization is not recommended. Such situation may indicate the need to use a fertilizer where the total concentration of N, comes from a mixture of several sources.

da Silva J. T. A. and M. G. V. Rodrigues. 2013. Production of 'Prata Ana' banana as affected by the application phosphate fertilizer, in four cycles: Produção da bananeira 'Prata Anã' em função da aplicação de adubo fosfatado, em quatro ciclos. Pesquisa Agropecuaria Brasileira, 48:613-618.
Reference ID: 21212
Notes: #21212e
Abstract: The objective of this work was to evaluate the response of irrigated 'Prata Ana' banana (AAB) to soil application of phosphorus, in four production cycles. The

experiment was carried out in the semiarid region of the north of the state of Minas Gerais, Brazil, in a clayey Oxisol, with very low available P (4.6 mg dm(-3), Mehlich). A randomized complete block design was used, in a 5x4 factorial arrangement, with five doses of triple superphosphate (0, 50, 100, 200, and 300 g P2O5 per plant per year), four production cycles, and four replicates. In the first cycle, the soil application of P increased plant height, pseudostem diameter, weight and number of fruits per bunch of banana; however, banana plants did not respond to P application in the second, third, and fourth cycles. 'Prata Ana' banana, even when grown in soil with low P content, responds to the application of this nutrient only in the first production cycle.

da Silva J. T. A., R. D. Pereira, and M. G. V. Rodrigues. 2012. Fertilization of the banana 'Prata Ana' with different rates and sources of nitrogen: Adubação da bananeira 'Prata Anã' com diferentes doses e fontes de nitrogênio. Revista Brasileira De Engenharia Agricola e Ambiental, 16:1314-1320.
Reference ID: 21213
Notes: #21213e
Abstract: The objective of this study was to verify appropiate N sources (ammonium sulfate, ammonium nitrate, calcium nitrate and urea) for banana and to determine the application rate for maximum physical and economic efficiency. The experiments were conducted in northern semiarid region of Minas Gerais in Red Latosol and Red-Yellow Latosol. The experimental design was in randomized blocks with 20 treatments and four repetitions. The treatments were arranged in (4 x 5) factorial, being four N sources (ammonium sulfate, ammonium nitrate, calcium nitrate and urea) and five N rates (0, 100, 200, 400 and 800 kg ha(-1) year(-1)). The N increased production in the 1st cycle of banana grown in the Red-Yellow Latosol, where N rates for maximum physical efficiency were 521, 471, 410, 424 kg ha(-1) and to achieve maximum economic efficiency were 105, 204, 260 and 5 kg ha(-1) for ammonium sulfate, ammonium nitrate, urea and calcium nitrate, respectively, with urea being the most efficient source of nitrogen. In the 2nd and 3rd cycles N reduced production. In the Red Latosol, no effects of N on the variables of plant growth and production were observed in the 1st and 2nd cycles of banana.

Pauli N., C. Donough, T. Oberthur, J. Cock, R. Verdooren, Rahmadsyah, G. Abdurrohim, K. Indrasuara, A. Lubis, T. Dolong, and J. M. Pasuquin. 2014. Changes in soil quality indicators under oil palm plantations following application of 'best management practices' in a four-year field trial. Agriculture, Ecosystems & Environment, 195:98-111.
Reference ID: 21214
Notes: H 8.1.1.8 #21214e
Abstract: Increasing the yield of existing oil palm plantations is one means of accommodating some of the growing demand for palm oil. The International Plant Nutrition Institute (IPNI) has developed and tested a process to deploy a series of 'best management practices' (BMPs) that cover a range of agronomic practices intended to intensify oil palm production and improve yield at a given site using cost-effective, practical methods. Many of these BMPs include techniques that should also improve soil quality, such as the addition of organic matter to the soil surface, and improved timing and tailored application of mineral and organic fertilisers. Six plantations in Kalimantan and Sumatra applied BMPs prescribed by IPNI (BMP treatment), and standard management practices (REF treatment) in paired blocks of oil palm over four years; 30 pairs of blocks were included in the research. Soils were

sampled in both treatments before and after the field trial, from beneath weeded circles surrounding individual palms and beneath frond piles in between rows of palms, at 0-20 cm depth and 20-40 cm depth. Soils were tested for a range of properties, including soil pH, % soil organic carbon (% SOC), total N, available P, and exchangeable cations. No clear, consistent differences were found in the degree of change in soil properties between BMP and REF treatments over four years. However, improvements in some soil properties were noted for both treatments, particularly for soil pH and % SOC. There was no significant deterioration in the measured soil properties over the four years. The results suggest that appropriate management practices for oil palm can improve several aspects of soil quality. Further research on the mechanisms by which BMPs can improve soil quality, and monitoring over longer periods of time is recommended to give plantation managers a clearer picture of the potential 'co-benefits' that can be obtained with adoption of BMPs designed to increase oil palm yield.

Ribeiro L. R., L. M. de Oliveira, S. D. E. Silva, and A. L. Borges. 2012. Physical and Chemical Characterization of Bananas Produced in Conventional and Organic Cultivation Systems: Caracterização física e química de bananas produzidas em sistemas decultivo convencional e orgânico. Revista Brasileira De Fruticultura, 34:774-782.
Reference ID: 21215
Notes: #21215e
Abstract: The demand for organic fruit grows every year around the world and banana can show growth in this sector both in the domestic and in the foreigner market. However, there is a lack of information that supports the production of organic fruit and that confirms the advantages and disadvantages of the cropping systems. Thus, the purpose of this study was to evaluate bananas from conventional tillage and organic relation to physical aspects. It was used Caipira (AAA), Maravilha (AAAB), Pacovan Ken (AAAB), Prata Ana (AAB), Thap Maeo (AAB) and Tropical (AAAB) cultivars. Organic farming was used in green roof (Canavalia ensiformis and Arachis pintoi) and fertilization with organic compost, rock phosphate, castor bean and wood ashes. In conventional farming it was not used green cover, proceeding only the chemical fertilization with urea (100 kg ha(-1)), simple superphosphate (280 kg ha(-1)) and potassium chloride (540 kg ha-1). It was evaluate the physical attributes, number of fruit per bunch, diameter (cm) and fruit length (cm), shell thickness (mm) and chemical attributes, total soluble solids (TSS) pH, total acidity (TTA), humidity (H) and soluble sugar (reducing, non reducing and total). There were no significant differences between organic and conventional crops on these parameters, Tukey test at 5% probability. Virtually there were no differences in the characteristic of banana produced in the organic or traditional systems.

Ratke R. F., S. C. Santos, H. S. Pereira, E. D. de Souza, and M. A. C. Cameiro. 2012. Growth and Yield of Banana Trees Cultivar Thap Maeo and Prata-Ana with Different Levels of Nitrogen And Potassium Fertilization: Desenvolvimento e produção de bananeiras Thap Maeo e Prata-Anã com diferentes níveis de adubação nitrogenada e potássica. Revista Brasileira De Fruticultura, 34:277-288.
Reference ID: 21216
Notes: #21216e
Abstract: The objective of this research is to characterize the development and yield of banana trees in the Southwest region of Goias and to adjust different combination levels of N and K. The experiment was conducted in dystrophic red Oxisol, in the

district of Rio Verde, Goias, and consisted on five doses of increasing rates of N and K (N0/K0 - 0 kg ha(-1) year(-1) of N and 0 kg ha(-1) year(-1) of K; N1/K1 - 150 kg ha(-1) year(-1) of N and 200 kg ha(-1) year(-1) of K ; N2/K2 - 300 kg ha(-1) year(-1) of N and 450 kg ha(-1) year(-1) of K; N3/K3 - 450 kg ha(-1) year(-1) of N and 600 kg ha(-1) year(-1) of K; N4/K4 - 600 kg ha(-1) year(-1) of N and 800 kg ha(-1) year(-1) of K), applied to two cultivars of bananas, Thap Maeo and Prata-ana. The evaluations conducted in the plants were: plant height, pseudo stem diameter and leaf number at 150 days after planting (DAT) and at flowering. The plants were assessed at the flowering and at the harvest observing the following yield components: the time elapsed between planting and flowering, leaf number at harvest, number of bunch per cluster and number of fruits in the second bunch, the length of the stem and the fruits in the second bunch, the diameter of the stem and fruits in the second bunch and the weight of the bunch, the stem and the fruits in the second bunch. The banana plants were sampled at flowering for analyzing the nutrient content. With the data of yield components were calculated durability index of the leaf and absolute rate of banana growth. The results were submitted to ANOVA and regression, and the mean comparison by the Tukey test. The attributes of development, production and leaf levels of nutrients in Thap Maeo and Prata-Ana were influenced by different rates of combined N and K. The smallest interval between flowering days was found with rates of 300 kg ha(-1) of N and 450 kg ha(-1) of K in Thap Maeo. There was no better combination of N and K parameters for the development, production and leaf levels of nutrients in Prata-Ana.

da Silva J. T. A., R. D. Pereira, I. P. da Silva, and P. M. de Oliveira. 2011. Production of banana tree cv. Prata anã (AAB) as a function of different doses and sources of potassium: Produção da bananeira 'Prata anã'(AAB) em função de diferentes doses e fontes de potássio. Revista Ceres, 58:817-822.
Reference ID: 21217
Notes: #21217e
Abstract: Among the nutrients required by the banana tree, the potassium (K) is what most influences the production of the crop. This study aimed to compare the effects of two K sources, potassium chloride (KCl) and potassium sulfate (K2SO4) on production, and estimate the dose of K for maximum physical efficiency (MPE) and maximum economic efficiency (MEE), besides determine the critical levels of leaf K for the banana tree, cultivar Prata anã (AAB) irrigated, cultivated in the semi-arid region of northern Minas Gerais State, Brazil. The experiment was conducted in an oxisol, medium texture. The treatments were derived from the factorial (4 x 2), being four rates of K (0, 400, 800 and 1200 kg ha-1 yr-1 of K2O) and two K sources (KCl and K2SO4), resulting in eight treatments. These were distributed in randomized blocks with four replications. There were no differences among the effects of KCl and K2SO4 on the production of banana. The KCl showed greater economic viability to be used as a source of K. The estimated doses for MPE of banana in the 2nd and 3rd production cycles using the KCl were 827 and 835 kg ha-1 yr-1 of K2O, respectively, while for MEE, doses were 157 and 670 kg ha-1 yr-1 of K2O, respectively. The critical levels of leaf K obtained in the 2nd and 3rd production cycles were 2.85 dag kg-1 for the MPE and for MEE, the values were 2.41 and 2.80 dag kg-1, respectively.

Lichtemberg L. A. and P. D. F. Lichtemberg. 2011. Advances on the Brazilian banana crop: Avanços na bananicultura brasileira. Revista Brasileira De Fruticultura, 33:29-36.
Reference ID: 21218
Notes: #21218e
Abstract: Since the beginning of the last century the Brazilian banana crop pass by a transformation generated by the export trade from the coast of Sao Paulo State to the Latin and European market. Achievements from the Agriculture Department of Sao Paulo State allowed changes from the semi-extraction system for a modern banana production, involving practices such as: crop and fertilization management and also disease and plagues control. In the 1950's the Agronomic Institute (Instituto Agronomico) and the Biological Institute (Instituto Biologico), both from Sao Paulo State increased the banana crop research. On the 1970's with the establishment of the Fruit-Crops Brazilian Society (Sociedade rasileira e Fruticultura), Embrapa Research, and the progress attained by the National Research Center of Cassava and Fruit-crops (Centro Nacional de Pesquisa de Mandioca e Fruticultura), the several State Research Centers and the universities permit important improvements for the national banana production. Moreover, the official and private extension services, the private corporations and the irrigation projects at the Brazilian semi-arid, increased significantly the banana cultivation areas using most technological methodologies. The two last decades the number of grower associations raised, and with better organization they implemented and improved the available technologies with technician support. On this paper statistical data and crop techniques available for the Brazilian banana crop are described with emphasis on the selection of new genotypes. Good agricultural practices such as seedling, pre- and pos-harvesting management, plant protection strategies and alternative cultivation systems are also demonstrated.

Nomura E. S., L. A. J. Teixeira, R. M. Boaretto, V. A. Garcia, E. J. Fuzitani, E. R. Jr. Damatto, L. A. Saes, and D. Jr. de Mattos. 2011. Boron Application In Banana Plant. Revista Brasileira De Fruticultura, 33:608-617.
Reference ID: 21219
Notes: #21219e
Abstract: The fertilization with micronutrients is poorly studied for banana production, especially boron (B) application, which affects the development of apical meristems. This experiment aimed to study responses of B fertilization with different rates and application methods in banana plant 'Grande Naine'. The experimental design was in randomized block and factorial scheme with three rates (0.85, 1.70 and 3.40 g plant(-1)) and three fertilizer application methods (soil, leaves and tiller hole chopped) and a control, without B application, using boric acid as the source of B. Treatments effects were evaluated by B availability on soil, plant grown, plant nutritional status and by the yield. Treatments effects were submitted to variance analysis and when significant it was adjusted by regression equations. The B application on soil and in the leaves increased this micronutrient content in topsoil (between 1.0-1.5 mg kg(-1), with the highest rate of the nutrient) and a corresponding increase up the soil layer to 20-40 cm, as a result of leaching. The contribution of foliar fertilization increasing the content in the soil was due to the washing and by draining the fertilizer solution from the leaves to the soil surface. Moreover, there was no effect of B availability in the soil when the fertilizer was applied in the tiller hole chopped (similar to 0.3 mg kg(-1) of B). It was also verified that there were no effects of B application on banana plant growth (height and

pseudostem diameter) at the blooming stage. In leaf samples, collected each 15 days, it was observed that when the micronutrient was applied in the tiller hole chopped, leaf B concentration was higher and lasted up for one month. However, in the last foliar sampling (at blooming) it was observed that there was no effect of application methods on leaf B concentration (similar to 20 mg kg(-1)). There were no effects of fertilization in yield according to rates and application methods of B, but the application on the tiller hole chopped promoted an increased accumulation of this micronutrient in the bunch due to the applied rates. Under the conditions of this experiment, it can be concluded that B application did not influenced the development and production of banana plant 'Grande Naine' according to the rates and application methods of this micronutrient.

Barroso A. D. F., T. V. D. Viana, A. B. Marinho, S. C. Costa, and B. M. de Azevedo. 2011. Macronutrient Composition In Banana Leaves cv. Pacovan Apodi, Under Irrgation Levels And Potassium Doses: Teores de macronutrientes em folhas de bananeira CV. Pacovan Apodi, sob lâminas de irrigação e doses de potássio. Engenharia Agricola, 31:529-538.
Reference ID: 21220
Notes: H 8.6.2.1 #21220e
Abstract: Through chemical analysis on the sheet, it is possible to assess the nutritional status of the plant, where the results are compared to standards (correlation between the concentration in the leaves and the development of the culture). The objective of this study was to evaluate the levels of nutrients in banana leaves under irrigation levels and potassium levels in Apodi plateau, Ceara. It was used a randomized block design with split plot arrangement with three replications. It was used five irrigation levels (in the plot): 50%, 75%, 100%, 125% and 150% of the lysimeter ETc and four doses of potassium (in the subplot): 0%, 60%, 140% and 200% of K(2)O (recommended by soil analysis). The variables analyzed were: N, P, K, Ca, Mg and S. Through the software "SAEG 9.0-UFV" the data were subjected to analysis of variance and then when significant by the F test at 5% probability, to the regression analysis. The water depth influenced significantly ($p < 0.05$) in Ca and Mg, and K fertilization influenced only the contents of K, Mg and S.

da Silva J. T. A., I. P. Silva, and R. D. Pereira. 2011. Phosphorus fertilization in banana 'Prata anã' (AAB) cultivated in two latosols: Adubação fosfatada em mudas de bananeira 'Prata anã'(AAB), cultivadas em dois Latossolos. Revista Ceres, 58:238-242.
Reference ID: 21221
Notes: #21221e
Abstract: Data on the effect of phosphorus on the development of banana are scarce. The objectives of this work were to evaluate the effect of the application of phosphorus on the development of banana "Prata Anã" growing in Red Latosol (RL) and Red-Yellow Latosol (RYL) and to determine the phosphorus critical level. The treatments were distributed in randomized design, in a 8 x 2 in factorial arrangement, with three replications. The factors corresponded to eight phosphorus dosis (0; 50; 100; 150; 300; 450; 600; 750 mg.dm-3) and two soils types, respectively. The dry mass production of banana seedlings increased with the applications of phosphorus in soils. The phosphorus soil critical levels in RL and RYL were 18.9 and 40.2 mg dm-3, respectively. In the leaves of banana seedlings growing in RL and RYL the phosphorus critical levels were 0.20 and 0.31 dag kg-1, respectively. The phosphorus was used more efficiently by banana seedlings growing in RL.

Teixeira L. A. J., J. A. Quaggio, and E. V. Mellis. 2011. Enhancing Nutrient Use Efficiency In Banana Tree Under Irrigation And Fertigation: Ganhos de eficiência fertilizante em bananeira sob irrigação e fertirrigação. Revista Brasileira De Fruticultura, 33:272-278.
Reference ID: 21222
Notes: #21222e
Abstract: The best nutritional practices aim to increase nutrient use efficiency in order to reduce production costs and environmental impacts. In order to evaluate nitrogen and potassium use efficiency in banana crops, two field experiments were carried out during four cycles of production. The experiments were cropped with Giant Cavendish banana (Musa AAA, Cavendish subgroup) in Planalto Region of State of Sao Paulo, Brazil. This region is characterized by a summer rainy season and dry winter. In the first experiment, the efficiency of the rates of N (0, 200, 400 and 800 kg ha(-1)) and K (0, 300, 600 and 900 kg ha(-1) of K(2)O) were compared in banana grown in irrigated and non-irrigated plots. In the second experiment, was compared N and K fertilizer efficiency applied through fertigation and conventional solid fertilization. In both experiments, irrigation and fertigation were made by micro-sprinkler and employed ammonium nitrate and potassium chloride as a source of N and K, respectively. The fertilizer efficiency was estimated by the ratio of the mass of fruit produced per unit of applied nutrient. The results of polled harvest have shown that irrigation increased the nutrient use efficiency compared to non-irrigated, for the averaged nutrient rates, close to 36% and 32% for N and K, respectively. Fertigation promoted an increase of 36% in nutrient use efficiency compared to conventional fertilization, for either nitrogen or potassium. Increases in nutrient use efficiency contributed to reduce fertilization costs.

Damatto E. R. Jr., R. L. V. Boas, E. S. Nomura, E. J. Fuzitani, and V. A. Garcia. 2011. Changes In Nutritional Leaves Of Banana 'Prata-Ana' Fertilized With Organic Compost For Five Production Cycles: Alterações nos teores nutricionais foliares de bananeira 'prata-anã' adubada com composto orgânico em cinco ciclos de produção. Revista Brasileira De Fruticultura, 33:692-698.
Reference ID: 21223
Notes: #21223e
Abstract: This work aimed to assess the nutritional status of banana 'Prata-ana' leaves for five cycles of cultivation with organic fertilization, in Botucatu, SP, Brazil. Plants were fertilized with organic compost produced with wood residue and cattle manure. Treatments consisted of the compost rates (0, 98.5, 197.0, 290.5 and 394.0 g of K(2)O per plant). The experiment was arranged in a randomized block design, with 5 treatments and 5 replications. At blooming, leaves of two plants were collected to analyze the levels of nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, boron, copper, iron, manganese and zinc. The content of most nutrients in leaves was not influenced by the increasing rates of organic compost. During the cycles assessed the levels of leaf nitrogen, phosphorus, potassium, sulfur, boron, iron and manganese decreased, whereas there was an increase of the calcium and magnesium contents. The levels of potassium were below the standards for the cultivar in the state of Sao Paulo, for all the years studied, and yet plants did not show symptoms of weakness or collapse of production. It can be conclude that the range considered appropriate for the culture may be lower than the standards currently adopted.

Rodrigues M. G. V., D. D. Pacheco, W. Natale, J. T. A. da Silva, and M. S. C. Dias. 2010. Biomass and Minerals Distribution in "Family" of Banana 'Prata-Ana' Fertilized with Zinc Through Thinned Sprout: Distribuição da biomassa e minerais em "família" de bananeira 'prata-anã' adubada com zinco via broto desbastado. Revista Brasileira De Fruticultura, 32:599-611.
Reference ID: 21224
Notes: #21224e
Abstract: In the North of Minas Gerais it is cultivated basically 'Prata-Ana' banana, a cultivar that requires mainly Zn. The possibility of zinc supply, without this nutrient getting in contact with the soil, it is important for the region, since several factors take to the low availability of the element supplied by the soil, as: elevated organic matter content on the surface (from cultural residues); maintenance of high pH of the soil - above 6,00 - as strategy contrary to the proliferation of the causal agent of the Fusarium Wilt; frequent fertilizations with potassium and magnesium that, besides converting the medium into base, they reduce the participation of Zn in the balance cation/anion of the soil, hindering the absortion of this micronutrient by the plant. For determining the distribution of biomass and minerals in the Prata-Ana" banana, cultivated under irrigation in the North of Minas Gerais, when the zinc was supplied through thinned sprout, an experiment was carried out in the Irrigated Perimeter of Jaiba. The plants were fertilized with 0,00; 1,66 and 3,33 g.family-(1) of Zn, through thinned sprout. One month after the fertilizations from October 2007 and February 2008, the production of fresh mass (FM) and dry mass (DM) were evaluated, the contents and meanings of minerals in all the bananas "family" bodies composed by mother-plant with bunch + tall daughter-plant + granddaughter-plant. The doses of Zn did not influence on the production of FM and DM of the plants in the first evaluation, while in the second evaluation positive effect of the treatment was observed just for MF accumulated in the inferior leaves, in the portions of the medium third and inferior of the pseudostem, and in the mother-plant's rhizome. As much the content as the accumulation of nutrients in the mother-plants presented the following decreasing order: K > N > Ca > Mg > P > S > Fe > Zn > B > Cu. The Zn contents were affected by the dose of that micronutrient in the most of the studied situations. The zinc supplied through thinned sprout increased in the mother-plant, and then it was redistributed in the banana's "family".

Nomura E. S., J. D. Lima, D. S. Rodrigues, V. A. Garcia, and E. J. Fuzitani. 2009. Influence of substrate and fertilizer type on the acclimatization of 'Prata-Ana' banana plantlets: Influência do substrato e do tipo de fertilizante na aclimatação de mudas de bananeira 'Prata-Anã'. Ciencia E Agrotecnologia, 33:773-779.
Reference ID: 21225
Notes: #21225e
Abstract: With the aim of evaluating the influence of the substrate and fertilizer type on the acclimatization of plantlets of 'Prata-Ana' banana obtained from micropropagation, a complete randomized block design was installed, in a 5 x 3 factorial structure, with four replications. The substrates used were: S1 - subsoil dirt + carbonized rice hull + Rendimax Floreira (R) commercial substrate; S2 - subsoil dirt + carbonized rice hull + Organifol (R) organic mixture; S3 - subsoil dirt + carbonized rice hull + Organifol (R) 9% SiO organic mixture; S4 - Technes Vivatto (R) commercial substrate; S5 - thick sand + carbonized rice hull + Rendimax Floreira (R) commercial substrate, all in proportion 1:1:1 (v:v:v). The fertilizers used were: WF- without fertilizer; FSR - slow-release fertilizer, 14-14-14 (5.0 kg m(-3)) mixed to the substrate; and FNR - normal-release fertilizer, 14-14-14 (5.0 kg m(-3)) applied as

top dressing 30 days after the planting. The seedlings were planted in polyethylene bags when they presented four to five leaves, being kept at a nursery with 50% shading. Height, stem base diameter, and number of leaves were measured and the dry mass of the plantlets was determined. The chemical differences of the mixtures used as substrate, together with the fertilizer type used, resulted in differentiated growth of the plantlets. The S4 substrate may be used without fertilization. The substrate S2 and S3 may be used with fertilizer of normal or slow release of nutrients, and S1 and S5, being poor in nutrients, with fertilizer of slow release.

de Melo A. S., C. D. da Silva, P. D. Fernandes, L. F. Sobral, M. E. B. Brito, and J. D. M. Dantas. 2009. Alteration of the physiologic characteristics in banana under fertirrigation conditions: Alterações das características fisiológicas da bananeira sob condições de fertirrigação. Ciência Rural, 39:733-741.
Reference ID: 21226
Notes: #21226e
Abstract: Fertilizer application through the irrigation system, has become an important way to supply nutrients to fruit trees. However, it is necessary to study its effects on the banana tree physiology, in order to improve fertilizer use efficiency. The objective of this study was to evaluate doses of nitrogen and potassium through irrigation water, on the physiological characteristics of the banana tree, cv. 'Prata-Ana', in the coastal tablelands of Sergipe State. The experiment was established in the field, using a 4(2) factorial with four randomized blocks, at the Sergipe Federal University Experimental Station. Two factors were tested: nitrogen (0; 250; 500 and 750, in kg ha(-1) of N, as urea) and potassium (0; 290; 580 and 870, in kg ha(-1) of K2O, as potassium chloride). Rate of net CO2 assimilation, transpiration, stomatal conductance, internal leaf CO2 concentration, water use efficiency and carboxylation efficiency were determined. The stomatal conductance was reduced in the fertilization with 700kg ha(-1) of N and absence of K, affecting the gas exchanges and, consequently, the photosynthesis. In situations of higher potassium readiness, the banana trees need smaller amounts of nitrogen in order to maintain the efficiency in the water use, as consequence of the best stomatal adjustment.

Damatto E. R. Jr., R. L. V. Boas, S. Leonel, J. C. Cabrera, and V. G. Sauco. 2009. Banana Production Under Different Conditions In Tenerife Island: Cultivo de bananas em diferentes áreas na ilha de Tenerife. Revista Brasileira De Fruticultura, 31:596-601.
Reference ID: 21227
Notes: #21227e
Abstract: Aiming to characterize the production and the banana quality produced in different plantation conditions of Tenerife Island, three regions of the island were studied (Cueva del Polvo, Hoya Melleque and Canaria Forestal) where bananas of Gruesa, Gran Enana and Laja cultivars are produced in open-air conditions. In Cueva del Polvo and Hoya Melleque the production was carried out in conventional management, while in Canaria Forestal the plants were carried out under organic system. Plants spacing was 1.67 x 5.0 m, with two plants per hole; 1.3 x 3.0 m, with one plant per hole and; 2.0 x 5.0 m, with two plants per hole, respectivitly to Cueva del Polvo, Hoya Melleque and Canaria Forestal. Our data show that plants of Gran Enana are higher and Gruesa plants have the thickest pseudostem. Differences were not found regarding the physical fruit characteristics and the average yield was 99.8 t.ha(-1).

Dorel M., R. Archard, and P. Tixier. 2008. SIMBA-N: Modeling nitrogen dynamics in banana populations in wet tropical climate. Application to fertilization management in the Caribbean. European Journal of Agronomy, 29:38-45.
Reference ID: 21228
Notes: #21228e
Abstract: In banana plantations of the Caribbean, nitrogen (N) fertilization widely exceeds nutrient outputs after harvest. Under wet tropical climate, leaching results in considerable waste of N. Fertilization management aims at maintaining soil mineral N at the optimal level for banana nutrition throughout the year but it does not take into account variations in crop N demand or N supply through mineralization of crop residues. The dynamics of crop N demand and crop residue supply depend on the structure of banana populations, which become asynchronous with time. We designed the SIMBA-N model to simulate N dynamics in successive crop cycles of banana. The model calculates the N balance weekly, including N uptake by banana, N leaching, and N supply by organic matter mineralization. We validated the model using data from a field experiment comparing five levels of fertilization. Results showed SIMBA-N provides reliable indicators to support banana fertilization management taking into account N flows in the soil and change in N demand related to banana population structure.

Teixeira L. A. J., B. Van Raid, and J. E. B. Neto. 2008. Estimate nutrition needs of Cavendish banana trees subgroup grown in the state of Sao Paulo, Brazil: Estimativa das necessidades nutricionais de bananeiras do subgrupo Cavendish cultivadas no Estado de São Paulo. Revista Brasileira De Fruticultura, 30:540-545.
Reference ID: 21229
Notes: H 8.6.2.1 #21229e
Abstract: Fertilizer recommendations for banana take into consideration the accumulation of nutrients in plants and the amount removed in the bunches, among other factors. Nutrient contents accumulated in plants and removed by bunches of Cavendish bananas in the State of Sao Paulo (Brazil) were assessed from a data bank of nutrient concentrations (N, P, K, Ca, Mg, S, B, Cu, Fe, Mn and Zn) in bunches (fruits+peduncle) and bunch weight with 293 samples. Data bank comprises information from plants of Grand Naine and Giant Cavendish cultivars growing in irrigated and non-irrigated areas, with different sources and rates of fertilizers during seven crop cycles. This data came from fertilization experiments accomplished at Planalto Paulista and at the Vale do Ribeira. Potassium was the nutrient most removed by the bunches (182 kg ha (1)) followed by N (68 kg ha(1)), Mg (10 kg ha(1)), P (8 kg ha(1)), Ca (6 kg ha(1)), S (3 kg ha(1)), Mn (191 g ha(1)), Fe (147 g ha(1)), B (89 g ha(1)), Zn (68 g ha(1)), and Cu (25 g ha(1)) for an average bunch yield of 40 t ha(-1). Fertilizer recommendations for banana in the State of Sao Paulo underestimate K requirements for plant establishing. The recommended rates of N are higher than N removal by bunches. The recommendation of P fertilizer is in accordance with plant requirements.

Crisostomo L. A., A. A. T. Montenegro, J. D. Neto, and R. N. de Lima. 2008. Influence of NPK fertilization on production and fruit quality of banana cv Pacovan. Revista Ciencia Agronomica, 39:45-52.
Reference ID: 21230
Notes: #21230e
Abstract: This study was carried out on a Arenosol at Curu Experimental Farm, in Ceara state. The objective of this study was: demonstrate the viability of growing

banana in a sandy soils and the influence of N P K fertilization over plant production and fruit quality. The trials were a combinations of N (0; 200; 400 and 600), P (0; 100; 200; 300 of P2O5) and K(0; 350; 700 and 1050 of K2O), in a randomized block of a factorial arrangement 1/4(4(3)), with six replications. NPK fertilization did no influence total fruit production and quality on the first growing cycle. The fruit production on second growing cycle was linearly influenced by nitrogen while on the third only potassium had some effect over fruit production. Almost all quality parameters were affected by NPK fertilization.

Rodrigues M. G. V., C. Ruggiero, W. Natale, and D. D. Pacheco. 2007. 'Prata Ana' banana plant nutrition and production fertilized with zinc and boron via rhizoma: Nutrição e produção da bananeira 'Prata-anã' adubada com zinco e boro diretamente no rizoma, via muda desbastada. Revista Brasileira De Fruticultura, 29:645-651.
Reference ID: 21231
Notes: #21231e
Abstract: It was installed one experiment in Jaiba-MG in a 6.6 year-old banana plantation, conducted for three consecutive(productive cycles, aiming to evaluate the effect of different proportions of zinc and boron applied directly in the cut off seedling, unde the nutrition of the plants and in the production of 'Prata Ana' banana plant. It was used the "lurdinha" cut off to extract the apical vita point of a germination, which was cut near the soil, in such a way that it remained an opening where the fertilizer was applied. It was utilized the entirely casual experimental delineation, with 10 repetitions of one plant, and with 20 resultant treatments of a complet(factorial between 5 proportions of Zinc (0; 2.5; 5.0; 7.5 and 10.0 g of year(-1) plant(-1) Zinc) x 4 proportions of boron (0; 0.68; 1.36 and 2.0, g year(-1) plant(-1) Boron). The fertilizers promoted some alterations in the foliar contents of nutrients, however it happened without enough magnitude to alter the nutritional condition when it is considered the bands of sufficiency. Although the Zinc interfered in the production, this was in statistics the same when compared to the evidence (zero proportion) and the biggest proportion.

Teixeira L. A. J., W. Natale, J. E. Bettiol, and A. L. M. Martins. 2007. Nitrogen and potassium application on banana plant by fertirrigation and conventional fertilization - Soil chemical properties: Nitrogênio e potássio em bananeira via fertirrigação e adubação convencional-atributos químicos do solo. Revista Brasileira De Fruticultura, 29:143-152.
Reference ID: 21232
Notes: #21232e
Abstract: A field experiment was carried out in Pindorama (Sao Paulo State, Brazil) in which it was evaluated the effects of N and K application through fertirrigation and conventional fertilization on soil chemical properties in a banana plantation, during two cycles of production. Nutrient (P, K, Ca and Mg) availability and movement in soil profile and some chemical properties (organic matter, pH and base saturation) were evaluated through samples carried out in the experiment implantation and at the end of the first and second production cycles. The most important treatment effects were on soil pH and on exchangeable K. Fertilizers, applied by fertirrigation or conventional fertilization, increased soil pH specially in soil layer depth of 0 to 20 cm. It was observed that the impact of pH soil fertilization via fertirrigation was proportional to fertilizer rate. The conventional fertilization also caused a pH decrease on soil, and it was more intense near the plants, reflecting the effect of

fertilizer local application. The application of solid fertilizer on the soil surface determined a significant accumulation of exchangeable K on layers until the depth of 20 cm and in the region nearer the plant pseudo-stem. The effects of fertirrigation on soil chemical properties were more diffuse because fertilizers were spread in a larger area than the application of conventional fertilization.

Teixeira L. A. J., W. Natale, and A. L. M. Martins. 2007. Nitrogen and potassium application on banana plant by fertirrigation and conventional fertilization-nutritional status of banana plants and fruit production: Nitrogênio e potássio via fertirrigação e adubação convencional-estado nutricional das bananeiras e produção de frutos. Revista Brasileira De Fruticultura, 29:153-160.
Reference ID: 21233
Notes: H 8.6.2.1 #21233e
Abstract: A field experiment was carried out in Pindorama (Sao Paulo State, Brazil) with the objective of investigating the effects of N and K application through fertirrigation and conventional fertilization on banana plants during two crop cycles. Plant growth, nutrition status and fruit production were evaluated. The fertilization caused a reduction in the productive cycle. Fertilizers applied by fertirrigation or conventional fertilization changed the N and K leaf content. The fruit production varied in function of the treatment in the two cultivated cycles. Fruit production (t ha(1) year(1)) obtained with application of 80% of N and K doses by fertirrigation was comparable to fruit production with 100% of fertilizer rate applied by conventional fertilization.

Damatto E. R. Jr., R. L. V. Boas, S. Leonel, and D. M. Fernandes. 2006. Nutritional leaves evaluation of banana 'Prata-anã' with organic compost: Avaliação nutricional em folhas de bananeira 'Prata-anã' adubadas com composto orgânico. Revista Brasileira De Fruticultura, 28:109-112.
Reference ID: 21234
Notes: #21234e
Abstract: The present work was carried out aiming to evaluate nutritional plants conditions with different organic compost rates in the first production cycle of banana 'Prata Anã' in Botucatu-SP. Different organic compost rates were used for the treatments: T1 = 0 g of K2O/plant (zero of the compost); T2 = 98,5 g of K2O/plant (43 kg of the compost/plant); T3 = 197,0 g of K2O/plant (86 kg of the compost/plant); T4 = 290,5 g of K2O/plant (129 kg of the compost/plant); and T5 = 394,0 g of K2O/plant (172 kg of the compost/plant). The compost rates were calculated based on the quantity of potassium contained in the compost. The experiment was arranged in randomized blocks design, with 5 treatments, 5 replications and 2 plants per plot. The obtained data were submitted to variance analyses and to regression analyses. The effects of organic fertilization were evaluated by chemical leaves analyses of macro and micro nutrients during blooming and harvest. The organic fertilization didn't provide differences in leaves nutrients concentration of banana 'Prata Anã'. Therefore it was observed that the potassium contents in the leaves, considered appropriate to 'Prata-Anã' banana, could be smaller than the ones recommended to the culture.

Weber O. B., A. A. T. Montenegro, I. M. N. Silva, I. Soares, and L. A. Crisostomo. 2006. Nitrogen and potassium fertilization for banana 'Pacovan' (musa AAB, prata subgroup) at the Apodi plateau in the State of Ceará: Adubação nitrogenada e potássica em bananeira 'Pacovan' (musa AAB, subgrupo prata) na chapada do Apodi, Estado do Ceará. Revista Brasileira De Fruticultura, 28**:**154-157.
Reference ID: 21235
Notes: #21235e
Abstract: The objective of this work was to evaluate nitrogen and potassium effects on the production of banana trees 'Pacovan', under irrigation, during three cycles, and the fruit quality during the 1st cycle, at the Apodi plateau in the State of Ceará, Brazil. The basic fertilization consisted of the application of 20 L plant-1 of cattle manure, 200 g plant-1 of mono-ammonium phosphate and 100 g of FTE-BR12 plant-1. Four and a half months aster planting, were applied, monthly, 1/12 of the doses of N:K2O (180:330; 180:770; 420:330; 420:770; 30:330; 570:770; 180:55; 420:1045 e 300:550 kg ha-1), using as source, urea and potassium chloride. The crop productivity was not affected by potassium during three yield cycles, suggesting the dose of 55 kg ha-1 year-1 of K2O. However, the nitrogen fertilization increased the number of fruits on bunches during the second yield cycle, allowing to estimate an optimal N dosage (198,3 kg ha-1 ano-1). The content of soluble solids, soluble sugars and tritable acids of fruits harvested during the first cycle were affected by the potassium and nitrogen fertilization.

Orozco-Romero J. and O. Perez-Zamora. 2006. Soil moisture tension and nitrogen fertilization on banana (Musa AAA Simmonds) cv. Gran Enano: TENSIÓN DE HUMEDAD DEL SUELO Y FERTILIZACIÓN NITROGENADA EN PLÁTANO (*Musa* AAA Simmonds) cv. Gran Enano. Agrociencia, 40:149-162.
Reference ID: 21236
Notes: #21236e
Abstract: Banana (Musa AAA Simmonds) cv Gran Enano is the second most important fruit crop of the State of Colima, where the climate is semiarid and agricultural production requires irrigation. Nitrogen fertilization practices are empirical. This study was conducted to test dosages of N (0 to 300 kg ha(-1)) and soil moisture tension (10, 25, 45 and 75 kPa) oil yield and quality of banana fruits cv Gran Enano during four years. The results showed that bananas respond to the application of N and moisture; the interaction of both inputs was positive in yield and fruit quality. Maximum yields were obtained with 290 to 300 kg N ha(-1) and soil moisture tension close to field capacity during the entire crop cycle, but the maximum economic benefit (benefit/cost ratio) was obtained with 25 kPa-200 N. Reduction (0.521 Mg ha(-1)) in yield was linear for every unit (kPa) that moisture tension moved away from 10 kPa. Yield had a high degree of reliability (R-2 = 0.94) with the equation Y = 159.12-0.195 X+0.33 N-0.0005 N-2-0.001 XN, where Y = banana yield (Mg ha(-1)), X = soil moisture tension (kPa), N = kg N ha(-1). N applied to the soil had no effect on fruit quality, but moisture did, improving with tensions of 30 kPA or lower.

de Oliveira F. H. T., R. F. Novais, V. V. H. Alvarez, and R. B. Cantarutti. 2005. Development of a fertilization recommendation system for banana plantations: Desenvolvimento de um sistema para recomendacao de adubacao para a cultura da bananeira. Revista Brasileira De Ciencia Do Solo, 29:131-143.
Reference ID: 21237
Notes: #21237e

Abstract: Fertilizer recommendations for banana plantations should be technically sound and, mainly, more adjustable on a scientific base than the usual recommendation tables. A system was developed to estimate recommendable nutrient doses for banana (FERTICALC®-Bananeira), by means of modeling nutrient balance. This nutrient balance is obtained by the difference between the crop nutrient demand and supply through soil and plant residues. When the demand is higher than the supply, fertilizer application is recommended; when it is lower or equal to the supply, fertilizer application is not recommended. Simulations showed that the recommendable nutrient doses by the FERTICALC®-Bananeira increase continuously with the expected productivity rise and the reduction of nutrient contents in the soil that are higher in the first cycle and lower from the second cycle on. The FERTICALC®-Bananeira represents an important alternative for the recommendation of fertilizers for banana plantations due to the underlying logic and variables.

Guerra A. G., J. R. Zanini, W. Natale, and L. C. Pavani. 2004. Frequency of fertigation with nitrogen and potassium applied by microsprinkler system on prata-anã banana plant: Freqüência da fertirrigação da bananeira prata-anã com nitrogênio e potássio aplicados por microaspersão. Engenharia Agricola, 24:80-88.
Reference ID: 21238
Notes: #21238e
Abstract: This study was carried out in order to evaluate the effect of fertigations with nitrogen and potassium applied by microsprinkler system on the plantation of Prata-Anã banana (Musa sp AAB), during two growing seasons, under field conditions. The experiment was carried out in the irrigation area of the Department of Agricultural Engineering, FCAV/UNESP - Jaboticabal, São Paulo State, Brazil. It was used a completely randomized block design in split plot with five replications. The treatments studied were composed of four fertilizer application modalities (side dressing fertilization, monthly fertigation, bimonthly fertigation and three monthly fertigation) combined with two rates of nitrogen and potassium, corresponding to 100% (rate 1) and 50% (rate 2) of the recommended rates based on the soil analysis. Monthly fertigation promoted bunch weight and yield higher than side dressing fertilization and lower acidity of the fruits than three monthly fertigation; reducing 50% the doses of N and K did not affect yield and quality of the banana fruit.

Maia V. M., L. C. C. Salomao, R. B. Cantarutti, V. H. A. Venegas, and F. A. D. Couto. 2003. Effects of nitrogen, phosphorous and potassium on components of production and quality of 'Prata Anã' banana in the Jaíba agro-industrial district: Efeitos de dose de nitrogênio, fósforo e potássio sobre os componentes da produção e a qualidade de bananas 'Prata Anã' no distrito agroindustrial de Jaíba. Revista Brasileira De Fruticultura, 25:319-322.
Reference ID: 21239
Notes: #21239e
Abstract: An experiment was carried out in the Jaíba Agro-industrial District, located in Matias Cardoso, Minas Gerais, to evaluate the effect of nitrogen, phosphate and potassium fertilization on 'Prata Anã' banana production and quality. The experiment consisted of ten treatments with compound fertilizers using a baconian matrix (1: 250-45-700, 2: 250-25-700, 3: 250-70-700, 4: 250-100-700, 5: 250-45-300, 6: 250-45-500, 7: 250-45-1000, 8: 150-45-700, 9: 400-45-700, 10: 600-45-700 g/shoot of N, P and K, respectively, in which the first treatment includes the reference doses used

by the region's banana growers). The treatments were arranged in a randomized block design with four repetitions. After the first production cycle began, banana bunches were harvested, hands were dehanding and the number of hands and fruits, the weight of bunches, average weight of hands and fruits, and diameter and total and commercial fruit lengths were measured. Results indicated that average doses of nitrogen or phosphorous used by the banana growers of Jaíba Agro-industrial District can be reduced by 150 or 25 g/shoot without harming fruit production and quality characteristics. On the other hand, increasing the potassium dose to 1000 g/shoot, applied weekly, will lead to a significant increase in average weight and total and commercial lengths of fruits.

da Silva J. T. A., A. L. Borges, J. G. Carvalho, and J. E. A. Damasceno. 2003. Fertilization with nitrogen and potassium on irrigated banana crop cv. 'prata-anã', in three cycles: Adubação com potássio e nitrogênio em três cíclos de produção da bananeira cv. prata-anã. Revista Brasileira De Fruticultura, 25:152-155.
Reference ID: 21240
Notes: #21240e
Abstract: Nitrogen, after potassium, is the chemical element most required by banana crop. This work evaluated the effect of nitrogen and potassium fertilization on irrigated banana crop (Prata-Anã, AAB) yield. Five rates of N (0 , 200 , 400 , 800 and 1600 kg ha-1 year-1) and five rates of K2O (0; 200; 400; 800 and 1600 kg ha-1 year-1), in a (5x5) factorial design were studied. The data were obtained during three yield cycles (second, third and four cycles), on an eutrofic Red-Yellow latosol, sandy-clay, in the North of Minas Gerais State, Brazil. The content of Mn have increased in the leaves with the increased amount of N applied in the soil. The banana yield reduced with the rise of the Mn content in the leaves, on the second and third cycle. The maximum yield was obtained with the application of 962,5 kg of K2O ha-1year-1, on the fourth cycle. No interaction between N and K was found.

Fontes P. S. F., A. J. C. de Carvalho, B. S. Cereja, C. S. Marinho, and P. H. Monnerat. 2003. Evaluation of the nutricional status and development of banana cultivar "prata anã" (Musa spp.) in relation to nitrogen fertilization: Avaliação do estado nutricional e do desenvolvimento da bananeira-prata-anã (Musa spp.) em função da adubação nitrogenada. Revista Brasileira De Fruticultura, 25:156-159.
Reference ID: 21241
Notes: #21241e
Abstract: The experiment was carried in Yellow Podzolic at Itaocara, Rio de Janeiro State, Brazil, (Latitude 21º 39' 12" South and Longitude 42º 04' 36" West, with climate, conform Köppen, classified as Awi,), to evaluate the nutritional status and the development of the banana cultivar "Prata Anã" in relation to five nitrogen fertilization levels (0, 150, 300, 450 and 600 kg ha-1 year-1 of N). In general, the analyzed nutrients contents in the leaf dry matter were not modified by the increase of N dosage, being exception Mn and Cl. The levels of leaf nutrients differed between sampling seasons, with the exception of Ca. There was no variation in the levels of N in the leaf dry matter, in relation to nitrogen fertilization. Lower levels of K were observed in the leaf dry matter during the blooming and bunch development. In the first growing cycle, the nitrogen fertilization had no effect either on blooming time or in the bunch height. There was a decrease in the number of offshoots with the increasing of N levels.

Borges A. L., T. O. da Silva, R. C. Caldas, and I. E. de Almeida. 2002. Nitrogenous fertilization for 'Terra' banana (Musa sp. AAB, Plantain subgroup): Adubação nitrogenada para bananeira-'Terra' (Musa sp. AAB, subgrupo Terra). Revista Brasileira De Fruticultura, 24:189-193.
Reference ID: 21242
Notes: #21242e
Abstract: A field experiment was carried out in the South Coastal region of Bahia State, in order to define nitrogen (N) rates for maximum physical and economical efficiency, as well as the best nitrogenous fertilization, either mineral or organic, for 'Terra' banana (Musa sp. AAB, Plantain subgroup). The trial was started in May 1998, in a 4m x 2m x 3m spacing, using a microsprinkler irrigation. In a randomized blocks design with six treatments and four replications, were studied five levels of mineral nitrogen (0, 50, 200, 350 and 500 kg/ha/year), supplied as urea, and one treatment with cattle manure (267 kg/ha/year of N), as source of organic nitrogen, applied on the soil surface. Nitrogenous fertilization affected plant height, number of fruits per bunch, and fruit length and diameter in the first plant cycle (duration of 528 days, on the average). There was no significant effect of increasing rates and sources of nitrogen on yield, but the organic fertilization increased the number of fruits per bunch and the fruit length.

Irizarry H., R. Goenaga, and U. Chardon. 2002. Nitrogen fertilization in banana grown on a highly weathered soil of the humid mountain region of Puerto Rico. Journal of Agriculturre of The University of Puerto Rico, 86:15-26.
Reference ID: 21243
Notes: #21243e
Abstract: A 40-month experiment was conducted to re-evaluate the nitrogen fertilization recommendation for banana grown on a clayey, mixed isohyperthermic Aquic Haplohumults under rainfed conditions. Five nitrogen rates (0, 85, 170, 255 and 340 kg/ha/crop) were arranged in a randomized complete block design with three replications. The nitrogen treatments were applied with 24.4 kg/ha of phosphorus, 651.7 kg/ha of potassium, and a minor element mixture containing 22.7 kg/t of fertilizer. Treatments were applied every three months. Applications of magnesium alone were also applied between treatments at the rate of 55 kg/ha in the plant crop (PC) and 110 kg/ha in each of two ratoon crops (R1, R2). During growth and development of three crops we collected data of plant and bunch traits, green and oven-dry biomass weight, nitrogen concentration in various plant organs, and bunch marketable weight at harvest. Results showed that the rate x crop interaction was highly significant (P less than or equal to 0.01) for total nitrogen uptake, and for nitrogen concentration in the leaf-lamina four months before bunch harvest, and significant (P less than or equal to 0.05) for total dry matter production. Total nitrogen uptake, leaf nitrogen concentration, and total dry matter production linearly increased with increments in the nitrogen rates. Overall total nitrogen uptake and total dry matter production were always significantly higher in the R2 than in the PC. Regardless of the nitrogen rate, a significantly higher nutrient concentration was always found in the leaf-lamina of the R1 plants than in either the PC or the R2 plants. Crop had no significant effect on yield, but nitrogen rate significantly influenced yield. A maximum yield of 57,060 kg/ha/crop was obtained with an estimated nitrogen application of 240 kg/ha. This amount corresponded to a leaf nitrogen concentration of between 2.75 and 2.85 g/kg. Since the maximum yield for all crops was obtained with a nitrogen application of only 240 kg/ha, we concluded that the linear response to fertilization in excess of this amount for total nitrogen

uptake, nutrient concentration, and total dry matter production may be attributed to luxury consumption of nitrogen.

Smithson P. C., B. D. McIntyre, C. S. Gold, H. Ssali, and I. N. Kashaija. 2001. Nitrogen and potassium fertilizer vs. nematode and weevil effects on yield and foliar nutrient status of banana in Uganda. Nutrient Cycling in Agroecosystems, 59:239-250.

Reference ID: 21244

Notes: #21244e

Abstract: Banana (Musa AAA) production is declining in central Uganda. A decline in soil fertility is often cited as one of the causes of the declining production. From 1996 to 1998, we studied banana yield responses to N and K fertilization at three sites in Uganda, where plantations ranged in age from 8 to 50 years. Phosphorus was applied to all treatments at 25 kg ha(-1), while N and K were applied (kg ha(-1)) at ON-OK, ON-100K. 100N-0K, 100N-100K, and 100N-200K. Fresh fruit yields ranged from 4 to 67 Mg ha(-1) yr(-1). At one site the yield response to 100N-100K fertilization was significant ($p<0.01$). The other sites showed positive but non-significant yield responses to N or NK fertilization. Economic analysis indicated that fertilizer use would be profitable only at the single site with significant yield increases. This site had negligible banana weevil (Cosmopolites sordidus (Germar)) and nematode (Radopholus similis; Helicotylenchus multicinctus) populations whereas the other sites were characterized by either severe nematode or weevil pressure. Fertilizer did not affect the damage caused by either nematodes or weevils. The best predictor of yield ($p<0.001$, $r(2)=0.75$) was the number of functional leaves during anthesis. Measured soil nutrient parameters were highly variable but fell within sufficiency ranges. Foliar N contents were near diagnostic norms, but K levels fell below them, even when yields were satisfactory, suggesting that norms developed froth other regions may not be suitable for Uganda. We conclude that in established plantations soil nutrient status is but one, and often a secondary, factor in the decline of banana yields in the central region of Uganda. Pest and disease infestations that result in reduced plantation productivity will need to be addressed before fertilizer use is likely to make a significant improvement in banana fruit yields.

Brasil E. C., A. H. L. Oeiras, A. J. E. A. de Menezes, and C. A. C. Veloso. 2000. Development and production of fruits of banana plant as a response to nitrogen and potassium fertilization: Desenvolvimento E Produção De Frutos De Bananeira Em Resposta À Adubação Nitrogenada E Potássica. Pesquisa Agropecuaria Brasileira, 35:2407-2414.

Reference ID: 21245

Notes: H 8.6.2 #21245e

Abstract: The effect of the N and K fertilization on the development and production of the banana plant (Musa spp.), cv. Pioneira, was evaluated in an experiment carried out in Capitao Poco county, Para State, Brazil, in a Yellow Latosol, using a randomized blocks design, in factorial arrangement of 4x4. The treatments were: 0, 80, 160 and 240 g of N per plant per year; 0, 150, 300 and 450 g of K2O per plant per year. Urea and potassium chloride were used as nutrient sources. The results of plant growth showed that there was effect of N on circumference of pseudostem and plant height. The quadratic model was better adjusted to all the variables. The results of production of the second cycle indicated that K increased quadratically the bunch weight, hands weight per bunch and average weight of hands, with production

increments of 73, 76 and 39%, respectively, in comparison to the treatment without potassium. The nitrogen application promoted a linear increase of the weight of bunch and hands per bunch, with increments of 32 and 30%, respectively, proportionate by the highest level of N, in relation to the treatment without this nutrient. During the third production cycle only K application influenced the weights of bunch, of hands per bunch and average weight of hands, with increments of 39, 40% and 26%, respectively.

Ssali H., B. D. McIntyre, C. S. Gold, I. N. Kashaija, and F. Kizito. 2003. Effects of mulch and mineral fertilizer on crop, weevil and soil quality parameters in highland banana. Nutrient Cycling in Agroecosystems, 65:141-150.
Reference ID: 21246
Notes: #21246e
Abstract: The decline of cooking banana production in parts of East Africa has been associated with a loss of soil fertility and increased pest pressure. Previous work indicated that the use of mineral fertilizers at recommended rates is not financially viable on plantations where pest pressure is high. The objectives of this study were to determine the effects of half the recommended rates of mineral fertilizers and organic mulch on banana yield, soil and foliar nutrient status, soil water and pest damage in the central region of Uganda. The study was conducted in a four-year old banana plantation infested with weevils. Treatments consisted of mineral fertilizer alone, mulch alone, a combination of mulch with fertilizer, and a control (no mulch from outside the plot, or mineral fertilizer applied). Fruit yield was generally low (mean of 7.4 Mg ha(-1) yr(-1)) and increases above the control ranged from 1.1 to 2.0 Mg ha(-1) yr(-1). Banana yield was significantly higher in the sole mulch treatment than in the control. However, there were no significant differences in yield among the treatments that received external inputs. Thus, there was no demonstrable yield advantage of combining mineral fertilizer with mulch. At the end of the trial, soil K concentrations in the two treatments that were mulched, were almost twice those of the control, but this difference was not statistically significant. Concentrations of Ca and Mg did not differ with treatment. Soil available P significantly increased when mineral fertilizer and organic mulch were combined. Treatments that received organic mulch were lower in foliar concentrations of N and Mg, and higher in K. Soil water content was greater in the surface soil layer in the treatments that received mulch, presumably due to less surface run-off and evaporation, since there was no change in surface soil porosity. The effect of organic and inorganic amendments had no impact on weevil damage, which remained above 5% at the end of the trial. We conclude that where weevil damage is over 5% of the cross section near the collar, banana production may not be economically increased through use of either mineral fertilizer and/or organic mulch.

Benzon H. R. L., D. M. Mendoza, W. C. Cosico, and N. K. Torreta. 2014. The Effect of Endophytic Bacterial Inoculation on Banana, Musa acuminata cv. Lakatan. Philippine Journal of Crop Science, 39:12-21.
Reference ID: 21247
Notes: #21247e
Abstract: Banana is one of the most popular fruit in the world and is a top export commodity in the Philippines. This study aimed to assess the response of banana to endophytic bacterial inoculation (EBI) and to develop a simple technology that farmers can easily adopt. EBI presents multiple positive potential benefits to crops like banana, including increase in plant growth and nitrogen fixing capabilities, and

may serve as an alternative to intensive fertilizer use. The first of the two experiments was done to test the effects of EBI on Musa acuminata cv. Lakatan. Of the treatments used, the plants treated with the isolate MUCp 12 were significantly greater in plant height and pseudostem diameter, which was comparable to those treated with inorganic fertilizer treatment The root dry weight and total dry matter yield were also enhanced significantly, as well as in the total phosphorous and total potassium content of inoculated plants. EBI also significantly increased phosphorous uptake. A second experiment, designed to test the combined effects of EBI and inorganic fertilizer application, was shown to considerably but not significantly enhance plant height. A significant increase in pseudostem diameter was seen most in the treatment with combined 60-60-60 fertilizer and MUCp 14 treatment. However, the effect of this treatment was not significantly different from inoculation with isolate MUCp 12 alone and inoculation combined with a lower rate of inorganic fertilizer application. This suggests that inoculation alone can increase pseudostem diameter. Even though isolates MUCp 12 and MUCp 14 increased the shoot dry weight, total dry matter yield, and P content of banana, when combined with either 30-30-30 or 60-60-60 fertilizer treatments, the effect seemed to be unfavorable. The same observation was seen in the N content when isolate MUCp 12 was used. The improved growth and development of the inoculated plants could be attributed to the production of growth promoting substances by the endophytic bacteria. It is recommended that inoculation with bacterial endophytes should be done during nursery stage for seedling establishment. Proper identification and characterization of the bacterial endophytes and growth promoting substances are highly advised. Further research involving field trials using modified inoculation methods are recommended.

Johns G. G. and I. A. Vimpany. 1999. Interaction of pH amendment and potassium fertiliser on soil chemistry and banana plant growth. Australian Journal of Agricultural Research, 50:199-210.
Reference ID: 21248
Notes: #21248e
Abstract: Two glasshouse trials were conducted at Alstonville, NSW, to investigate the effects of rates of potassium (K) fertiliser and pH amendment on soil chemistry, plant nutrient content, and growth of tissue-cultured banana plants. The first trial used 5 rates of lime combined with 5 rates of KCl with plants in 1.5-L pots, and the subsequent trial used 4 rates of pH amendment (CaCO(3) + MgO) combined with 4 rates of K(2)SO(4) with plants in 140-L troughs. The soil used in both trials was the A horizon of a Yellow Kurosol.
In the pot trial, very high rates of KCl caused a reduction in plant weight, and heaviest plants were produced at pH 4.5-5 (pH(Ca), measured with CaCl(2)). Analysis of exchangeable and soluble cations indicated that increasing rates of added KCl displaced both Ca and Mg off cation exchange surfaces into the soil solution, from where they could be lost by leaching. Liming caused a marked decrease in plant Zn and Mn concentrations to levels that may have limited growth when soil pH(Ca) exceeded about 5.0.
In the trough trial, plant weight was greatest at pH(Ca) 4.3. Plant weight responded negatively to increasing K(2)SO(4) at pH(Ca) 3.5, positively at pH(Ca) 4.3, and was generally unresponsive at the higher pH(Ca) values of 5.0 and 5.8. A multiplicative Mitscherlich model was used to relate plant weight to leaf nutrient concentrations and indicated that plant weight was most limited by Mg deficiency at pH(Ca) 3.5 and Mn deficiency at pH(Ca) 5.8, with K availability having a moderate effect on growth

at intermediate pH(Ca) levels. Mg deficiency occurred at low pH despite regular foliar applications of this element, indicating the inefficacy of the foliar pathway for fertilising bananas with macro-nutrients. The study indicated that attempting to raise the pH(Ca) of this soil above 5.0 for banana growing may not be appropriate, and due attention should be paid to Mg requirements and possible effects of liming on trace element availability.

dos Santos B. H. C., R. C. F. Ribeiro, A. A. Xavier, J. A. D. Neto, and V. J. G. Mota. 2013. Control of Meloidogyne Javanica On 'Prata-Ana' Banana Seedlings By Organic Compounds: Controle de *Meloidogyne javanica* em mudas de bananeira 'prata-anã' por compostos orgânicos. Revista Brasileira De Fruticultura, 35:650-656.
Reference ID: 21249
Notes: #21249e
Abstract: The study aimed to evaluate the effect of organic compounds in the control of Meloidogyne javanica, and in the development of 'Prata-Ana' banana seedlings. The experiment was carried out in a completely randomized design with ten replicates, and treatments consisted of four compounds made from different raw materials (remnants of bananas crop, sugar cane, cattle manure, banana skins, weeds, Andropogon grass), the manure, the castor bean cake, and controls (mineral fertilizer; 'carbofuran' and absolute control (no added organic compounds). It was placed in each pot 3 kg of soil, autoclaved, mixed with each one of the treatments and inoculated with a suspension containing 4,000 eggs of M. javanica. After four days one 'Prata-Ana' micropropagated seedling was transplanted and at 60 days it was evaluated: plant height, diameter, number of leaves, dry matter weight of shoots, number of galls, egg masses, number of eggs and the number of second-stage juveniles (J2) per 100 cm(3) of soil. It was tested in vitro the effect of humic fractions of the four compounds (which did not cause phytotoxicity) and cattle manure on mortality and motility of J2 of M. javanica. The essay was set on ELISA plates in a completely randomized design with five replications. Organic compounds and manure increased the growth of plantlets. The castor bean cake caused phytotoxic effect on the seedlings. Less number of nematological variables was provided by the castor bean cake and by the 'carbofuran'. The number of J2 was also lower in plots treated with 'carbofuran' and also by the Compound 3 constituted of weed + sugar cane residues + cattle manure and by the mineral fertilizer. For the in vitro test, the humic substances presented nematicide and nematostatic effects. Among the compounds, the C3 showed itself promise for reducing the development of the nematode and for not present phytotoxic effect.

Wang B. B., J. Yuan, J. Zhang, Z. Z. Shen, M. X. Zhang, R. Li, Y. Z. Ruan, and Q. R. Shen. 2013. Effects of novel bioorganic fertilizer produced by Bacillus amyloliquefaciens W19 on antagonism of Fusarium wilt of banana. Biology and Fertility of Soils, 49:435-446.
Reference ID: 21250
Notes: #21250e
Abstract: Banana production has been severely hindered by the long-term practice of monoculture agriculture. Fusarium wilt, caused by the Fusarium oxysporum f. sp. cubense (FOC), is one of the most destructive diseases that can afflict banana plants. It is both necessary and urgent to find an efficient method for protecting banana production worldwide. In this study, 57 antagonistic bacterial strains were isolated from the rhizospheres of healthy banana plants grown in a heavily wilt-diseased field; of the 57 strains, six strains with the best survival abilities were

chosen for further study. Compared with the control and the other strains in the greenhouse experiment, W19 strain was found to observably decrease the incidence of Fusarium wilt and promote the growth of banana plants when combined with the organic fertilizer (OF). This strain was identified as Bacillus amyloliquefaciens based on its morphological, physiological, and biochemical properties, as well as 16S rRNA analysis. Two kinds of antifungal lipopeptides (iturin and bacillomycin D) produced by W19 strain were detected and identified using HPLC-ESI-MS. Another lipopeptide, called surfactin, was also produced by the thick biological film forming W19 strain. In addition to lipopeptides, 18 volatile antifungal compounds with significant antagonistic effect against F. oxysporum were detected and identified using gas chromatography-mass spectrometer (GC-MS). The work described herein not only highlights how the bioorganic fertilizer with B. amyloliquefaciens can be used to control Fusarium wilt of banana but also examines some of the potential mechanisms involved in the biocontrol of Fusarium wilt.

Yuan J., Y. Z. Ruan, B. B. Wang, J. Zhang, R. Waseem, Q. W. Huang, and Q. R. Shen. 2013. Plant Growth-Promoting Rhizobacteria Strain Bacillus amyloliquefaciens NJN-6-Enriched Bio-organic Fertilizer Suppressed Fusarium Wilt and Promoted the Growth of Banana Plants. Journal of Agricultural and Food Chemistry, 61:3774-3780.
Reference ID: 21251
Notes: #21251e
Abstract: Bacillus amyloliquefaciens strain NJN-6 is an important plant growth-promoting rhizobacteria (PGPR) which can produce secondary metabolites antagonistic to several soil-borne pathogens. In this study, the ability of a bio-organic fertilizer (BIO) containing NJN-6 strain to promote the growth and suppress Fusarium wilt of banana plants was evaluated in a pot experiment. The results showed that the application of BIO significantly decreased the incidence of Fusarium wilt and promoted the growth of banana plants compared to that for the organic fertilizer (OF). To determine the beneficial mechanism of the strain, the colonization of NJN-6 strain on banana roots was evaluated using scanning electron microscopy (SEM). The plant growth-promoting hormones indole-3-acetic acid (IAA) and gibberellin A3 (GA3), along with antifungal lipopeptides iturin A, were detected when the NJN-6 strain was incubated in both Landy medium with additional L-tryptophan and in root exudates of banana plants. In addition, some antifungal volatile organic compounds and iturin A were also detected in BIO. In summary, strain NJN-6 could colonize the roots of banana plants after the application of BIO and produced active compounds which were beneficial for the growth of banana plants.

Zhang N., K. Wu, X. He, S. Q. Li, Z. H. Zhang, B. A. Shen, X. M. Yang, R. F. Zhang, Q. W. Huang, and Q. R. Shen. 2011. A new bioorganic fertilizer can effectively control banana wilt by strong colonization with Bacillus subtilis N11. Plant and Soil, 344:87-97.
Reference ID: 21252
Notes: #21252e
Abstract: Fusarium wilt is one of the most serious diseases caused by a soil-borne pathogen affecting banana production. The goal of this study was to evaluate the capability of a novel bio-organic fertilizer (BIO2) that integrated the biocontrol agent Bacillus subtilis N11, and mature composts to control Fusarium wilt of banana in pot experiments. The results showed that the application of the BIO2 significantly decreased the incidence rate of Fusarium wilt compared to the control. To determine

the antagonistic mechanism of the strain, we also studied the colonization of the natural biocontrol agent on banana roots using a GFP marker. The studies were performed in a hydroponic culture system, a sand system and a natural soil system. The results indicated that the bacteria colonized predominantly by forming biofilms along the elongation and differentiation zones of the roots. The fact that similar observations were obtained in all three systems suggests that colonization by N11 can be studied in a defined system. The population of B. subtilis N11 in the rhizosphere and on banana roots was also monitored. We speculate that the colonization pattern of B.subtilis N11 can be linked to the mechanism of protection of plants from fungal infection.

Mia M. A. B., Z. H. Shamsuddin, Z. Wahab, and M. Marziah. 2010. Effect of plant growth promoting rhizobacterial (PGPR) inoculation on growth and nitrogen incorporation of tissue-cultured Musa plantlets under nitrogen-free hydroponics condition. Australian Journal of Crop Science, 4:85-90.
Reference ID: 21253
Notes: #21253e
Abstract: Banana requires large amounts of chemical fertilizers which are costly and can be hazardous to the environments when are used excessively. Biological N(2) fixation (BNF) technology can play a vital role as substitution to commercially available N-fertilizer in crop production and reduction of environmental problem to some extent. An experiment was conducted in the shade-house of University Putra Malaysia, Malaysia under hydroponics condition using nitrogen-free plant nutrient solution to evaluate the effect of PGPR (Plant Growth Promoting Rhizobacterial) inoculation on growth and N2 fixation of tissue-cultured banana plantlets under nitrogen (N) free hydroponics condition. The experiment was a completely randomized design with six replicates. There were three treatments viz. T(1): (control; N(0) -PGPR), T(2): (N(0) + Sp7) and T(3): (N(0) + UPMB10). One tissue-cultured banana plantlet (ex-laboratory, about 10-11 cm height of three-leafed stage) cv. 'Berangan' (Musa spp. dessert type) was planted per pot (4.0 L). The results indicated that a remarkable increase in root growth, namely length (33-44%), volume (76-168%) and mass (137-141%) were recorded due to the PGPR inoculation, beside a higher shoot growth (123-202%) and N yield (94-144%). The inoculated plants showed higher formation of root hair which was visible within 7 days of inoculation. The growth attributes namely, leaf area, chlorophyll content, and consequently the total biomass were also increased due to PGPR inoculation. The overall growth performance of inoculated seedlings was higher in compare to un-inoculated control. Thus, it might be concluded that PGPR strains Sp7 and UPMB10 could be used as crop-enhancer and bio-fertilizer for vigor seedling and production of bananas.

Mia M. A. B., Z. H. Shamsuddin, Z. Wahab, and M. Marziah. 2009. The effect of rhizobacterial inoculation on growth and nutrient accumulation of tissue-cultured banana plantlets under low N-fertilizer regime. African Journal of Biotechnology, 8:5855-5866.
Reference ID: 21254
Notes: #21254e
Abstract: Banana, an important fruit crop, requires high amounts of N-fertilizers for commercial cultivation. This, however, is costly and can be hazardous to the soil environment when used excessively. Biofertilizer is globally accepted as an alternative source of N-fertilizer and can substantially supplement the N requirement

while enhancing the uptake of water and mineral nutrients of crop plants. An experiment was conducted to observe the effect of plant growth promoting rhizobacterial inoculation on growth, nutrient uptake of bananas grown under hydroponics condition. The design of the experiment was randomized complete block with five replicates. The following six treatments were imposed: T(1) (control; N(0)-PGPR), T(2): (N(0)+Sp7), T(3): (N(0)+ UPMB10), T(4): (N(33%)+ Sp7), T(5): (N(33%) + UPMB10), and T(6): (N(100%)-PGPR). The results showed that inoculation by UPMB10 with minimal fertilizer-N supply increased ($P < 0.05$) the primary root elongation and secondary root initiation and subsequently increased ($P < 0.05$) the root biomass. The same treatment also increased ($P < 0.05$) N concentration in pseudostem and leaves and Ca concentration in roots. The total accumulation of N, P, K, Ca and Mg were increased due to inoculation; a consequence of increased plant growth. Plants with this treatment produced an equivalent total dry matter as those supplied with 100% N.

Nomura E. S., J. D. Lima, V. A. Garcia, and D. S. Rodrigues. 2008. Growth of micropropagated cavendish banana seedlings in different substrates and fertilizer sources: Crescimento de mudas micropropagadas da bananeira cv. Nanicão, em diferentes substratos e fontes de fertilizante. Acta Scientiarum-Agronomy, 30:359-363.
Reference ID: 21255
Notes: #21255e
Abstract: With the objective of evaluating the effect of different substrates combined with fertilizers in the growth of micropropagated seedlings of Cavendish banana (Musa spp. AAA), ail experiment was conducted in a randomized block design, in a 5 x 3 factorial scheme, with four repetitions. The substrates used were: S1 - subsoil land + carbonized rice hull + Rendmax Floreira (R); S2 - subsoil land + carbonized rice hull + Organifol (R); S3 - subsoil land + carbonized rice hull + Organifol (R) 9% SiO; S4 - Technes Vivatto (R); S5 - thick sand + carbonized rice hull + Rendmax Floreira (R). The fertilizer sources were: SA - without fertilizer; LL - slow-release fertilizer - Osmocote (R) 3M 14-14-14 (5.0 kg m(-3)) inixed in the substrate; and LN - normal-release fertilizer, 14-14-14 (7.5 g seedling(-1)) applied in covering. The height, collar diameter, leaf number, leaf area and dry matter were determined. Based on the differences of growth, substrates S 1, S2, S3 and S4 can be used with fertilizer 14-14-14, with slow (5.0 kg m(-3)) or normal (7.5 g seedling(-1)) release of nutrients.

Sansoulet J., Y. M. Cabidoche, and P. Cattan. 2007. Adsorption and transport of nitrate and potassium in an Andosol under banana (Guadeloupe, French West Indies). European Journal of Soil Science, 58:478-489.
Reference ID: 21256
Notes: #21256e
Abstract: A series of batch, soil column and field experiments was carried out in order to study nitrate and potassium transport and to improve fertilizer practices in an Andosol under a banana plantation. The focus of the study was on the influence of the substantial variable charge of the soil on ion transport. Leaching of both K+ and NO3--N through the Andosol were both retarded, as expected, because of the soil's cation and anion exchange capacities (CEC and AEC). Under acidic conditions, the B horizon, with the greater allophane content, developed preferential affinity for nitrate. The A horizon, with both organic and mineral adsorption sites, exhibited a stronger affinity for potassium than the B horizon when the soil solution pH was

below the zero point of charge (ZPC). Fast leaching of nutrients occurred under the banana stem due to the abundant stemflow derived from rainfall interception by the banana plant. Intensive leaching under the plant questions the concept of fertilizer application at the plant stem.

Cavalcante A. T., E. V. S. B. Sampaio, and U. M. T. Cavalcante. 2005. Interdependence between mother and daughter banana plants in their absorption and redistribution of phosphorus: Interdependência na absorção e redistribuição de fósforo entre planta mãe e filha de bananeira. Revista Brasileira De Fruticultura, 27:255-259.
Reference ID: 21257
Notes: #21257e
Abstract: Although knowledge of the interdependence between banana mother and daughter plants is important to establish adequate management practices, the subject has been little studied in Brazil. An experiment was set up to measure 32P redistribution between mother and daughter plants, grown for 2, 4 and 6 months, with and without P fertilization, applying 32P in the soil. Masses increased until the last harvest, being higher in mothers (1450 g) than in daughters (900 g), without fertilizer effect. Rhizomes had the highest plant biomasses (53-68%) and corm the lowest ones (2-4%), while the opposite occurred with P rates (0.14-0.26 e 0.33-0.54%). At all harvests, there were redistribution between mothers and daughters, and vice versa, but while mothers retained most of their P, although declining with time (95 to 78%); daughters divided their P equally with their mothers, except at the last harvest when they retained more (60%). More 32P was translated to rhizomes and pseudo stems and less to corms, with leaves and roots at intermediate positions. However, 32P concentrations per mass or total P units were higher in the corms. Therefore, mothers and daughters remained interdependent, with ample distribution of the absorbed 32P, although with preference for the corms.

Zake J., S. A. Pietsch, J. K. Friedel, and S. Zechmeister-Boltenstern. 2015. Can agroforestry improve soil fertility and carbon storage in smallholder banana farming systems? Journal of Plant Nutrition and Soil Science, 178:237-249.
Reference ID: 21258
Notes: #21258e
Abstract: Soil fertility depletion is a major constraint to agricultural production for smallholder farming households in many sub-Saharan countries, and it is worsened by climate variability. In order to sustain food security for a growing population, measures have to be taken against C and nutrient losses from soils. This study examines whether banana-coffee agroforestry systems can improve soil fertility and C pools in smallholder farms in E Africa amidst observed climate variability. We selected 20 farms in Central Uganda, where soil samples were obtained from the top and subsoil layers. Samples were analyzed for several soil fertility parameters including soil organic matter (SOM), total soil organic C, pH, total N, plant-available P, exchangeable K, texture, and bulk density. Soil C stocks were calculated based on soil organic C concentrations and bulky density. We measured tree diameter and height and calculated aboveground plant biomass using allometric equations. Belowground biomass was estimated using equations based on the respective aboveground plant biomass. Our results show that banana-coffee agroforestry farming systems had significantly higher total SOM and total N compared to the banana monoculture. Similar trends were observed for soil C stocks and total C pools. The former contained 1.5 times higher soil C stocks than the latter. Likewise,

the mean total C pools for the banana-coffee agroforestry farm plots were 26% larger than that under banana monoculture. However, exchangeable K was higher in the soil of banana monocultures. Plant-available P levels were limiting under both farming systems. The study demonstrates that beyond socio-economic benefits banana-coffee agroforestry farming systems have beneficial effects on soil fertility and C sequestration compared to banana monocultures in the study area. However, precautions to avoid P depletion have to be taken under current climate conditions.

Machovina B. and K. J. Feeley. 2013. Climate change driven shifts in the extent and location of areas suitable for export banana production. Ecological Economics, 95:83-95.
Reference ID: 21259
Notes: #21259e
Abstract: Species distribution modeling (SDM) is used to map areas predicted to be suitable for commercial banana production in Central and northwestern South America. Using the downscaled climate projections for 2060 from seven leading global climate models we then predict the geographical shifts in areas suitable for banana production. We repeat this process for conventional and organic banana production. Approximately half of the existing conventional plantations included in the analysis are located in areas predicted to become unsuitable for banana production by 2060. The overall extent of areas suitable for conventional banana cultivation is predicted to decrease by 19%, but all countries are predicted to maintain some suitable areas. The extent of areas suitable for organic banana cultivation is predicted to nearly double due primarily to climatic drying. Several countries (e.g.. Colombia and Honduras) are predicted to experience large net decreases in the extent of areas suitable for banana cultivation. Some countries (e.g.. Mexico) are predicted to experience large net increases in the extent of suitable areas. The shifts in the location of areas that will be suitable for banana cultivation are predicted to occur mainly within areas outside of protected areas and that are already under agricultural production.

Gondim R. S., M. A. H. de Castro, A. D. Teixeira, and S. R. D. Evangelista. 2011. Impact of climate change on irrigation requirement of banana in Jaguaribe river Basin, Ceara, Brazil: Impactos das mudanças climáticas na demanda de irrigação da bananeira na Bacia do Jaguaribe. Revista Brasileira De Engenharia Agricola e Ambiental, 15:594-600.
Reference ID: 21260
Notes: #21260e
Abstract: Climate change has a potential to impact hydrologic cycle processes, such as rainfall, which affect runoff, temperature and air humidity that have relationship to evaporation over water bodies and plant evapotranspiration. The purpose of this study was to assess impacts of climate change on irrigation water demand of banana, at the river basin level.

Ghini R., W. Bettiol, and E. Hamada. 2011. Diseases in tropical and plantation crops as affected by climate changes: current knowledge and perspectives. Plant Pathology, 60:122-132.
Reference ID: 21261
Notes: #21261e
Abstract: Tropical and plantation crops include important crops for food security and alternative energy resources. Even so, there are few studies on the impact of climate

change on diseases of these crops. Findings from previous studies concerning some climate-change effects on diseases of coffee, sugarcane, eucalyptus, cassava, citrus, banana, pineapple, cashew, coconut and papaya have been summarized to provide a context. By reviewing available methods to evaluate the impact of climate change on diseases of tropical and plantation crops, we present trends for some diseases and their management strategies, identify critical gaps in knowledge, and suggest experimental and analytical approaches to advance knowledge. As the projected climate conditions will probably vary greatly in the future from continent to continent and from developed to developing countries, studies must be conducted under tropical regions considering their specific environmental conditions. Multifactor studies under realistic field situations, such as free air CO2 enrichment with increasing CO2 and O-3 concentrations incorporating spectral reflectance measures in situ for realistic assessment of plant growth, are a way forward. Effects of a changing climate on chemical and biological controls are discussed in the context of changing global outlook on environmental demands for the future.

Raymundo A. D. and I. B. Pangga. 2011. Simulation Modeling of Bunchy Top Epidemics in a Changing Climate. Journal of Environmental Science and Management, 14:13-20.
Reference ID: 21262
Notes: #21262e
Abstract: Epidemics of bunchy top, the most destructive viral disease of abaca and banana in the Philippines, were modeled using STELLA version 9.1, a modeling software appropriate for systems analysis of biological populations. A previously developed coupled model of the population dynamics of the insect vector Pentalonia nigronervosa and epidemic progress of the bunchy top disease was improved and modified by incorporating the effects of temperature. Both insect vector and bunchy top epidemic submodels followed the H-L-S-R (healthy (H) - latent (L) - infectious (S) removed (R)) epidemic modeling approach where the diseased plants or insect population was partitioned into nonoverlapping compartments or states. The modified model satisfactorily simulated P nigronervosa population dynamics and bunchy top epidemics. The effect of climate change on bunchy top epidemics was simulated through the addition of 1 and 2 degrees C to the average monthly temperature from 1998-2007 in Davao City; Philippines. The increase in monthly average temperatures of 1 and 2 degrees C reduced the simulated bunchy top epidemics as the rates of increase in the number of viruliferous aphids and disease incidence were reduced, and epidemic onset was delayed.

Li N., Z. Huo, N. He, J. Xiao, and Q. Wen. 2010. Climatic risk zoning for banana and litchi's chilling injury in South China. The Journal of Applied Ecology, 21:1244-1251.
Reference ID: 21263
Notes: #21263e
Abstract: Based on the 1951-2006 climatic observation data from 224 meteorological stations in South China (Guangdong Province, Guangxi Autonomous Region, and Fujian Province) and the historical information about the chilling injury losses of banana and litchi, the accumulated harmful chilling for the processes with minimum daily temperature < or = 5.0 degrees C and more than 3 days was used to indicate the climatic risk of chilling injury during the whole growth season, and an integrated climatic index with the background of climate change was constructed. The maps of geographical distribution of climatic risk probability for each grade chilling injury, and of integrated climatic risk zoning for banana and litchi's chilling injury were drawn,

and the spatial variation of climatic risk for banana and litchi's chilling injury was commented. The results indicated that in the study area, climate warming might lead to the decrease of cold resistance of banana and litchi, which could increase the disaster risk of chilling injury. The geographical distribution of climatic risk probability for banana and litchi's chilling injury showed a zonal pattern. According to the integrated climatic risk index, the banana and litchi's chilling injury region was divided into three risk types, i.e., high risk, moderate risk, and low risk, which provided an important basis for the adjustment of agricultural production structure.

de Jesus W. C., R. Valadares, R. A. Cecilio, W. B. Moraes, F. X. R. do Vale, F. R. Alves, and P. A. Paul. 2008. Worldwide Geographical Distribution of Black Sigatoka for Banana: Predictions Based on Climate Change Models. Scientia Agricola, 65:40-53.
Reference ID: 21264
Notes: #21264e
Abstract: Global climatic changes will potentially influence plant diseases and the efficacy of their management options. One of the most likely impacts of climate change will be felt by the geographical distribution of plant diseases. Black Sigatoka is considered the most damaging and costly disease of banana. The socio-economic impact of this disease has continued to increase as the pathogen reaches new areas and the disease becomes more difficult to be controled. The objectives of this research were to compare the global geographical distribution of the disease based on maps elaborated using weather data representing: i) current and future periods (2020, 2050 and 2080), ii) Intergovernmental Panel on Climate Change scenarios A2 and B2, iii) predictions based on six different climate change models and the "multimodel ensemble" and, iv) individual months. The "multimodel ensemble" lead to a reduction in the variability of the simulations when compared to the results obtained using the individual models separately. The predictions suggested that, in the future, areas favorable for the development of the Black Sigatoka disease will decrease. This reduction will occur gradually and will be higher for the A2 than for the B2 scenario. Changes in the geographical distribution of the disease will occur from one month to another, with unfavorable areas becoming favorable and vice-versa. However, in spite of these changes, extensive areas will still continue to be favorable for the occurrence of Black Sigatoka.

Thomson J. A. 2015. Prospects for the utilization of genetically modified crops in Africa. Canadian Journal of Plant Pathology, 37:152-159.
Reference ID: 21265
Notes: #21265e
Abstract: Plant diseases not found in many other parts of the world can be found in Africa. These diseases severely hinder crop production, potentially resulting in a lack of food security. Many of the disease problems are amenable to both classical and modern breeding solutions. However, some are challenging diseases that require the use of genetic modification. This paper discusses some of the diseases whereby genetically modified crops (GMO) can provide a solution. They include maize resistant to the endemic African Maize streak virus, cassava resistant to Cassava mosaic virus, and bananas resistant to bacterial wilt. In addition, other traits of value to farmers in Africa may include maize resistant to insects, post-harvest fungi and to weeds, drought-tolerant maize and vitamin-enriched crops. Consideration is given to some of the concerns preventing governments from approving the commercialization of these crops, including food and safety issues.

Tripathi, L., Babirye, A., Roderick, H., Tripathi, J. N., Changa, C., Urwin, P. E., Tushemereirwe, W. K., Coyne, D., and Atkinson, H. J. Field resistance of transgenic plantain to nematodes has potential for future African food security. Scientific Reports 5, 1-10. 2015.
Reference ID: 21266
Notes: #21266e
Abstract: Plant parasitic nematodes impose losses of up to 70% on plantains and cooking bananas in Africa. Application of nematicides is inappropriate and resistant cultivars are unavailable. Where grown, demand for plantain is more than for other staple crops. Confined field testing demonstrated that transgenic expression of a biosafe, anti-feedant cysteine proteinase inhibitor and an anti-root invasion, non-lethal synthetic peptide confers resistance to plantain against the key nematode pests Radopholus similis and Helicotylenchus multicinctus. The best peptide transgenic line showed improved agronomic performance relative to non-transgenic controls and provided about 99% nematode resistance at harvest of the mother crop. Its yield was about 186% in comparison with the nematode challenged control non-transgenic plants based on larger bunches and diminished plant toppling in storms, due to less root damage. This is strong evidence for utilizing this resistance to support the future food security of 70 million, mainly poor Africans that depend upon plantain as a staple food.

Kabunga N. S., T. Dubois, and M. Qaim. 2014. Impact of tissue culture banana technology on farm household income and food security in Kenya. Food Policy, 45:25-34.
Reference ID: 21267
Notes: #21267e
Abstract: While tissue culture (TC) technology for vegetative plant propagation is gradually gaining in importance in Africa, rigorous assessment of broader welfare effects for adopting smallholder farm households is lacking. Using survey data and accounting for selection bias in technology adoption, we analyze the impact of TC banana technology on household income and food security in Kenya. To assess food security outcomes, we employ the Household Food Insecurity Access Scale (HFIAS) - a tool that has not been used for impact assessment before. Estimates of treatment-effects models show that TC banana adoption, combined with improved crop management, causes considerable increases in farm and household income. Technology adoption also reduces relative food insecurity in a significant way. These results indicate that TC technology can be welfare enhancing for adopting farm households. Adoption should be further promoted through upscaling appropriate technology delivery systems.

Munyuli M. B. T., P. Nyeko, S. Potts, P. Atkinson, D. Pomeroy, and J. Vickery. 2013. Patterns of bee diversity in mosaic agricultural landscapes of central Uganda: implication of pollination services conservation for food security. Journal of Insect Conservation, 17:79-93.
Reference ID: 21268
Notes: #21268e
Abstract: Little is known about bee communities and pollination services conservation strategies in sub-Sahara Africa. A study was conducted at 26 different sites with varying local landscape characteristics in farmlands of central Uganda in 2006. Bees were sampled using coloured pantraps, handnet and line transect counts. Overall 80,883 bee individuals from 6 families and 652 species were

encountered. The bee fauna was characterized by a lower diversity of Melittidae and Andrenidae and a high diversity of Apidae, Megachilidae and Halictidae. Megachile and Lasioglossum were the two most species-rich genera. The most abundant species was Apis mellifera adansonii Linnaeus (23 % of total individuals) followed by Hypotrigona gribodoi Magretti (19 %), Meliponula ferruginea Lepeletier (13 %), Lasioglossum ugandicum Cockerell (7 %), Apis mellifera scutellata Latreille (6 %), Allodapula acutigera Cockerell (6 %), Ceratina rufigastra Cockerell (5 %), Ceratina tanganyicensis Strand (5 %), Braunsapis angolensis Cockerell (5 %), Megachile rufipes Fabricius (5 %), Meliponula bocandei Spinola (5 %) and Seladonia jucundus Smith (5 %). The mean number of species recorded per study site per day ranged between 14 and 49, whereas the abundance ranged between 188 and 1,859 individuals. Study sites in areas with intense land-use had species-poor bee communities compared to sites with medium to low land-use intensities. Study sites with riparian forest fragments and wetlands, or with forest fallows in their vicinity had significantly ($P < 0.05$) higher species richness and diversity than sites dominated by small-scale monoculture/polyculture fields or sites dominated by either simple or complex traditional agroforestry systems. An ordination analysis also revealed that bee communities were significantly ($P < 0.01$) influenced by the presence of semi-natural habitats (woodlands, fallows) and forest fragments in the surrounding of fields. Thus, natural and semi-natural habitats are of great value for afrotropical farmland bee communities. There is a need to put in place strategies and policies for semi-natural and forest fragments preservation for spatio-temporal stability of pollination services in rural landscapes. Farmers are recommended to increase on-farm trees cover to safeguard and enhance pollination function and services in fields. Mimicking natural vegetation through promoting establishment of forest plantations and village community forestry in rural landscapes is also critical for conserving pollination services.

Fedepalma and Cenipalma. 2015. Palma De Aceite: 18th International Oil Palm Conference 2015: Cartagena de Indias, Colombia 22-25 September 2015. Pages 1-201 Colombia.
Reference ID: 21269
Notes: S 8.1.1 #21269

Fischer E. and M. Qaim. 2012. Gender, agricultural commercialization, and collective action in Kenya. Food Security, 4:441-453.
Reference ID: 21270
Notes: #21270e
Abstract: With the commercialization of agriculture, women are increasingly disadvantaged because of persistent gender disparities in access to productive resources. Farmer collective action that intends to improve smallholder access to markets and technology could potentially accelerate this trend. Here, we use survey data of small-scale banana producers in Kenya to investigate the gender implications of recently established farmer groups. Traditionally, banana has been a women's crop in Kenya. Our results confirm that the groups contribute to increasing male control over banana. We also analyze nutritional implications. While male control over banana revenues does not affect household calorie consumption, it has a negative marginal effect on dietary quality. We demonstrate that the negative gender implications of farmer groups can be avoided when women are group members themselves. In the poorest income segments, group membership even seems to

have a positive effect on female-controlled income share. Some policy implications towards gender mainstreaming of farmer collective action are discussed.

Temple L., M. Kwa, J. Tetang, and A. Bikoi. 2011. Organizational determinant of technological innovation in food agriculture and impacts on sustainable development. Agronomy For Sustainable Development, 31:745-755.
Reference ID: 21271
Notes: #21271e
Abstract: The food security challenges faced by populations in sub-Saharan Africa and the fact that extensive production systems are reaching their limits in the food-producing agricultural chain have increased the need to accelerate technological innovation toward the ecological intensification of agricultural production systems. Here, a review of the research conducted on plantain bananas (Musa paradisiaca) in Cameroon since 1988 revealed how institutional innovation has enabled the hybridization of different research forms-such as fundamental, systems, and action research-and reinforced the organizational innovation required for technical change. We found that impact evaluation underlined the complementarity between the increases in productivity and income in rural areas, as well as the production of human and social capital and the protection of forest resources.

Lassois L., J. P. Busogoro, and H. Jijakli. 2009. Banana: from origin to market. Biotechnologie Agronomie Societe Et Environnement, 13:575-586.
Reference ID: 21272
Notes: #21272e
Abstract: Banana: from origin to market. Cultivated bananas are giant herbaceous plants within the genus Musa. They are both sterile and parthenocarpic. There are well over a thousand domesticated Musa cultivars, they are mostly triploid (a few are diploid or tetraploid) and are derived from crosses between two wild species, Musa acuminata and Musa balbisiana. In terms of production, bananas are the fourth agricultural product after rice, wheat, and maize. They constitute the basis of food security for many people. Cropping systems vary widely around the world and contrasting objectives are encountered: consumption by the producer, sale on local or national markets, export, etc. Cooking bananas, including plantains, must be distinguished from dessert bananas, which constitute a major international trade. This international trade started only in the early 1900s but it has since grown continuously. Banana is currently the most exported fruit, in terms of both value and quantity. Despite the high genetic diversity found within the genus Musa, the export market is mainly based on single Cavendish. There are major challenges to banana production from biotic or abiotic stresses to continue to meet the criteria of sustainability, quality and yield that are imposed.

Gold C. S., A. Kiggundu, A. M. K. Abera, and D. Karamura. 2002. Diversity, distribution and farmer preference of Musa cultivars in Uganda. Experimental Agriculture, 38:39-50.
Reference ID: 21273
Notes: #21273e
Abstract: The East African highlands, home to more than 80 cultivated varieties of locally evolved bananas, constitute a secondary centre of banana diversity. Uganda is the leading producer and consumer of banana in the region and also enjoys the highest diversity of a group of bananas uniquely adapted to this region. These East African highland bananas comprise cooking and brewing types. The former is a

staple for more than 7 million people and thus important for food security. Little is known about the distribution of the vast germplasm and this stud), was set up to help determine a distribution pattern and to understand the dynamics of cultivar change using farmers participatory appraisal methods. The study involved a guided interview with 120 farmers, at 24 sites throughout the banana-growing region of Uganda, to reveal cultivar diversity, proportions, distribution and preferences. Cultivar diversity ranged from 18 to 34 (mean = 26) cultivars per site, and from 4 to 22 (mean = 12.3), cultivars per individual farm. Such high diversity was attributed to a variety of end uses, better food security and the perception that each cultivar had a unique range of strengths and weaknesses. Highland banana (AAA-EA) represented 76% of total production while Kayinja ('Pisang Awak' subgroup) (ABB) contributed 8%; Ndiizi ('Ney Poovan' subgroup) (AB) 7%; Kisubi ('Ney Poovan' subgroup) (AB) 5%; Gros Michel ('Bogoya') (AAA) 2%; and plantain (AAB) 2%. Although 130 highland cultivars were recorded, only 10 constituted 50% of highland banana production while 45 cultivars were found at only I or 2 sites. A few cultivars showed more universal distribution and it is proposed that these may be the oldest and best performing local landraces.

Lipoeto N. I., Z. Agus, F. Oenzil, M. Masrul, N. Wattanapenpaiboon, and M. L. Wahlqvist. 2001. Contemporary Minangkabau food culture in West Sumatra, Indonesia. Asia Pacific Journal of Clinical Nutrition, 10:10-16.
Reference ID: 21274
Notes: #21274e
Abstract: Diet has a strong relationship with food culture and changes in it are likely to be involved in the pathogenesis of newly emergent degenerative diseases. To obtain in-depth opinions about the food culture of Minangkabau people, focus group discussions were conducted in a Minangkabau region, represented by four villages in West Sumatra, Indonesia, from January to March 1999. The members of the discussion groups were principally women aged from 35 to 82 years old. Minangkabau culture is matriarchal and matrilineal which accounts for female gender dominants in the discussions. Rice, fish, coconut and chilli are the basic ingredients of the Minangkabau meals. Meat, especially beef and chicken, is mainly prepared for special occasions; pork is not halal and therefore not eaten by Muslim Minangkabau people; and for reasons of taste preference and availability, lamb, goat and wild game are rarely eaten. However, rendang, a popular meat dish, has been identified as one of the Minangkabau food culture characteristic dishes. Vegetables are consumed daily. Fruit is mainly seasonal, although certain kinds of fruit, such as banana, papaya and citrus, can be found all year around. Coconut has an important role in Minangkabau food culture and is the main source of dietary fat. While almost all food items consumed by the Minangkabau can be cooked with coconut milk, fried food with coconut oil is considered to be a daily basic food. Desiccated coconut is also used as a food ingredient on about a weekly basis and in snack foods almost every day. Although there have been no changes in food preparation and there is a slight difference in taste preference between the young and the old generations, there has been a dramatic shift in food preferences, which is reflected in the changing percentage of energy consumed over the past 15 years. The traditional combination of rice. fish and coconut in Minangkabau culture goes back hundreds of years, long before the emergence of the degenerative diseases of the newer economies, and is likely to offer food security and health protection to the Minangkabau for as long as the lifestyle remains traditional. Whether or not a recent increase in energy intake from fat and the quality of fat may contribute to the shift of

disease pattern is fundamentally important for the Minangkabau, it seems unlikely the traditional use of coconut and its products was a health issue. Moreover, it was clear from the focus group discussions that the use of coconut encouraged the consumption of fish and vegetables.

Rout G. R., S. Samantaray, and P. Das. 2000. Biotechnology of the banana: A review of recent progress. Plant Biology, 2:512-524.
Reference ID: 21275
Notes: #21275e
Abstract: A number of biotechnological tools have been developed which could help breeders to evolve new plant types to meet the demand of the food industry in the next century. Available techniques for the transfer of genes could significantly shorten the breeding procedures and overcome some of the agronomic and environmental problems which would otherwise not be possible through conventional methods. In vitro protocols have been standardized to allow commercially viable propagation of desired clones of Musa. An overview of the regeneration of banana by direct and indirect organogenesis, and somatic embryogenesis is presented in this article. In addition, the use of several other biotechnological techniques to enrich the genome of banana, such as selection of somaclonal variants, screening for various useful characteristics, cryopreservation, genetic transformation and molecular genetics are reviewed. In conclusion, the improvement of banana through modern biotechnology should help ensure food security by stabilizing production levels in sustainable cropping systems geared towards meeting domestic and export market demands.

Pijls L., A. Timmer, Z. Woldegebriel, and C. West. 1995. Cultivation, Preparation and Consumption of Ensete (Ensete Ventricosum) in Ethiopia. Journal of the Science of Food and Agriculture, 67:1-11.
Reference ID: 21276
Notes: #21276e
Abstract: In Ethiopia almost 10 million people are dependent on ensete (Ensete ventricosum (Welw) Cheesman), also known as 'false banana'. In the Gurage area in Central Ethiopia, agronomic and nutritional aspects of ensete were studied in 60 households in six villages. Ensete is propagated vegetatively and has a 6-year growing cycle during which it is transplanted three or four times. Men harvest the plants; women scrape the pseudo stem in order to separate the starchy pulp from the fibre, and pulverise the corm. The pulp is fermented and stored for up to 5-7 years in earthen pits. The yield of ensete food (ko'cho) was found to be 34 kg per plant or 9.5 tons ha(-1) per year. Compared with other foods grown in Ethiopia, the energy yield of ensete (6.1 MJ m(-2) per year) was higher than that of all cereals, Irish potato, sweet potato and banana, but lower than that of cassava. The protein yield of ensete was higher (11.4 g m(-2) per year) than all of the crops mentioned above, except for banana and Irish potato. To make ensete bread, fermented pulp is squeezed to make it drier, chopped to shorten the fibres and a 2 cm layer is baked for 15 min. Unfermented freshly harvested corm is also eaten after boiling. All foods have a low protein content (4-22 g kg(-1)). Bu'lla, white desiccated juice collected from the pulp, is more energy rich (8.5 MJ kg(-1)) than ko'cho (6.5 MJ kg(-1)). A dietary survey, conducted in 39 households comprising 237 persons, showed that the average daily intake of 0.55 kg ensete provided 68% of total energy intake, 20% of protein, 28% of iron but no vitamin A. Energy intake from all food consumed was very low, being only 60% of requirements, while protein intake at 107% was ample.

Since ensete can be stored for years, is readily available throughout the year and can withstand dry periods, its cultivation can significantly improve household food security in highland areas prone to drought and famine.

Moradi A., C. T. B. Sung, K. J. Goh, A. H. M. Hanif, and C. F. Ishak. 2015. Effect of four soil and water conservation practices on soil physical processes in a non-terraced oil palm plantation. Soil & Tillage Research, 145:62-71.
Reference ID: 21277
Notes: #21277e
Abstract: Mulching materials from oil palm residues such as pruned palm fronds (OPF), empty fruit bunches (EFB), and Eco-mat (ECO; a compressed EFB mat) are often the recommended soil and water conservation practices (CP) for oil palm plantations on hill slopes. Another recommended CP is the construction of silt pits or trenches (SIL) across the hill slope to capture runoff and then return the water and nutrients into the surrounding soil. Although these four CP are recommended practices, their relative effects on improving soil physical properties and on increasing the soil water content have never been compared with one another. Consequently, the objective of this study was to fill in this knowledge gap. A three-year field experiment was conducted in a non-terraced oil palm plantation, and soil samples from 0 to 0.15, 0.15 to 0.30, and 0.30 to 0.45 m depths were collected every three months and analyzed for their soil physical properties. Soil water content up to 0.75 m depth was also measured daily. EFB released the highest amount of organic matter and nutrients into the soil compared to OPF, ECO, and SIL. Hence, EFB was most effective to increase soil aggregation, aggregate stability, soil water retention at field capacity, available soil water content, and the relative proportion of soil mesopores. Due to these improved soil physical properties, EFB also gave the highest soil water content. Unlike ECO that concentrated more water in the upper soil layers, EFB distributed the soil water more uniformly throughout the whole soil profile, but SIL concentrated more soil water in the lower soil layers (>0.30 m) because the water levels in the pits were often below 0.30 m from the soil surface. The large opening area of the silt pits could have also caused large evaporative water losses from the pits. EFB mulching is recommended as the best CP, particularly for oil palm plantations on hill slopes.

Lee C. T., Z. A. Rahman, M. M. Hanafi, C. F. Ishak, M. S. Norizan, C. C. Tan, and M. S. M. Yusof. 2014. Rachis Nutrient Concentrations of Different Oil Palm Genotypes as Affected by Irrigation and Terrain. Journal of Oil Palm Research, 26:146-153.
Reference ID: 21278
Notes: #21278e
Abstract: Four clonal oil palm materials namely AVROS, Yangambi, La Me and NIFOR, and two DxP hybrid Yangambi have been planted on terraced and non-terraced contours that are subjected to irrigated and non-irrigated conditions. Under favourable growing environment, i.e., through irrigation, and to some extent favourable terrain of undulating plain, the palms were able to retain higher rachis nutrient concentrations, and subsequently had larger petiole cross-section and exhibited higher rachis nutrient contents. There were significant differences in all rachis nutrient concentrations for all of the planting materials for both terrain and irrigation conditions except for sulphur (S) nutrient. Previous study revealed that leaf potassium (K) concentration for DxP hybrid Yangambi-DQ8 was consistently lower than AVROS-A122 by almost 15%-20% in all the growing conditions. In contrast, the rachis nutrient concentrations for both materials were comparable. In fact, DxP

Yangambi-DQ8, retained higher rachis K content (by 22%) due to larger petiole cross-section (PCS) as compared to that of AVROS-A122. The poor yielding materials, appeared to contain lower nutrient concentrations particularly those of magnesium (Mg), chlorine (Cl) and calcium (Ca). The present fertiliser regime is able to sustain high yields and capable of producing more than 10.5 t ha(-1) yr(-1) of total economic product (TEP) without the need for additional fertiliser inputs. Therefore, the understanding of rachis nutrient behaviour on different oil palm genotypes is crucial to produce sustainable oil yield in the near future.

Maas B., T. Tscharntke, S. Saleh, S. S. Putra, and Y. Clough. 2015. Avian species identity drives predation success in tropical cacao agroforestry. Journal of Applied Ecology, 52:735-743.
Reference ID: 21279
Notes: #21279e
Abstract: Avian ecosystem services such as the suppression of pests are considered to be of high ecological and economic importance in a range of ecosystems, especially in tropical agroforestry. However, how bird predation success is related to the diversity and composition of the bird community, as well as local and landscape factors, is poorly understood. We quantified arthropod predation in relation to the identity and diversity of insectivorous birds using experimental exposure of artificial, caterpillar-like prey in 15 smallholder cacao agroforestry systems differing in local shade-tree management and distance to primary forest. The bird community was assessed using both mist-netting (targeting active understorey insectivores) and point counts (higher completeness of species inventories). Bird predation was not related to local shade-tree management or overall bird species diversity, but to the activity of insectivorous bird species and the proximity to primary forest. Insectivore activity was best predicted by mist-netting-based data, not by point counts. We identified the abundant Indonesian endemic lemon-bellied white-eye Zosterops chloris as the main driver of predation on artificial prey.Synthesis and applications. The suppression of arthropods is a major ecosystem service provided by insectivorous birds in agricultural systems world-wide, potentially reducing herbivore damage on plants and increasing yields. Our results show that avian predation success can be driven by single and abundant insectivorous species, rather than by overall bird species richness. Forest proximity was important for enhancing the density of this key species, but did also promote bird species richness. Hence, our findings are both of economical as well as ecological interest because the conservation of nearby forest remnants will likely benefit human needs and biodiversity conservation alike.
The suppression of arthropods is a major ecosystem service provided by insectivorous birds in agricultural systems world-wide, potentially reducing herbivore damage on plants and increasing yields. Our results show that avian predation success can be driven by single and abundant insectivorous species, rather than by overall bird species richness. Forest proximity was important for enhancing the density of this key species, but did also promote bird species richness. Hence, our findings are both of economical as well as ecological interest because the conservation of nearby forest remnants will likely benefit human needs and biodiversity conservation alike.

Waldron A., R. Justicia, and L. E. Smith. 2015. Making biodiversity-friendly cocoa pay: combining yield, certification, and REDD for shade management. Ecological Applications, 25:361-372.
Reference ID: 21280
Notes: #21280e
Abstract: The twin United Nations' Millennium Development Goals of biodiversity preservation and poverty reduction both strongly depend on actions in the tropics. In particular, traditional agroforestry could be critical to both biological conservation and human livelihoods in human-altered rainforest areas. However, traditional agroforestry is rapidly disappearing, because the system itself is economically precarious, and because the forest trees that shade traditional crops are now perceived to be overly detrimental to agricultural yield. Here, we show a case where the commonly used agroforestry shade metric, canopy cover, would indeed suggest complete removal of shade trees to maximize yield, with strongly negative biodiversity and climate implications. However, a yield over 50% higher was achievable if approximately 100 shade trees per hectare were planted in a spatially organized fashion, a win-win for biodiversity and the smallholder. The higher yield option was detected by optimizing simultaneously for canopy cover, and a second shade metric, neighboring tree density, which was designed to better capture the yield value of ecological services flowing from forest trees. Nevertheless, even a 50% yield increase may prove insufficient to stop farmers converting away from traditional agroforestry. To further increase agroforestry rents, we apply our results to the design of a sustainable certification (eco-labelling) scheme for cocoa-based products in a biodiversity hotspot, and consider their implications for the use of the United Nations REDD (reducing emissions from deforestation and forest degradation) program in agroforestry systems. Combining yield boost, certification, and REDD has the potential to incentivize eco-friendly agroforestry and lift smallholders out of poverty, simultaneously.

Diaz-Jose J., O. Diaz-Jose, S. Mora-Flores, R. Rendon-Medel, and R. Tellez-Delgado. 2014. Cacao in Mexico: Restrictive factors and productivity levels. Chilean Journal of Agricultural Research, 74:397-403.
Reference ID: 21281
Notes: #21281e
Abstract: Cacao (Theobroma cacao L.) represents one of the most important agricultural crops of the humid Mexican tropics. In the last 10 yr, approximately 23000 t of this grain were no longer produced per cycle. The objective of this study was to identify characteristics and factors that restrict production in the states of Tabasco and Chiapas. A survey was applied to obtain information about 184 producers and their plantations by two-stage sampling. Descriptive statistics were calculated and multilevel models were adjusted to analyze the information. Results show that there are differences ($P < 0.05$) in cacao yield between municipalities (380 kg ha(-1) + mu(oj) is the estimated residual for each municipality). Crop productivity levels are higher in the state of Tabasco than in Chiapas (644 and 344 kg ha(-1), respectively). Incidence of frosty pod rot of cacoa, also known as moniliasis, induced by Moniliophthora roreri [(Cif) H. C. Evans, Stalpers, Samson & Benny 1978] is significantly greater ($P < 0.05$) in the state of Chiapas (60%) than in Tabasco (48%). Producers who carry out more crop management practices increase yields and decrease the pathogen's impact on their plantations. Results suggest the need to apply differentiated public policies to promote production within each region or municipality.

Vaast P. and E. Somarriba. 2014. Trade-offs between crop intensification and ecosystem services: the role of agroforestry in cocoa cultivation. Agroforestry Systems, 88:947-956.
Reference ID: 21282
Notes: #21282e
Abstract: Research published in this special issue on cocoa agroforestry illustrates the multifunctional role of shade trees for sustaining cocoa production and improving farmers' livelihoods, and addresses trade-offs between higher cocoa yield and the provision of ecosystem services to local households and global society. Indeed, the use of diverse shade in cocoa cultivation is threatened by a new drive towards crop intensification. The removal of shade trees diminishes smallholders' ability to adapt to global change driven by demographic pressure, food insecurity, cocoa price volatility and climate change. Some forms of crop intensification may reduce ecological resilience of cocoa production systems, making adaptation strategies, combining shade trees with innovative management practices, essential for sustaining cocoa yield. Managing trade-offs between yield and environmental services at the cocoa plot and landscape scales requires a multi-disciplinary approach to identify key management options that goes beyond the artificially polarized debates around intensified versus traditional agroforestry practices, or more generally, land-sparing versus land-sharing strategies. The global challenge facing the cocoa sector today is how to increase cocoa production to meet growing demand, without expanding the area under cocoa. This means finding sustainable ways to maintain cocoa production within today's producing regions, particularly West Africa, through a series of technical innovations geared towards smallholders. Inappropriate intensification may result in heavy deforestation on new pioneer fronts, such as the Congo basin, and existing cocoa being replaced either by other agricultural commodities, or by less resilient and less environmentally friendly production practices.

Cerda R., O. Deheuvels, D. Calvache, L. Niehaus, Y. Saenz, J. Kent, S. Vilchez, A. Villota, C. Martinez, and E. Somarriba. 2014. Contribution of cocoa agroforestry systems to family income and domestic consumption: looking toward intensification.
groforestry Systems, 88:957-981.
Reference ID: 21283
Notes: #21283e
Abstract: While the potential of agroforestry products to contribute to rural livelihoods is well-recognized, the quantification of their yields, incomes, and value for domestic consumption (VDC) and knowledge about their relationships with biodiversity are still scarce. This information is crucial for choosing the best strategy for growing cocoa in tropical landscapes while conserving biodiversity and enhancing ecosystem services. We analyzed the contribution of cocoa agroforestry farming to the incomes and domestic consumption of small farmers' families in 179 cocoa agroforestry systems (CAFS) (254 ha) in five Central American countries. The two hypotheses were: (1) agroforestry products are as important as cocoa in contributing to livelihoods, (2) the typology of CAFS determines the relationships between socioeconomic indicators and yield, biodiversity, and structure of the shade canopy, as well as the relationships between plant species richness and cocoa yield. We quantified the yields of agroforestry products and their contribution to net income, cash flow, and family benefits and developed a typology of CAFS production to evaluate relationships for each CAFS cluster. The main agroforestry products other than cocoa were bananas, oranges, peach palm, other fruits, and timber, which

generated modest cash incomes but high VDC at low cash costs, thus contributing to family savings and food security. Timber volumes and harvest rates were low but significant increase was deemed feasible. The contribution of the set of agroforestry products to family benefits was similar or higher than cocoa, depending on the typology of the CAFS. Intensified highly diverse-dense CAFS demonstrated remarkably higher yields, net income, cash flow, and family benefits, and had more synergetic relationships than extensive CAFS and traditional highly diverse-dense CAFS, which showed more trade-offs. Our findings point to intensified highly diverse-dense CAFS as feasible for farming within a land-sparing strategy. Further research is needed to better understand the mechanisms that could regulate synergies or trade-offs to improve this type of intensification.

Gyau A., K. Smoot, C. Kouame, L. Diby, J. Kahia, and D. Ofori. 2014. Farmer attitudes and intentions towards trees in cocoa (Theobroma cacao L.) farms in Cote 'Ivoire. Agroforestry Systems, 88:1035-1045.
Reference ID: 21284
Notes: #21284e
Abstract: Cocoa yields in Cote d'Ivoire are low and falling each year, partly as a result of full-sun cropping systems. Thus, interest is now high in establishing sustainable cocoa agroforestry systems through the reintroduction of shade trees. This article uses data collected from a sample of 400 cocoa farmers in the Soubre region of Cote d'Ivoire to analyze farmers' current and intention to plant trees in their cocoa farms in the future and the motivation for their decision. Logit regressions are used to assess the various determinants of current tree planting behaviour and future adoption intention. Results show that both current and likelihood of deliberately planting trees with cocoa in the future is significantly affected by extension and certification programs, severity of diseases affecting cocoa, and geographic zone. Future intentions to associate trees with cocoa are further influenced by the age of the farmers, household size and the average age of the cocoa farm. To increase the adoption of tree planting in cocoa fields there is the need to intensify extension messages on the benefit of shade trees in cocoa farms especially in areas where adoption intention is still low. Where awareness is high, adoption can be increased through the supply of seedlings and provision of specific trainings on planting density and management techniques to ensure that agroforestry has the maximum positive effect.

Hidalgo O. T., A. J. Otiniano, R. B. Ventura, P. R. Quispe, and M. S. Mendez. 2014. Cocoa farm typology in the mid sub-basin of Huayabamba river in the Huicungo district- San Martín- Peru: Tipología de fincas cacaoteras en la subcuenca media del río Huayabamba, distrito de Huicungo (San Martín, Perú). Ecologia Aplicada, 13:71-78.
Reference ID: 21285
Notes: #21285e
Abstract: This research was carried out in order to typify cocoa farms located in the middle Huayabamba River basin, Huicungo district, San Martín, Peru. We worked with the ACOPAGRO Cocoa Agricultural Cooperative from which a sample (n = 77) was taken from a population of 332 farmers. A survey was conducted that took into account six components (family, natural resources, agricultural activity, economics, technology and social management). It was found out that cocoa farms are grouped into three types, significantly differentiated from each other. Group I was the major group (68% of the farmers). Farmers in this group also perform other farming

activities besides cocoa farming; they practice a conventional production system based on polyclonal plantations and have an average yield of 963.46 kg ha-1, which is higher than the regional and national average. Group II (13% of the farms) basically includes organic production farms having hybrid plantations associated with CCN51, with yields lower than the regional average but higher than the national average. Group III, includes monoclonal plantations planted only with CCN-51. The results suggest that if future projects of technological improvements or others are implemented, they should be specific for each one of the three groups found in this study area.

Jacobi J., M. Schneider, P. Bottazi, M. Pillco, P. Calizaya, and S. Rist. 2015. Agroecosystem resilience and farmers' perceptions of climate change impacts on cocoa farms in Alto Beni, Bolivia. Renewable Agriculture and Food Systems, 30:170-183.
Reference ID: 21286
Notes: #21286e
Abstract: Cocoa-based small-scale agriculture is the most important source of income for most farming families in the region of Alto Beni in the sub-humid foothills of the Andes. Cocoa is grown in cultivation systems of varying ecological complexity. The plantations are highly susceptible to climate change impacts. Local cocoa producers mention heat waves, droughts, floods and plant diseases as the main impacts affecting plants and working conditions, and they associate these impacts with global climate change. From a sustainable regional development point of view, cocoa farms need to become more resilient in order to cope with the climate change related effects that are putting cocoa-based livelihoods at risk. This study assesses agroecosystem resilience under three different cocoa cultivation systems (successional agroforestry, simple agroforestry and common practice monocultures). In a first step, farmers' perceptions of climate change impacts were assessed and eight indicators of agroecological resilience were derived in a transdisciplinary process (focus groups and workshop) based on farmers' and scientists' knowledge. These indicators (soil organic matter, depth of Ah horizon, soil bulk density, tree species diversity, crop varieties diversity, ant species diversity, cocoa yields and infestation of cocoa trees with Moniliophthora perniciosa) were then surveyed on 15 cocoa farms and compared for the three different cultivation systems. Parts of the socio-economic aspects of resilience were covered by evaluating the role of cocoa cooperatives and organic certification in transitioning to more resilient cocoa farms (interviews with 15 cocoa farmers combined with five expert interviews). Agroecosystem resilience was higher under the two agroforestry systems than under common practice monoculture, especially under successional agroforestry. Both agroforestry systems achieved higher cocoa yields than common practice monoculture due to agroforestry farmers' enhanced knowledge regarding cocoa cultivation. Knowledge sharing was promoted by local organizations facilitating organic certification. These organizations were thus found to enhance the social process of farmers' integration into cooperatives and their reorientation toward organic principles and diversified agroforestry.

de Caires S. A., M. N. Wuddivira, and I. Bekele. 2015. Spatial analysis for management zone delineation in a humid tropic cocoa plantation. Precision Agriculture, 16:129-147.
Reference ID: 21287
Notes: #21287e

Abstract: Identifying spatio-temporal patterns of key soil properties could ensure efficient management and input use in agricultural fields with possible increase in yields. A multi-variate geostatistical approach was used to characterize the spatio-temporal variability of the key soil variables to determine management zones in a cocoa field (5.81 ha). One hundred and twenty soil samples were collected. Additionally, a total of nine apparent electrical conductivity (ECa) sampling campaigns at shallow, ECas (0-0.75 m) and deep, ECad (0.75-1.5 m) were conducted with a DUALEM-1S EC meter at the International Cocoa GeneBank, Trinidad between 2009 and 2010. ECad and ECas gave the strongest linear correlation with clay-silt content (r = 0.67 and r = 0.78, respectively) and soil solution electrical conductivity (ECe), ECe (r = 0.76 and r = 0.60, respectively). Multiple linear regressions indicated that clay-silt content and ECe dominated the signal surface response of both ECad and ECas accounting for 66.7 and 63.2 % of ECa variability, respectively. Spearman's rank correlation coefficients (r(s)) ranged between 0.89 and 0.97 for ECad and 0.81 and 0.95 for ECas signifying strong temporal stability. Since ECas covers the depth where cocoa feeder roots concentrate, ECas of the wettest month surveyed (August 2009) was used as secondary data in cokriging to improve the spatial and temporal estimation of clay-silt content and ECe. Cokriged data was subjected to fuzzy cluster classification using the Management Zone Analyst software. Two was determined to be the optimum number of management zones. This zone delineation potentially facilitates cost-effective, environmentally friendly and energy efficient management of the field.

Gyau A., K. Smoot, L. Diby, and C. Kouame. 2015. Drivers of tree presence and densities: the case of cocoa agroforestry systems in the Soubre region of Republic of Cote d'Ivoire. Agroforestry Systems, 89:149-161.
Reference ID: 21288
Notes: #21288e
Abstract: Cocoa yields in Cte d'Ivoire are low and falling each year, in part as a result of full-sun cropping systems. Thus, interest is now high in establishing sustainable cocoa agroforests through the re-introduction of shade trees. This article uses data collected from a sample of 400 cocoa farmers in the Soubr, region of Cte d'Ivoire to rank the top alternative tree species of interest to farmers and to analyze the determinants of their presence and density in cocoa farms. Results show that the most significant determinants are: social network effects, ethnic group, and geographic zone. Also, poorer farmers and those in more isolated villages were more likely to associate their cocoa with crops popular for household consumption like oil palm. We thus suggest that future agroforestry programs should tailor the tree species promoted based on location, ethnic group, market access, and income level, and that extension programs should be designed to take advantage of networking effects.

Araujo J. B. S., M. C. Rodrigues, L. B. Rodrigues, R. H. S. Santos, and H. E. P. Martinez. 2013. Nitrogen fertilization of coffee: organic compost and Crotalaria juncea L.: Adubação nitrogenada de cafeeiros com composto e crotalária. Revista Ceres, 60:842-851.
Reference ID: 21289
Notes: #21289e
Abstract: Information concerning the response of coffee to organic fertilizers is scarce. This study evaluates the effect of different doses of compost and Crotalaria juncea L. on growth, production and nitrogen nutrition of coffee trees. The treatments

consisted of compost at rates of 25, 50, 75 and 100% of the recommended fertilization, with or without the aerial part of C. juncea. C. juncea was grown with NH4-N (2% 15N) and applied to coffee. The use of C. juncea increased growth in height and diameter of the coffee canopy. In the first year, the percentage of N derived from C. juncea reached 8.5% at seven months and 4.1% at fifteen months after fertilization. In the second year, the percentage of N derived from C. juncea reached 17.9% N at the early harvest, five months after fertilization. Increased rates of compost increased pH , P , K , Ca , Mg , sum of bases , effective CEC, base saturation and organic matter and reduced potential acidity. 15N allowed the identification of the N contribution from C. juncea with percentage of leaf N derived from Crotalaria juncea from 9.2 to 17.9%.

da Silva V. M., A. F. R. Teixeira, E. F. dos Reis, and E. D. Mendonca. 2013. Yield and nutritional status of the conilon coffee tree in organic fertilizer systems. Revista Ciencia Agronomica, 44:773-781.
Reference ID: 21290
Notes: #21290e
Abstract: The conilon coffee tree presents high yield potential, the replacement of soil nutrients usually being by the use of mineral fertilizers. To reduce these fertilizers, the use of organic waste may be an alternative. The objective of this study was to evaluate the effect of organic fertilizer systems on the nutritional status and yield of the conilon coffee tree. On a farm, located in the town of Linhares, Espirito Santo, during the agricultural year of 2009/2010, a trial was set up using a completely randomized block design with a factorial distribution of 2 x 2 x 5 and three replications, the factors being: organic compost (compost 1 and compost 2); legumes (the presence and absence of jack beans, sown between the rows of coffee trees); and the proportions of each compost (0; 25; 50; 75 and 100%) as a substitute for the recommended mineral fertilizer. The increase in the proportion of compost 2 was reflected as increases in the P content of the leaves due to the higher concentration of this nutrient in the compost. The increase in compost input increased the S content of the leaves as a response to the increase in soil pH. Maximum values of 61 and 66 sacks ha-1 were obtained with substitutions (mineral source by organic) in the proportion of 40 and 37% for compost 1 and compost 2 respectively. The use of organic-waste composts is an alternative as a partial replacement of mineral fertilizers in the conilon coffee tree, resulting in increases in yield.

Evangelista A. W. P., J. Alves, and P. C. de Melo. 2013. Response of coffee crop to irrigation levels and fertilization with Alfertil: Resposta do cafeeiro à aplicação de níveis de irrigação e adubação com Alfertil. Revista Brasileira De Engenharia Agricola e Ambiental, 17:392-396.
Reference ID: 21291
Notes: #21291e
Abstract: The objective of this study was to evaluate the effect of the irrigation and fertilization with Alfertil (R) on the yield of coffee crop. The statistical design used was in randomized blocks, with subdivided plots and four replications. The coffee plants received four irrigation levels: L-0 = 0 (not irrigated); L-40 = 40% Evaporation of Class A Pan (ECA); L-80 = 80% ECA; and L-120 = 120% ECA. Coffee plants were fertilized with: A(0) = 0 kg ha(-1) (no fertilizer); A(f) = Alfertil (R) applied by foliar application by a 5% solution; and A(s) = Alfertil (R) applied in the soil surface with 100 g plant(-1). The results show that the coffee productivity was influenced by

irrigation and Alfertil (R) fertilization. However, only the different irrigation levels influenced significantly the yield of coffee crop. Irrigation levels that maximized productivity and yield of the plant was estimated at 60.08 and 70.20% ECA, respectively, and the plants fertilized with Alfertil (R) either foliar or soil application enhanced the productivity of coffee crop.

Wairegi L. W. I. and P. J. A. van Asten. 2012. Norms for Multivariate Diagnosis of Nutrient Imbalance in Arabica and Robusta Coffee in the East African Highlands. Experimental Agriculture, 48:448-460.
Reference ID: 21292
Notes: #21292e
Abstract: Poor soil fertility is a constraint to coffee production. Targeting fertiliser recommendations to nutrient deficiencies can contribute to improved crop response to fertiliser. This study aimed to derive and compare the Compositional Nutrient Diagnosis (CND) and Diagnosis and Recommendation Integrated System (DRIS) norms for Arabica and Robusta, and to investigate nutrient interactions using data derived from 164 plots. The high-yield sub-populations of Arabica had significantly ($p < 0.01$) higher P (0.23 vs. 0.14) and K (2.87 vs. 2.04), and lower N (2.96 vs. 3.61), Ca (0.99 vs. 1.50) and Mg (0.40 vs. 0.23) than those of Robusta. With respect to the CND norms, Arabica had significantly ($p < 0.001$) higher P and K, and lower N, Ca and Mg means of row-centered log ratios than Robusta. The relationship between the CND and DRIS indices had coefficient of determination (R-2) = 0.75-0.99 for both coffee types. The relationship between nutrient imbalance indices for CND and DRIS had R-2 of 0.95 (Arabica) and 0.76 (Robusta). Both coffee types had negative N-Ca, P-Mg and K-Mg interactions. Arabica had positive N-Mg and K-Ca interactions and Robusta had positive N-K, P-K and Ca-Mg interactions and negative N-P, N-Mg, P-Ca and K-Ca interactions. The study concludes, there is a need for cultivar-specific norms, but such norms developed under one set of conditions may not be applicable under different conditions. The study also concludes that both CND and DRIS can be used to determine nutrient imbalances, and fertiliser requirements could be cultivar-specific.

Molin J. P., A. V. D. Motomiya, F. R. Frasson, G. D. Faulin, and W. Tosta. 2010. Test procedure for variable rate fertilizer on coffee. Acta Scientiarum-Agronomy, 32:569-575.
Reference ID: 21293
Notes: #21293e
Abstract: The objective was to develop and test a procedure for applying variable rates of fertilizers and evaluate yield response in coffee (Coffea arabica L.) with regard to the application of phosphorus and potassium. The work was conducted during the 2004 season in a 6.4 ha field located in central Sao Paulo state. Two treatments were applied with alternating strips of fixed and variable rates during the whole season: one following the fertilizing procedures recommended locally, and the other based on a grid soil sampling. A prototype pneumatic fertilizer applicator was used, carrying two conveyor belts, one for each row. Harvesting was done with a commercial harvester equipped with a customized volumetric yield monitor, separating the two treatments. Data were analyzed based on geostatistics, correlations and regressions. The procedure showed to be feasible and effective. The area that received fertilizer applications at a variable rate showed a 34% yield increase compared to the area that received a fixed rate. The variable rate fertilizer resulted in a savings of 23% in phosphate fertilizer and a 13% increase in potassium

fertilizer, when compared to fixed rate fertilizer. Yield in 2005, the year after the variable rate treatments, still presented residual effect from treatments carried out during the previous cycle.

Arizaleta M. and R. Pire. 2008. Coffee seedlings response to pot size and nitrogen and phosphorus fertilization at nursery condition. Agrociencia, 42:47-55.
Reference ID: 21294
Notes: #21294e
Abstract: The production of vigorous coffee plants at the nursery is the basis of their successful establishment in the field. The replacement of old plantations by the new high-yielding varieties requires a high production of good quality seedlings and good knowledge of the most appropriate size of the nursery bags. The response of seedlings of Coffea arabica L. 'Caturra' grown in bags with three sizes (13 x 15, 15 x 19 or 18 x 23 cm) under three doses of fertilization (2, 4 and 6 g plant(-1) of fertilizer with 10% N and 50% P2O5) was assessed in Duaca, Lara State, Venezuela. The local soil, characterized by its high organic matter content, good fertility and proper permeability, was utilized as substrate. A factorial arrangement of treatments was used in a randomized complete block design with four replications and 10 bags per plot. The highest root and shoot growth of the seedlings (root length, plant height and biomass dry) was obtained in the largest bags. The different doses of fertilization affected the nutritional status of the plant but not its growth, since the substrate apparently provided the necessary nutrients. It is concluded that the largest bags allow sustained growth of the seedlings during the six months in the nursery and that small doses of fertilizer may be sufficient to bring them to completion before their final establishment in the field.

Nazareno R. B., C. A. D. Oliveira, C. Sanzonowicz, J. B. R. Sampaio, J. C. P. da Silva, and A. F. Guerra. 2003. Initial growth of Rubi coffee plant in response to nitrogen, phosphorus and potassium and water regimes. Pesquisa Agropecuaria Brasileira, 38:903-910.
Reference ID: 21295
Notes: #21295e
Abstract: The objective of this work was to evaluate shoot growth of coffee trees (Coffea arabica L.) cultivar Rubi MG 1192 under three N, P and K doses and two water regimes during the first year after transplanting, starting on the 2011, November 2000. The growth was evaluated at 134, 196, 236, 284, 334 and 383 days after transplanting (DAT). Nitrogen and K affected the number of plagiotropic branches per plant. Nevertheless, only N affected the number of nodes with axillary buds. There was no growth response to N, P, and K in terms of the total shoot dry mass and leaf area index during the experimental period. Irrigated treatments presented the best plant growth results, provided more vigorous plants and anticipated the fast growth phase to July (236 DAT), but could not avoid growth rate decrease during the winter. The fast plant growth phase of non-irrigated plants occurred by the middle of October (334 DAT); in these treatments, the development of buds into fruits or secondary branches altered the dry matter distribution and reduced stem, branches and leaves growth.

de Freitas R. B., J. D. Alves, M. M. Magalhaes, P. D. P. Goulart, M. N. do Nascimento, and D. D. Fries. 2007. Coffee tree fertilization with potassium nitrate via leaf and soil, in autumn-winter and spring-summer: effects on nitrate reductase activity, on plant growth and production. Ciencia E Agrotecnologia, 31:945-952.
Reference ID: 21296
Notes: #21296e
Abstract: The objective of this work was to verify the effect of the fertilization of 100g N/year/plant, in three periods (autumn-winter, spring-summer and autumn-winter/spring-summer) and three types of application (leaf, soil and leaf/soil) on the development, production and nitrate reductase activity (NR) on four years old Rubi-MG cultivar. The analysis of type and time of application showed no alteration on NR activity being higher on roots in cold weather and higher on leaves in warmer weather. The same was observed with growth pattern, fast in hot/rain season and slow in dry/cold period. During autumn-winter, applications may be performed on leaf or leaf-soil. These types of fertilization were the most efficient during growth recovering. When the fertilization occurred in both periods, any type may be used. Although, several pulverizations are nonviable, one or more pulverization with KNO3 can efficiently replace soil fertilization.

de Oliveira R. B., J. S. D. Lima, A. C. Xavier, R. R. Passos, S. D. Silva, and A. F. da Silva. 2008. Comparison Between Soil Sampling Methods for Conilon Coffee Liming and Fertilization Recommendation. Engenharia Agricola, 28:176-186.
Reference ID: 21297
Notes: #21297e
Abstract: This study aimed to evaluate the soil sampling conventional methodology with spatial analysis for liming and fertilization with nitrogen, phosphorus and potassium on soil cultivated with conilon coffee. The trial was carried out during the 2004/2005-2005/2006 harvests in a 1.0 ha area with samples collected at 0-0.20 m depth. Fifteen sub samples in zigzag were collected for the conventional method forming a compound sample; as for the spatial method, 109 georeferenced points formed a sample grid. After the analysis results, the liming and fertilization needs were calculated based on the function of the element content in the soil and on the plant expected yield. Data were analyzed by both the classical statistics (descriptive and exploratory) and spatial analysis, using geostatistics techniques (modeling of the spatial variability structure and inferences) and geoprocessing (map algebra). Except for phosphorus in 2005 and potassium in 2006, every other recommendation showed spatial dependence. Data analysis by the spatial method provided the identification of zones with deficient or excessive liming and fertilization which could not be defined by the conventional sampling method (zigzag).

Neves Y. P., H. E. P. Martinez, C. M. de Souza, and P. R. Cecon. 2007. Soil moisture and soil fertility of coffee in agroforestry systems: Teor de água e fertilidade do solo com cafeeiros cultivados em sistemas agroflorestais. Revista Arvore, 31:575-588.
Reference ID: 21298
Notes: #21298e
Abstract: The aim of this study was to compare the soil moisture and fertility in coffee systems intercropped with trees with low levels of fertilization and in conventional system; the following systems were tested: coffee (Coffea arabica L.) under full light; coffee with Senna macranthera; coffee with Senna macranthera and Musa sp.; coffee with Senna macranthera, Musa sp. and Zeyhera tuberculosa. The last three

systems were evaluated with the same density of intercropped plants and all treatments with the same number of coffee plants. The trial was conducted during a 57-month period. A favorable balance for water conservation in the soil was obtained in the intercropped system at the beginning of the dry season. However, the maintenance of this balance will depend on the water demand of the components of the intercropped system and the dry season duration. The intercropped system favored pH stability and reduction in aluminum saturation, nevertheless the nutrient requirement of the components of the intercropped system should be supplied by means of external inputs, to avoid soil impoverishment.

de Lima Dias K. G., A. E. F. Neto, P. T. G. Guimarães, T. H. P. Reis, and C. H. C. de Oliveira. 2015. Coffee Yield and Phosphate Nutrition Provided to Plants by Various Phosphorus Sources and Levels: Produtividade e nutrição fosfatada de cafeeiros submetidos a fontes e doses de fósforo . Ciencia E Agrotecnologia, 39:110-120.
Reference ID: 21299
Notes: #21299e
Abstract: Phosphorus (P) is considered one of the nutrients that most limits crop yields, especially in soils with an advanced degree of weathering. To evaluate P dynamics and availability in soil resulting from various P doses and sources and to assess the resulting P content of coffee leaves and the final coffee yield, an experiment was conducted in the municipality of Três Pontas, MG, Brazil, in a Red Argisol (Ultisol) area. Fertilization, except for P fertilization, was performed based on the soil analysis results. The annual P doses tested were 0, 75, 150, 300, 450 and 600 kg ha-1 P2O5. Two P sources, simple superphosphate and magnesium thermal phosphate, were evaluated and compared in the study. A physicochemical analysis of the soil and an analysis of leaf dry matter were performed. The available P content in the soil increased as a result of the applications of the two sources. The leaf P levels stabilized at approximately 1.8 and 1.9 g kg-1 for simple superphosphate and magnesium thermal phosphate, respectively, as a result of the application of approximately 300 kg ha-1 P2O5. The coffee responded to P fertilization in the production phase. Averaged over three harvests, the yield per harvest showed gains of 45.3% and 40.3% for simple superphosphate and magnesium thermal phosphate, respectively, with the application of the highest studied dose, 600 kg ha-1 P2O5.

de Melo Moura W., Y. J. B. Soares, G. G. Jr. do Amaral, P. C. de Lima, H. E. P. Martinez, and G. D. A. Gravina. 2015. Genetic Diversity in Arabica Coffee Grown in Potassium- Constrained Environment. Ciencia E Agrotecnologia, 39:23-31.
Reference ID: 21300
Notes: #21300e
Abstract: Potassium is a source of non-renewable natural resource, and is used in large quantities in coffee fertilization through basically imported formulations in the form of potassium chloride. An alternative to make production systems more sustainable would be obtaining cultivars more efficient in the use of this nutrient. This study aimed to evaluate the genetic diversity among 20 cultivars of coffee, in conditions of low availability of potassium to identify the best combinations for composing future populations to be used in breeding programs. The experiment was arranged in a randomized block design with three replications of nutrient solution. Agronomic characteristics and efficiencies of rooting, absorption, translocation, biomass production and potassium utilization were evaluated. The clustering analysis was based on the unweighted pair group method with arithmetic mean clustering algorithm (UPGMA) and canonical variables. Variability was observed for

most treatments. The multivariate procedures produced similar discrimination of genotypes, with the formation of five groups. Hybridizations between the cultivar Icatu Precoce IAC 3283 with cultivars Catuaí Amarelo IAC 62, Araponga MG1, Caturra Vermelho IAC 477, Catuaí Vermelho IAC 15, Rubi MG 1192 and Catucaí 785/15, and between the cultivar Tupi IAC 1669-33 with cultivars Icatu Vermelho IAC 4045, Acaiá Cerrado MG 1474 and Oeiras MG 6851 are the most promising for obtaining segregating populations or heterotic hybrids in breeding programs aiming more efficiency in potassium utilization.

Mancuso M. A. C., R. P. Sorato, C. A. C. Crusciol, and G. S. A. Castro. 2014. Effect of Potassium Sources and Rates on Arabica Coffee Yield, Nutrition and Macronutrient Export. Revista Brasileira De Ciencia Do Solo, 38:1448-1456.
Reference ID: 21301
Notes: #21301e
Abstract: The use of potassium (K) rock powder can be an alternative for K supply of crops. Thus, to reduce K fertilizer imports from abroad, possibilities of extracting this nutrient from Brazilian rocks are being studied. The objective was to evaluate the effect of phonolite rock powder (F2) as K source (Ekosil (R)) on the air-dried fruit yield, nutrition and macronutrient export of Arabica coffee. The experiment was carried out on a dystroferric Red Latosol (Typic Haplorthox), in Piraju, Sao Paulo State, Brazil, in the 2008/09 and 2009/10 growing seasons. The experimental design was a randomized complete block, in a factorial 2 x 3 + 1 arrangement, with four replications. The treatments consisted of two K sources (KCl -58% of K2O and F2 - 8.42% K2O) and three rates 1/2-, 1-, and 2-fold the K2O rate recommended for coffee, i.e., 75, 150, and 300 kg ha(-1) of K2O), plus a control (without K application). Potassium supply increased coffee yield, regardless of the source. Application of source F2 increased coffee yield similarly to KCl at the recommended K rate for coffee (150 kg ha(-1) K2O), proving efficient as K supply for coffee. Potassium application increased macronutrient export in coffee, especially in the growing season with higher yield.

Martins L. D., W. N. Rodrigues, M. A. Tomaz, A. F. de Souza, and W. C. Jr. de Jesus. 2012. Function of vegetative growth of conilon coffee seedlings to levels of ciproconazol+tiametoxam and nitrogen: Função de crescimento vegetativo de mudas de cafeeiro conilon a níveis de ciproconazol+tiametoxam e nitrogênio. Revista de Ciências Agrárias, 35:173-183.
Reference ID: 21302
Notes: #21302e
Abstract: Although the chemical control of coffee rust and the nitrogen fertilization are widely studied in Brazil, there are no documented studies that show this interaction in conilon coffee plants. Thus, the objective of this experiment was to study the interaction between the effects of nitrogen and cyproconazole+thiamethoxam in the growth of conilon coffee seedlings, cultivar "Emcaper 8151 - Robusta Tropical", in controlled environment. For this, a completely randomized design was used, with four replicates, simple layout, with 13 levels of combinations of nitrogen and cyproconazole+thiamethoxam. The levels of nitrogen levels and cyproconazole+thiamethoxam were combined following a Box Berard increased to 3 (2k + 2k + 2k + 1) matrix model. The results show that the combinations of the recommended level of cyproconazole+thiamethoxam and nitrogen influenced negatively the analyzed variables of the conilon coffee plants, in the studied conditions.

Cock J., C. R. Donough, T. Oberthür, K. Indrasuara, Rahmadsyah, A. R. Gatot, and T. Dolong. 2014. Increasing palm oil yields by measuring oil recovery efficiency from the fields to the mills. Pusat Penellitian Kelapa Sawit, Indonesia.

Reference ID: 21303

Notes: S 8.1.1 #21303e < #20347e

Abstract: Oil palm has been commercially cultivated in South East Asia for more than a century to produce crude palm oil (CPO, or oil) and palm kernels (PK, or kernel). The primary products are the fresh fruit bunches (FFB) that are perishable and once harvested must be processed rapidly to extract the oil and the kernel. In other perishable crops like cassava and sugarcane, which must be processed rapidly after harvesting, the primary products are delivered to the processing plant or mill, weighed and analyzed to determine the amount of extractable final product i.e. starch or sugar. The producers are paid according to estimated final product content of their crop and therefore have a strong incentive to improve it. Furthermore, producers receive information on the product content of individual lots arriving at the mills. Consequently they are able to equate management practices and block characteristics with quality; hence they can improve the quality of the primary product. Similarly, the efficiency of mills in terms of their ability to extract starch or sugar can be evaluated if the quality of the product entering the mills is known. In oil palm, the FFB received at palm oil mills is graded for ripeness and other criteria that may affect the milling process and oil extraction rate (OER). However, there is no estimate of the oil content of the FFB received. The palm oil mills process FFB of unknown oil content from many sources, and then estimate the OER based on the amount of oil they produce. Thus, in the current system, while FFB yield can be attributed to specific blocks by growers, the OER is not determined for individual blocks or even estates: it is assigned indiscriminately using the average OER of the mill which receives FFB from many sources and blocks. On the basis of "what you cannot measure you cannot manage", oil palm growers can, and do, manage their plantings to maximize FFB yield, but not OER. The International Plant Nutrition Institute's Southeast Asia Program (IPNI SEAP) has shown that when best management practices (BMPs) are implemented in the field to maximize FFB yield, OER may not necessarily be maximized at the same time (Oberthür *et. al.*, 2012). Furthermore, there is no total oil balance at the mill based on total oil arriving in the FFB and oil eventually extracted from the FFB. Hence, milling efficiency is not normally evaluated on an overall balance of oil entering the mill and oil produced, but through estimates of losses in different stages of the process.
IPNI SEA recently showed that by combining bunch analysis (BA) data with harvest audit data, growers can compute their Field Oil Recovery Efficiency (FORE) and the Estimated Oil Content (EOC) of the harvested FFB delivered to the mill. The FORE is of the efficiency with which the oil produced in the field is recovered at harvest. The efficiency would be 100% if all bunches were harvested, the bunches were harvested ripe or mature and there were no losses of loose fruits (Donough *et. al.*, 2013). Thus estimates of FORE provide information on the efficiency of the harvesting operations in recovering oil. The pre-milling EOC of the FFB received for processing will allow mills to measure their Mill Oil Recovery Efficiency (MORE), which is a better indicator of mill performance than OER *per se*. Use of recovery efficiency measures in the field and at the mill will allow a more holistic and inclusive analysis of the overall oil recovery, clearly describing the efficiency of operations managed in the field and at the mill.
Knowledge of EOC will also allow mills to pay growers for the oil content of their crop, which in turn will stimulate growers to improve FORE. A virtuous cycle of

estimating potential product contents of individual FFB deliveries and using the information to improve crop recovery in the plantation may thus start. In this paper, we present the conceptual definitions and framework for assessing oil recovery efficiency (ORE) starting from the field until the mill.

SOPIB 2015. The Use Of Potassium Sulfate Fertilizer: Principles And Practices.
Reference ID: 21304
Notes: S 21 #21304

Sobreira F. M., R. J. Guimaraes, A. Colombo, M. S. Scalco, and J. G. Carvalho. 2011. Nitrogen and potassium fertigation in coffee at the formation phase, with high plant density. Pesquisa Agropecuaria Brasileira, 46:9-16.
Reference ID: 21305
Notes: #21305e
Abstract: The objective of this study was to evaluate the most adequate parceling and dose of nitrogen and potassium for the first and second years of coffee shrub (Coffea arabica) formation, under a drip fertigation system, in southern Minas Gerais, Brazil. Two experiments with high plant density (6.666 plants ha(-1)) were carried out simultaneously: in one of them, the fertilization was done in 4 applications yearly, and in the other one, in 12 applications. A randomized block design was used with five treatments and four replicates in both experiments. Treatments consisted of N and K(2)O doses applied via fertigation: 70, 100, 130, 160 and 190% from the N and K(2)O recommended doses for the rainfed cropping. A control treatment was carried out in rainfed conditions and fertilized with the standard dose (100%). In the first and second years, in both parceling types, there were no significant differences among doses regarding coffee shrub vegetative growth. Parceling into 12 applications is more suitable for fertilization at both first and second years after planting. Fertigated coffee shrubs at the formation phase have higher growth and demand less nitrogen and potassium fertilization than the ones in rainfed conditions.

Tezotto T., J. L. Favarin, A. P. Neto, P. L. Gratao, R. A. Azevedo, and P. Mazzafera. 2013. Simple procedure for nutrient analysis of coffee plant with energy dispersive X-ray fluorescence spectrometry (EDXRF) . Scientia Agricola, 70:263-267.
Reference ID: 21306
Notes: #21306e
Abstract: Nutrient analysis is used to estimate nutrient content of crop plants to Manage fertilizer application for sustained crop production. Direct solid analysis of agricultural and environmental samples by energy dispersive X-ray fluorescence spectrometry (EDXRF) was chosen as alternative technique to evaluate the simultaneous multielemental quantification of the most important essential elements in coffee (Coffee arabica L.) plants. Inductively coupled plasma atomic emission spectrometry and certified reference materials made from leaves were used to calibrate and check the trueness of EDXRF method for the determination of the concentration of several nutrients in coffee leaves and branches. Fluorescence spectrometry proved to be advantageous and presented low cost as loose powder samples could be used. Samples collected from a field experiment where coffee plants were treated with excess of Ni and Zn were used to verify the practical application of the method. Good relationships were achieved between certified values and data obtained by EDXRF, with recoveries ranging from 82 to 117%.

Guarconi M. A. and C. J. Fanton. 2011. Granite processing waste as an alternative fertilizer for the coffee crop . Revista Ciencia Agronomica, 42:16-26.
Reference ID: 21307
Notes: #21307e
Abstract: The granite processing waste is considered an environmental contaminant. Its agricultural use has been investigated and satisfactory results have been defined basically considering ideological questions instead of its real effectiveness. Aiming to evaluate the effect of the granite processing waste on conilon coffee fertilizing, an experiment was installed under greenhouse conditions. Two samples of only one soil (superficial and subsuperficial), six granite processing waste doses (0,0; 1,5; 3,0; 6,0; 9,0 and 15 g dm-3, equivalent the 0; 3; 6; 12; 18 e 30 t ha-1) and two liming levels (0,4 e 1,2 x liming necessity) were investigated. After soil incubations and following the transplantation, growth and harvesting of coffee plants, have been determined contents of chemicals elements and characteristics of plant and soil. The granite processing waste application induced a linearly increase on pH and reduces the Al3+ contents, but in small magnitude. Granite processing waste was more efficiently when used in grater buffer capacity soil sample; for de initial coffee plants growth, it must be used, with priority, as a source of K and Ca, in this case, a soil pH around 5.0 is recommended; doses of granite processing waste next to a 20.0 ton per hectare provided an adequate initial growth of coffee plants.

Fenilli T. A. B., K. Reichardt, O. O. S. Bacchi, P. C. O. Trivelin, and D. Dourado-Neto. 2007. The N-15 isotope to evaluate fertilizer nitrogen absorption efficiency by the coffee plant . Anais Da Academia Brasileira De Ciencias, 79:767-776.
Reference ID: 21308
Notes: #21308e
Abstract: The use of the N-15 label for agronomic research involving nitrogen (N) cycling and the fate of fertilizer-N is well established, however, in the case of long term experimentation with perennial crops like citrus, coffee and rubber tree, there are still shortcomings mainly due to large plant size, sampling procedures, detection levels and interferences on the system. This report tries to contribute methodologically to the design and development of N-15 labeled fertilizer experiments, using as an example a coffee crop fertilized with N-15 labeled ammonium sulfate, which was followed for two years. The N of the plant derived from the fertilizer was studied in the different parts of the coffee plant in order to evaluate its distribution within the plant and the agronomic efficiency of the fertilizer application practice. An enrichment of the fertilizer-N of the order of 2% N-15 abundance was sufficient to study N absorption rates and to establish fertilizer-N balances after one and two years of coffee cropping. The main source of errors in the estimated values lies in the inherent variability among field replicates and not in the measurements of N contents and N-15 enrichments of plant material by mass-spectrometry.

Cai C. T., Z. Q. Cai, T. Q. Yao, and X. Qi. 2007. Vegetative growth and photosynthesis in coffee plants under different watering and fertilization managements in Yunnan, SW China. Photosynthetica, 45:455-461.
Reference ID: 21309
Notes: #21309e
Abstract: In a field experiment Coffea arabica L. was subjected to various moisture and fertilizer regimes in Simao, Yunan, SW China. The experimental treatments consisted of eight factorial combinations of two fertilization levels (high and low) and

four watering treatments applied in the dry season: application of dry rice straw mulch, drip irrigation, mulching plus drip irrigation on the soil surface, and control (no mulching or irrigation). The growth of the coffee plants was monitored throughout the course of a full year. Two clear growth peaks were detected (one at the beginning and one in the middle of the wet season) in plants subjected to all treatments, and the growth rhythm of coffee plants was not regulated by extrinsic abiotic factors. High fertilization resulted in a significantly higher relative growth rates for both height and length of the branches during the growth peaks than the low fertilization treatment. In the dry season, increasing the soil moisture contents by irrigation and/or mulching enhanced the plants' gas exchange, but the soil water status had no significant effects on the internal fluorescence parameters of photosystem 2. More fertilized plants had a greater ability to acclimate to high-irradiance environments than the lightly fertilized plants, showing significant lower diurnal photoinhibition, associated with higher energy utilization through photochemistry and energy dissipation through the xanthophyll cycle. Hence the wet season is the optimum period for photosynthetic carbon fixation and vegetative growth of coffee plants. Higher than routinely applied levels of fertilization are required to optimize the coffee plants' photosynthetic acclimation and growth in the studied environment. Both soil moisture conserving practices tested, mulching and drip irrigation, had significant effects on the growth and photosynthesis of the coffee plants, but the former was more practical than the latter.

da Silva A. M., G. Coelho, and R. A. da Silva. 2005. Irrigation timing and split application of fertilizer on productivity of the coffee plant in 4 harvests: Épocas de irrigação e parcelamento de adubação sobre a produtividade do cafeeiro, em quatro safras . Revista Brasileira De Engenharia Agricola e Ambiental, 9:314-319.
Reference ID: 21310
Notes: #21310e
Abstract: The present work aimed to evaluate the effect of different periods of irrigation during and different fertilizer applications on productivity of coffee plant in 4 consecutive harvests. An experiment was accomplished in strips, in which the split fertilizer applications were tested: plot 1 received 12 applications of fertilizers in a manual way, plots 2, 3 and 4 received, respectively, 12, 24 and 36 applications of fertilizers through irrigation water. In the strips 3 irrigation periods were tested, 1/6 to 30/9, 15/7 to 30/9, 1/9 to 30/9 and a control treatment without irrigation, with 3 repetitions (blocks). The results of total coffee productivity expressed in kg ha-1, were submitted to the variance analysis and to mean comparison test, when it was necessary. The variance analysis detected significant effect for irrigation times and in harvests. The only significant interaction was between harvest and irrigation times, showing that the irrigation does not eliminate the biennial cycle of coffee plant productivity. The irrigation from 1/6 to 30/9, and from 15/7 to 30/9 provided better mean productivity of 3,852.2 and 3,527.1 kg ha-1, respectively.

de Melo B., K. V. Marcuzzo, R. E. F. Teodoro, and H. D. Carvalho. 2005. Sources and doses of phosphorus on coffee development and production on soil originally under savannah vegetation of Patrocinio - MG. Ciencia E Agrotecnologia, 29:315-321.
Reference ID: 21311
Notes: #21311e
Abstract: The objective of this work was to evaluate the effect of different sources and doses of phosphorus on coffee plant development and production, Acaia

Cerrado cultivate, MG 1474-lineage, on Distroferric Red Latosol, of Patrocinio Experimental Farm, belonging to EPAMIG. The experiment was installed on spacement of 3.50 x 0.70 m, in a randomized-block design, in a factorial 4 x 5, with four repetitions. The phosphorus sources were: "Araxa" phosphate, magnesium thermophosphate, Arad phosphate and triple superphosphate, all of them applied in five doses, corresponding to: 0 (zero), 125, 250, 500 and 1,000 g of P2O5 per meter of furrow. Each experimental plot was constituted by a line with eight plants, being used the four central ones as useful plants. Thirty and forty-one months after planting were evaluated the following characteristics: plant height, stem and canopy diameters and yield. The phosphorus sources had a similar behavior in relation to coffee development, 30 and 41 months after planting; 30 months after planting, the biggest yields were obtained when the triple superphosphate and the magnesium termophosphate were used; at 41 months, the biggest yields were obtained when the "Araxa" phosphate, the Arad phosphate and the magnesium termophosphate were used; the P2O5 doses influenced the coffee vegetative development, the best results were observed from 618,8 to 674,4 g of P2O5 per meter of furrow; the best yields were obtained with the doses from 539,7 to 855,0 g of P2O5 per meter of furrow, according to the used fertilizer, with exception of triple superphosphate, 41 months after planting, where the P2O5 maximum dose wasn't sufficient to obtain a maximum of yield.

da Silva A. M., L. S. D. Sorice, G. Coelho, M. A. de Faria, and F. C. de Rezende. 2003. Evaluation of Split Fertilizer Applications and Irrigations Starting Time Over Coffee Bean Yield. Ciencia E Agrotecnologia, 27:1354-1362.
Reference ID: 21312
Notes: #21312e
Abstract: The effect of starting the irrigation season at different dates and the effect of multiple fertilizer applications, through fertigation and traditional fertilizer hand spreading, were evaluated in an experiment conducted in a 12 years old 'Catua' coffee orchard, with plants in a 3.5 by 0.8 m spacing, located at the M quem Farm - FAEPE/UFLA in Lavras, MG. An experimental design with 3 completely randomized blocks was used. Each block was split in 4 randomized portions submitted to four different fertilization treatments: fertigation with three different numbers of multiple applications (P4 = 36; P3 = 24; P2 = 12) and multiple (P1 = 12) fertilizer applications by hand spread. Each one of the plots corresponding to a fertilization treatment was subdivided, without randomization, in 4 subplots: a non irrigated control (D) treatment receiving an even 4way fertilizer split application and three irrigated subplots with the irrigation season starting at different dates (A = 06/01; B = 07/15; C = 09/01 and D correspond to the). Crop yield (97/98 harvest season) was analyzed considering the amount of coffee picked by harvest manual in the cloth, coffee picked in the ground and the sum of both methods. Measured weight values were submitted to variance analysis and test of averages. The analysis of variance showed a significant effect of irrigation timing over all parameters, the amount of coffee picked in the ground was affected by fertigation, interaction between irrigation and fertilization split affected coffee picked by harvest manual in the cloth the total amount of picked coffee. The test of averages showed that the A parcel (irrigated starting in 06/01) presented the best yield results, 56.6 bags/ha of coffee picked by harvest manual in the cloth and a total of 67.7 bags/ha, that represents a 73% increase on coffee picked by harvest manual in the cloth and a 68,4% increase in the total coffee picked in relation to the non irrigated control treatment. Considering the interaction between fertilizer split and irrigation timing, it was noticed that only for the

A treatment there is an effect of fertilizer timing, by this way, it was noticed that 12 fertilizer multiple applications, by fertigation or hand spreading, achieve the best results, 82.3 bags/ha and 81.3 bags/ha respectively.

Bunn C., P. Laderach, O. O. Rivera, and D. Kirschke. 2015. A bitter cup: climate change profile of global production of Arabica and Robusta coffee. Climatic Change, 129:89-101.
Reference ID: 21313
Notes: #21313e
Abstract: Coffee has proven to be highly sensitive to climate change. Because coffee plantations have a lifespan of about thirty years, the likely effects of future climates are already a concern. Forward-looking research on adaptation is therefore in high demand across the entire supply chain. In this paper we seek to project current and future climate suitability for coffee production (Coffea arabica and Coffea canephora) on a global scale. We used machine learning algorithms to derive functions of climatic suitability from a database of geo-referenced production locations. Use of several parameter combinations enhances the robustness of our analysis. The resulting multi-model ensemble suggests that higher temperatures may reduce yields of C. arabica, while C. canephora could suffer from increasing variability of intra-seasonal temperatures. Climate change will reduce the global area suitable for coffee by about 50 % across emission scenarios. Impacts are highest at low latitudes and low altitudes. Impacts at higher altitudes and higher latitudes are still negative but less pronounced. The world's dominant production regions in Brazil and Vietnam may experience substantial reductions in area available for coffee. Some regions in East Africa and Asia may become more suitable, but these are partially in forested areas, which could pose a challenge to mitigation efforts.

Berecha G., R. Aerts, B. Muys, and O. Honnay. 2015. Fragmentation and Management of Ethiopian Moist Evergreen Forest Drive Compositional Shifts of Insect Communities Visiting Wild Arabica Coffee Flowers. Environmental Management, 55:373-382.
Reference ID: 21314
Notes: #21314e
Abstract: Coffea arabica is an indigenous understorey shrub of the moist evergreen Afromontane forest of SW Ethiopia. Coffee cultivation here occurs under different forest management intensities, ranging from almost no intervention in the 'forest coffee' system to far-reaching interventions that include the removal of competing shrubs and selective thinning of the upper canopy in the 'semi-forest coffee' system. We investigated whether increasing forest management intensity and fragmentation result in impacts upon potential coffee pollination services through examining shifts in insect communities that visit coffee flowers. Overall, we netted 2,976 insect individuals on C. arabica flowers, belonging to sixteen taxonomic groups, comprising 10 insect orders. Taxonomic richness of the flower-visiting insects significantly decreased and pollinator community changed with increasing forest management intensity and fragmentation. The relative abundance of honey bees significantly increased with increasing forest management intensity and fragmentation, likely resulting from the introduction of bee hives in the most intensively managed forests. The impoverishment of the insect communities through increased forest management intensity and fragmentation potentially decreases the resilience of the coffee production system as pollination increasingly relies on honey bees alone. This may negatively affect coffee productivity in the long term as global pollination

services by managed honey bees are expected to decline under current climate change scenarios. Coffee agroforestry management practices should urgently integrate pollinator conservation measures.

Rahn E., P. Laderach, M. Baca, C. Cressy, G. Schroth, D. Malin, H. Van Rikxoort, and J. Shriver. 2014. Climate change adaptation, mitigation and livelihood benefits in coffee production: where are the synergies? Mitigation And Adaptation Strategies For Global Change, 19:1119-1137.
Reference ID: 21315
Notes: #21315e
Abstract: There are worldwide approximately 4.3 million coffee (Coffea arabica) producing smallholders generating a large share of tropical developing countries' gross domestic product, notably in Central America. Their livelihoods and coffee production are facing major challenges due to projected climate change, requiring adaptation decisions that may range from changes in management practices to changes in crops or migration. Since management practices such as shade use and reforestation influence both climate vulnerability and carbon stocks in coffee, there may be synergies between climate change adaptation and mitigation that could make it advantageous to jointly pursue both objectives. In some cases, carbon accounting for mitigation actions might even be used to incentivize and subsidize adaptation actions. To assess potential synergies between climate change mitigation and adaptation in smallholder coffee production systems, we quantified (i) the potential of changes in coffee production and processing practices as well as other livelihood activities to reduce net greenhouse gas emissions, (ii) coffee farmers' climate change vulnerability and need for adaptation, including the possibility of carbon markets subsidizing adaptation. We worked with smallholder organic coffee farmers in Northern Nicaragua, using workshops, interviews, farm visits and the Cool Farm Tool software to calculate greenhouse gas balances of coffee farms. From the 12 activities found to be relevant for adaptation, two showed strong and five showed modest synergies with mitigation. Afforestation of degraded areas with coffee agroforestry systems and boundary tree plantings resulted in the highest synergies between adaptation and mitigation. Financing possibilities for joint adaptation-mitigation activities could arise through carbon offsetting, carbon insetting, and carbon footprint reductions. Non-monetary benefits such as technical assistance and capacity building could be effective in promoting such synergies at low transaction costs.

Campbell B. M., P. Thornton, R. Zougmore, P. van Asten, and L. Lipper. 2014. Sustainable intensification: What is its role in climate smart agriculture? Current Opinion in Environmental Sustainability, 8:39-43.
Reference ID: 21316
Notes: H 11.5 #21316e
Abstract: The 'sustainable intensification' (SI) approach and `climate-smart agriculture' (CSA) are highly complementary. SI is an essential means of adapting to climate change, also resulting in lower emissions per unit of output. With its emphasis on improving risk management, information flows and local institutions to support adaptive capacity, CSA provides the foundations for incentivizing and enabling intensification. But adaptation requires going beyond a narrow intensification lens to include diversified farming systems, local adaptation planning, building responsive governance systems, enhancing leadership skills, and building asset diversity. While SI and CSA are crucial for global food and nutritional security,

they are only part of a multi-pronged approach, that includes reducing consumption and waste, building social safety nets, facilitating trade, and enhancing diets.

Ruelas-Monjardin L. C., M. E. Nava-Tablada, J. Cervantes, and V. L. Barradas. 2014. Environmental importance of coffee shade agroecosystems of the mountainous central zone of Veracruz state, Mexico: Importancia ambiental de los agroecosistemas cafetaleros bajo sombra en la zona central montañosa del estado de Veracruz, México . Madera Y Bosques, 20:27-40.
Reference ID: 21317
Notes: #21317e
Abstract: The shade-grown coffee agroecosystem has contributed to mitigate the loss of ecosystem services provided by the tropical cloud forest in the mountainous central region of Veracruz. This is largely due to the fact that this cultivation type is friendly with that forest ecosystem. Although, despite the multiple services that this cultivation provides, coffee production has been losing importance among producers. The objective of this research was to identify the farmers' perception about the importance of growing coffee under shade in the provision of environmental services and whether this influences their willingness to maintain this agroecosystem. This perception is analyzed in the context of regional changes in temperature and precipitation, which could be related to transformations in forest cover. In order to address the perceptions a case study method was employed. The case study was carried out by analyzing the results of a questionnaire administered to 51 producers of the locality of La Orduna, Coatepec, Ver. In order to study the historical changes in regional precipitation and temperature, data from three climatic stations close to La Orduna were employed. Data were analyzed with the procedures recommended by the World Meteorological Organization. Results display changes in regional climate, as well as the producers' identification of the main environmental benefits that shade-grown coffee provide. Similarly, they show their willingness to maintain this culture, providing government policies financially remunerate the environmental services that this agroecosystem supply.

Gross, M. Coffee and Chocolate in Danger. Current Biology 24[11], R503-R506. 2014.
Reference ID: 21318
Notes: #21318e
Abstract: As a rapidly growing global consumer base appreciates the pleasures of coffee and chocolate and health warnings are being replaced by more encouraging sounds from medical experts, their supply is under threat from climate change, pests and financial problems. Coffee farmers in Central America, in particular, are highly vulnerable to the impact of climate change, made worse by financial insecurity.

Jha S., C. M. Bacon, S. M. Philpott, V. E. Mendez, P. Laderach, and R. A. Rice. 2014. Shade Coffee: Update on a Disappearing Refuge for Biodiversity. BioScience, 64:416-428.
Reference ID: 21319
Notes: #21319e
Abstract: In the past three decades, coffee cultivation has gained widespread attention for its crucial role in supporting local and global biodiversity. In this synthetic Overview, we present newly gathered data that summarize how global patterns in coffee distribution and shade vegetation have changed and discuss implications for biodiversity, ecosystem services, and livelihoods. Although overall

cultivated coffee area has decreased by 8% since 1990, coffee production and agricultural intensification have increased in many places and shifted globally, with production expanding in Asia while contracting in Africa. Ecosystem services such as pollination, pest control, climate regulation, and nutrient sequestration are generally greater in shaded coffee farms, but many coffee-growing regions are removing shade trees from their management. Although it is clear that there are ecological and socioeconomic benefits associated with shaded coffee, we expose the many challenges and future research priorities needed to link sustainable coffee management with sustainable livelihoods.

Richards M. B. and V. E. Mendez. 2014. Interactions between Carbon Sequestration and Shade Tree Diversity in a Smallholder Coffee Cooperative in El Salvador. Conservation Biology, 28:489-497.
Reference ID: 21320
Notes: #21320e
Abstract: Agroforestry systems have substantial potential to conserve native biodiversity and provide ecosystem services. In particular, agroforestry systems have the potential to conserve native tree diversity and sequester carbon for climate change mitigation. However, little research has been conducted on the temporal stability of species diversity and aboveground carbon stocks in these systems or the relation between species diversity and aboveground carbon sequestration. We measured changes in shade-tree diversity and shade-tree carbon stocks in 14 plots of a 35-ha coffee cooperative over 9 years and analyzed relations between species diversity and carbon sequestration. Carbon sequestration was positively correlated with initial species richness of shade trees. Species diversity of shade trees did not change significantly over the study period, but carbon stocks increased due to tree growth. Our results show a potential for carbon sequestration and long-term biodiversity conservation in smallholder coffee agroforestry systems and illustrate the opportunity for synergies between biodiversity conservation and climate change mitigation.

Baca M., P. Laderach, J. Haggar, G. Schroth, and O. Ovalle. 2014. An Integrated Framework for Assessing Vulnerability to Climate Change and Developing Adaptation Strategies for Coffee Growing Families in Mesoamerica. Plos One, 9.
Reference ID: 21321
Notes: #21321e
Abstract: The Mesoamerican region is considered to be one of the areas in the world most vulnerable to climate change. We developed a framework for quantifying the vulnerability of the livelihoods of coffee growers in Mesoamerica at regional and local levels and identify adaptation strategies. Following the Intergovernmental Panel on Climate Change (IPCC) concepts, vulnerability was defined as the combination of exposure, sensitivity and adaptive capacity. To quantify exposure, changes in the climatic suitability for coffee and other crops were predicted through niche modelling based on historical climate data and locations of coffee growing areas from Mexico, Guatemala, El Salvador and Nicaragua. Future climate projections were generated from 19 Global Circulation Models. Focus groups were used to identify nine indicators of sensitivity and eleven indicators of adaptive capacity, which were evaluated through semi-structured interviews with 558 coffee producers. Exposure, sensitivity and adaptive capacity were then condensed into an index of vulnerability, and adaptation strategies were identified in participatory workshops. Models predict that all target countries will experience a decrease in climatic suitability for growing

Arabica coffee, with highest suitability loss for El Salvador and lowest loss for Mexico. High vulnerability resulted from loss in climatic suitability for coffee production and high sensitivity through variability of yields and out-migration of the work force. This was combined with low adaptation capacity as evidenced by poor post harvest infrastructure and in some cases poor access to credit and low levels of social organization. Nevertheless, the specific contributors to vulnerability varied strongly among countries, municipalities and families making general trends difficult to identify. Flexible strategies for adaption are therefore needed. Families need the support of government and institutions specialized in impacts of climate change and strengthening of farmer organizations to enable the adjustment of adaptation strategies to local needs and conditions.

Turbay S., B. Nates, F. Jaramillo, J. J. Velez, and O. L. Ocampo. 2014. Adaptation to climate variability among the coffee farmers of the watersheds of the rivers Porce and Chinchiná, Colombia: Adaptación a la variabilidad climática entre los caficultores de las cuencas de los ríos Porce Y Chinchiná, Colombia. Investigaciones Geograficas, 85:95-112.
Reference ID: 21322
Notes: #21322e
Abstract: This article seeks to explain the practices used by small farmers to cope with climate variability and extreme weather events in the basins of the Chinchiná and Porce rivers located on the central Andes in Colombia. The information wasglacie collected through interviews, observations on farms and workshops with farmers. Additionally historical averages on temperature, precipitation and sunshine were compared with those values recorded in 2010 during the transition between El Niño an La Niña events. During the first quarter of 2010 the average temperature in Chinchiná increased by 1.4 Cº and the solar brightness by 14%, while the precipitation experienced a 46% reduction. In contrast, during the second half of the year there was a decrease of 0.8 Cº in temperature, a 31% reduction in solar brightness and an increase in precipitation of 62%. The coffee production in the years 2011 and 2012 was the lowest in the country in the last 35 years despite the cultivated area increased. These changes affected the coffee plantations and substantially decreased grain coffe production. Coffee production in the years 2011 and 2012 was the lowest in the country in the last 35 years despite the cultivated area increase. These fall in coffee production was also a result of the renewal with rust resistant varieties, which at that time had not yet begun to produce. Most of the farmers have 5 hectares or less and are union members in the National Federation of Coffee Growers of Colombia (FNCC), which provides multiple services to them including an extension service with spread of the findings of field investigations carried out by the National Coffee Research Center (CENICAFE). These study results indicates some strategies used by peasants to minimize the effects of climate variability: the shade management in coffee plantations, especially with banana (Musa sp.) and guamo (Inga sp); their renewal with the rust resistant variety named Castillo; the association of crops, particularly coffee, maize and bean; the use of mulches, organic fertilizers and mycorrhizae; a proper fertilization; the cultivation of two-axis coffee plants; the staggered planting of coffee in different plots and the reforestation of hillsides and births water, especially with (Guadua angustifolia), are strategies used to minimize the effects of climate variability. However these strategies are more frequent in Porce than in Chinchiná where sun coffee plantations and intensive agriculture are predominants. The article indicates that adaptation to climate variability is not achieved only by technological measures if do not decrease

the sources of vulnerability of the rural population. The farmers are more exposed to the effects of weather because of their poverty, as a result of building on steep slopes, by cause of the volatility in the international price of coffee, by virtue of the exchange rate, due to the lack of a culture of crop insurance and for the lack of generational renewal in agriculture. Additionally peasants in Chinchiná faced threats of earthquakes, eruption of Nevado del Ruiz volcano, susceptibility of volcanic soils to mass removals and glacier melting, an increasingly process accelerated by climate change. This paper also highlights the social, economic and political adaptation strategies to climate variability. We found that the resilience of rural households increases when resorting to agrotourism, integration of family labor, associations, political mobilization for claiming benefits, casual wage labor on other farms, integration to fair markets coffee and coffee certifications that increase the price of This work also highlights the social, economic and political adaptation strategies to climate variability. We found that the resilience of rural households increases when resorting to the agrotourism, integration of family labor, the union associations, political mobilization for claiming benefits, the casual wage labor on other farms, the integration to fair markets of coffee and coffee certifications that increase the price of grain of coffee grain. Not all spontaneous adaptation measures are positive, it is necessary to evaluate the experience of many coffee farms of medium length that were converted to livestock, rural tourism and citrus growing. Since climate change and climate variability has increased the frequency and intensity of extreme weather events, this work also helps to identify vulnerabilities and adaptation of rural populations to climate change and extreme events.

Eriyagama N., Y. Chemin, and R. Alankara. 2014. A methodology for quantifying global consumptive water use of coffee for sustainable production under conditions of climate change. Journal Of Water And Climate Change, 5:128-150.
Reference ID: 21323
Notes: #21323e
Abstract: Coffee is the second most traded commodity in the world after oil. A sustainable coffee industry is crucial to maintaining global agriculture, trade, human and environmental well-being, and livelihoods. With increasing water scarcity and a changing climate, understanding and quantifying the risks associated with water, a primary input in coffee production, is vital. This methodological paper examines the means of quantifying: (a) 'current' consumptive water use (CWU) of green coffee (coffee beans at harvest time) globally; (b) coffee 'hot spots' and 'bright spots' with respect to levels of CWU, yields and water stress; and (c) possible impacts of climate change on the CWU of coffee. The methodology employs satellite-derived monthly evapotranspiration data and climate projections from two global circulation models for three future scenarios. Initial estimates suggest that currently (on average) 18.9 m(3)/kg of water is consumed in producing one unit of green coffee. The same estimate for irrigated coffee is 8.6 m(3)/kg, while that for rain fed coffee is 19.6 m(3)/kg. Climate scenarios show that effective mean annual rainfall in many major coffee areas may decrease by the 2050s. The generic methodology presented here may be applied to other crops, too, if crop data are available.

Noponen M. R. A., J. R. Healey, G. Soto, and J. P. Haggar. 2013. Sink or source-The potential of coffee agroforestry systems to sequester atmospheric CO2 into soil organic carbon. Agriculture, Ecosystems & Environment, 175:60-68.
Reference ID: 21324
Notes: #21324e

Abstract: Current carbon accounting methodologies often assume interactions between above-ground and below-ground carbon, without considering effects of land management. We used data from two long-term coffee agroforestry experiments in Costa Rica and Nicaragua to assess the effect on total soil organic carbon (SOC) stocks of (i) organic versus conventional management, (ii) higher versus moderate agronomic inputs, (iii) tree shade types. During the first nine years of coffee establishment total 0-40 cm depth SOC stocks decreased by 12.4% in Costa Rica and 0.13% in Nicaragua. Change in SOC differed consistently amongst soil layers: at 0-10 cm SOC stocks increased by 2.14 and 1.26 Mg C ha(-1) in Costa Rica and Nicaragua respectively; however much greater reduction occurred at 20-40 cm (9.65 and 2.85 Mg C ha(-1) respectively). Organic management caused a greater increase in 0-10 cm SOC but did not influence its reduction at depth. Effects of shade type were smaller, though heavily pruned legume shade trees produced a greater increase in 0-10 cm SOC than unpruned timber trees. No significant differences in SOC stocks were found between shaded and unshaded systems at any depth and SOC was poorly correlated with above-ground biomass stocks highlighting poor validity of "expansion factors" currently used to estimate SOC. SOC stock changes were significantly negatively correlated with initial SOC stock per plot, providing evidence that during establishment of these woody-plant-dominated agricultural systems SOC stocks tend to converge towards a new equilibrium as a function of the change in the quantity and distribution of organic inputs. Therefore it cannot be assumed that tree-based agricultural systems necessarily lead to increases in soil C stocks. While high inputs of organic fertiliser/tree pruning mulch increased surface-layer SOC stocks, this did not affect stocks in deeper soil, where decreases generally exceeded any gains in surface soil. Therefore site- and system-specific sampling is essential to draw meaningful conclusions for climate change mitigation strategies.

Noponen M. R. A., J. P. Haggar, G. Edwards-Jones, and J. R. Healey. 2015. Intensification of coffee systems can increase the effectiveness of REDD mechanisms. Agricultural Systems, 119:1-9.
Reference ID: 21325
Notes: H 8.1.5 #21325e
Abstract: In agricultural production systems with shade trees, such as coffee, the increase in greenhouse gas (GHG) emissions from production intensification can be compensated for, or even outweighed, by the increase in carbon sequestration into above-ground and below-ground tree biomass. We use data from a long-term coffee agroforestry experiment in Costa Rica to evaluate the trade-offs between intensification, profitability and net greenhouse gas emissions through two scenarios. First, by assessing the GHG emissions associated with conversion from shaded to more profitable full-sun (un-shaded) systems, we calculate the break-even carbon price which would need to be paid to offset the opportunity cost of not converting. The price per tCO(2)e of emissions reduction required to compensate for the coffee production revenue foregone varies widely from 9.3 to 196.3 US$ amongst different shaded systems. Second, as an alternative to intensification, production area can be extended onto currently forested land. We estimate this land-use change required to compensate for the shortfall in profitability from retaining lower intensity coffee production systems. For four of the five shade types tested, this land-use change causes additional GHG emissions >5 tCO(2)e ha(-1) yr(-1) resulting in net emissions >8 tCO(2)e ha(-1) yr(-1) for the whole system. We conclude that instead, by intensifying production, mechanisms similar to REDD that are based on reducing

emissions through avoided land-use change (REAL) could play a major role in increasing the climate change mitigation success of agroforestry systems at the same time as aiding REDD through reducing pressure for further forest conversion to agriculture.

Alvarado J., H. J. Andrade, and M. Segura. 2013. Storage of soil organic carbon in coffee (Coffea arabica L.) production systems in the municipality of Líbano, Tolima, Colombia: Almacenamiento de carbono orgánico en suelos en sistemas de producción de café (coffea arabica l.) En el municipio del Líbano, Tolima, Colombia. Colombia Forestal, 16:21-31.
Reference ID: 21326
Notes: #21326e
Abstract: The increase in greenhouse gas emissions from anthropogenic sources has resulted in climate change, which affects all living beings. Coffee (Coffea arabica L.) plantations, in monoculture or together with timber species such as salmwood (Cordia alliodora), mitigate climate change due to fixation of atmospheric CO2 that is deposited in biomass and soils. This study was carried out in the municipality of Líbano, Tolima, Colombia with the objective of defining which of the following coffee production systems store more soil organic carbon (SOC): 1) monoculture, 2) agroforestry systems (AFS) with salmwood, and 3) AFS with plantain. Farms with those systems that are the most dominant in the study zone were selected. From each system, five repetitions were identified to be analyzed with a completely randomized design. In each plot or repetition, five samples for bulk density (BD) using the cylinder method and a composite sample for concentration of SOC were taken and analyzed using the Walkley and Black approach. The systems of production did not significantly ($p > 0.05$) affect either the BD or the concentration of SOC. However, AFS with plantain tended to have less BD than monoculture and AFS with salmwood (0.83 ± 0.03 vs 0.88 ± 0.03 vs 0.92 ± 0.04 g·cm-3, respectively). These systems of production stored between 50 and 54 t·ha-1 of SOC in the top 30 cm, which indicates their capacity for climate change mitigation.

Jaramillo J., M. Setamou, E. Muchugu, A. Chabi-Olaye, A. Jaramillo, J. Mukabana, J. Maina, S. Gathara, and C. Borgemeister. 2013. Climate Change or Urbanization? Impacts on a Traditional Coffee Production System in East Africa over the Last 80 Years. Plos One, 8.
Reference ID: 21327
Notes: #21327e
Abstract: Global environmental changes (GEC) such as climate change (CC) and climate variability have serious impacts in the tropics, particularly in Africa. These are compounded by changes in land use/land cover, which in turn are driven mainly by economic and population growth, and urbanization. These factors create a feedback loop, which affects ecosystems and particularly ecosystem services, for example plant-insect interactions, and by consequence agricultural productivity. We studied effects of GEC at a local level, using a traditional coffee production area in greater Nairobi, Kenya. We chose coffee, the most valuable agricultural commodity worldwide, as it generates income for 100 million people, mainly in the developing world. Using the coffee berry borer, the most serious biotic threat to global coffee production, we show how environmental changes and different production systems (shaded and sun-grown coffee) can affect the crop. We combined detailed entomological assessments with historic climate records (from 1929-2011), and spatial and demographic data, to assess GEC's impact on coffee at a local scale.

Additionally, we tested the utility of an adaptation strategy that is simple and easy to implement. Our results show that while interactions between CC and migration/urbanization, with its resultant landscape modifications, create a feedback loop whereby agroecosystems such as coffee are adversely affected, bio-diverse shaded coffee proved far more resilient and productive than coffee grown in monoculture, and was significantly less harmed by its insect pest. Thus, a relatively simple strategy such as shading coffee can tremendously improve resilience of agro-ecosystems, providing small-scale farmers in Africa with an easily implemented tool to safeguard their livelihoods in a changing climate.

Bertrand B., R. Boulanger, S. Dussert, F. Ribeyre, L. Berthiot, F. Descroix, and T. Joet. 2012. Climatic factors directly impact the volatile organic compound fingerprint in green Arabica coffee bean as well as coffee beverage quality. Food Chemistry, 135:2575-2583.
Reference ID: 21328
Notes: #21328e
Abstract: Coffee grown at high elevations fetches a better price than that grown in lowland regions. This study was aimed at determining whether climatic conditions during bean development affected sensory perception of the coffee beverage and combinations of volatile compounds in green coffee. Green coffee samples from 16 plots representative of the broad range of climatic variations in Reunion Island were compared by sensory analysis. Volatiles were extracted by solid phase micro-extraction and the volatile compounds were analysed by GC-MS. The results revealed that, among the climatic factors, the mean air temperature during seed development greatly influenced the sensory profile. Positive quality attributes such as acidity, fruity character and flavour quality were correlated and typical of coffees produced at cool climates. Two volatile compounds (ethanal and acetone) were identified as indicators of these cool temperatures. Among detected volatiles, most of the alcohols, aldehydes, hydrocarbons and ketones appeared to be positively linked to elevated temperatures and high solar radiation, while the sensory profiles displayed major defects (i.e. green, earthy flavour). Two alcohols (butan-1,3-diol and butan-2,3-diol) were closely correlated with a reduction in aromatic quality, acidity and an increase in earthy and green flavours. We assumed that high temperatures induce accumulation of these compounds in green coffee, and would be detected as off-flavours, even after roasting. Climate change, which generally involves a substantial increase in average temperatures in mountainous tropical regions, could be expected to have a negative impact on coffee quality.

Hager A. 2012. The effects of management and plant diversity on carbon storage in coffee agroforestry systems in Costa Rica. Agroforestry Systems, 86:159-174.
Reference ID: 21329
Notes: #21329e
Abstract: Agroforestry systems can mitigate greenhouse gas (GHG) emissions, conserve biodiversity and generate income. Whereas the provision of ecosystem services by agroforestry is well documented, the functional relationships between species composition, diversity and carbon (C)-storage remain uncertain. This study aimed to analyze the effects of management (conventional vs. organic), woody plant diversity and plant composition on aboveground and belowground C-storage in coffee agroforestry systems. It was expected that organic farms would store more C, and that an increase in plant diversity would enhance C-storage due to complementarity effects. Additionally, it was expected that steep slopes decrease C-

storage as a result of topsoil erosion. Woody plants were identified on 1 ha plots within 14 coffee farms (7 conventional and 7 organic). C-stocks in trees, coffee plants and roots were estimated from allometric equations. C-stocks in litter and topsoil (0-25 cm) were estimated by sampling. On average, farms stored 93 +/- A 29 Mg C ha(-1). Soil organic carbon accounted for 69 % of total C. Total C-stocks were 43 % higher on organic farms than on conventional farms ($P < 0.05$). Conventional and organic farms differed in vegetation structure, but not in species diversity. It was found that the combined effect of farm type, species richness, species composition and slope explained 83 % of the variation in total C-storage across all farms ($P < 0.001$). Coffee agroforestry in general and organic farms in particular may contribute to GHG mitigation and biodiversity conservation in a synergistic manner which has implications for the effective allocation of resources for conservation and climate change mitigation strategies in the agricultural sector.

Estrada F., C. Gay, and C. Conde. 2012. A methodology for the risk assessment of climate variability and change under uncertainty. A case study: coffee production in Veracruz, Mexico. Climatic Change, 113:455-479.
Reference ID: 21330
Notes: #21330e
Abstract: Existing methods for the assessment of the potential impacts of climate change in productive activities and sectors are usually limited to point estimates that do not consider the inherent variability and uncertainty of climatic and socioeconomic variables. This is a major drawback given that only a limited and potentially misleading estimation of risk can be expected when ignoring such determinant factors. In this paper, a new methodology is introduced that is capable of integrating the agent's beliefs and expert judgment into the assessment of the potential impacts of climate change in a quantitative manner by means of an objective procedure. The goal is to produce tailor-made information to assist decision-making under uncertainty in a way that is consistent with the current state of knowledge and the available subjective "expert" information. Time-charts of the evolution of different risk measures, that can be relevant for assisting decision-making and planning, can be constructed using this new methodology. This methodology is illustrated with a case study of coffee production in Mexico. Time-dependent probabilistic scenarios for coffee production and income, conditional on the agent's beliefs and expert judgment, are developed for the average producer under uncertain future conditions. It is shown that variability in production and income, generated by introducing climate variability and uncertainty are important factors affecting decision-making and the assessment of economic viability that are frequently ignored. The concept of Value at Risk, commonly applied in financial risk management, is introduced as a means for estimating the maximum expected loss for a previously chosen confidence level. Results are tailor-made for agents that have incomplete information and different beliefs. In this case study, the costs of climate change for coffee production in Veracruz are estimated to have a present value representing from 3 to 14 times the current annual value of coffee production in the state.

Peters V. E. and C. R. Carroll. 2012. Temporal variation in coffee flowering may influence the effects of bee species richness and abundance on coffee production. Agroforestry Systems, 85:95-103.
Reference ID: 21331
Notes: #21331e

Abstract: Accurately estimating the contribution of pollinators to production in crop species is important but could be challenging for species that are widely cultivated. One factor that may influence the pollinator-production relationship across regions is phenology, or the timing of recurring biological events, because crop phenology can be proximately controlled by climatic variables and phenology can affect plant reproductive success. For the economically important crop, coffee (), at least three aspects of flowering phenology (onset, density and frequency) are influenced by precipitation, which varies across coffee's cultivated range. Of these aspects of flowering phenology, flower density may particularly impact production in coffee because high-density flowering can severely limit outcrossing which is a major contributor to high yields and larger, high quality beans. We studied the coffee plant-pollinator interaction over 3 years and across two distinct types of coffee blooms: (1) low-density, synchronous flowering and (2) high-density, synchronous (mass) flowering. Bee species richness was similar for four out of five flowering periods (9.8 +/- A 2.7 95% CI), but nearly tripled during one high-density flowering period (26 +/- A 8.6 95% CI). During low-density flowering coffee fruit set rates were varied, but when coffee flowered at high-density, initial fruit set rates remained close to 60% (the rate obtained from manual self-pollination of coffee flowers in pollination experiments). We discuss how changing precipitation patterns may alter coffee flowering phenology and the coffee plant-pollinator relationship, providing insight into how climate change may influence this interaction as well as the resultant coffee production.

Murugan M., P. K. Shetty, R. Ravi, A. Anandhi, and A. J. Rajkumar. 2012. Climate change and crop yields in the Indian Cardamom Hills, 1978-2007 CE. Climatic Change, 110:737-753.
Reference ID: 21332
Notes: #21332e
Abstract: In this study we analyzed climate and crop yields data from Indian cardamom hills for the period 1978-2007 to investigate whether there were significant changes in weather elements, and if such changes have had significant impact on the production of spices and plantation crops. Spatial and temporal variations in air temperatures (maximum and minimum), rainfall and relative humidity are evident across stations. The mean air temperature increased significantly during the last 30 years; the greatest increase and the largest significant upward trend was observed in the daily temperature. The highest increase in minimum temperature was registered for June (0.37A degrees C/18 years) at the Myladumpara station. December and January showed greater warming across the stations. Rainfall during the main monsoon months (June-September) showed a downward trend. Relative humidity showed increasing and decreasing trends, respectively, at the cardamom and tea growing tracts. The warming trend coupled with frequent wet and dry spells during the summer is likely to have a favorable effect on insect pests and disease causing organisms thereby pesticide consumption can go up both during excess rainfall and drought years. The incidence of many minor pest insects and disease pathogens has increased in the recent years of our study along with warming. Significant and slight increases in the yield of small cardamom (Elettaria cardamomum M.) and coffee (Coffea arabica), respectively, were noticed in the recent years.; however the improvement of yield in tea (Thea sinensis) and black pepper (Piper nigrum L.) has not been seen in our analysis.

Andrade G. A., W. D. Ricce, P. H. Caramori, G. C. Zaro, and C. D. Medina. 2012. Agroclimatic zoning of robusta coffee in the State of Parana and impacts of climate change: Zoneamento agroclimático de café robusta no Estado do Paraná e impactos das mudanças climáticas. Semina-Ciencias Agrarias**,** 33:1381-1389.
Reference ID: 21333
Notes: #21333e
Abstract: The aim of the study was the agroclimatic zoning of robusta coffee (Coffea canephora Pierre ex Froehner) in the state of Parana, and to verify changes caused by temperature rise related to global warming, as predictions for the next 100 years reported by the IPCC (Intergovernmental Panel on Climate Change). An alternative to keep coffee production in the state of Parana will be the introduction of robusta coffee, original from Africa, adapted to areas with annual mean temperatures between 22 and 26 degrees C. We used the historical weather database from IAPAR (Agronomic Institute of Parana) and considered as apt for cropping the areas within the following conditions: risk of annual frost lower than 25% of probability, annual mean temperature between 22 and 26 degrees C, and annual water deficiency below 150 mm. The spatial analyzes were based on the Shuttle Radar Topography Mission (SRTM) and crossed into the environment of a Geographic Information System (GIS), generating maps of the agroclimatic zoning of Coffea canephora for the current climate and scenarios of climate change with the addition of 1.8 and 4 degrees C in the mean temperature. The zoning for the current weather indicated that parts of northwestern and western regions of Parana are suitable for cultivation. Under climate change scenarios, considering the rainfall regime unchanged, the area suitable for cultivation expands, justifying studies on this species in the state of Parana.

Jaramillo J., E. Muchugu, F. E. Vega, A. Davis, C. Borgemeister, and A. Chabi-Olaye. 2011. Some Like It Hot: The Influence and Implications of Climate Change on Coffee Berry Borer (Hypothenemus hampei) and Coffee Production in East Africa. los One, 6.
Reference ID: 21334
Notes: #21334e
Abstract: The negative effects of climate change are already evident for many of the 25 million coffee farmers across the tropics and the 90 billion dollar (US) coffee industry. The coffee berry borer (Hypothenemus hampei), the most important pest of coffee worldwide, has already benefited from the temperature rise in East Africa: increased damage to coffee crops and expansion in its distribution range have been reported. In order to anticipate threats and prioritize management actions for H. hampei we present here, maps on future distributions of H. hampei in coffee producing areas of East Africa. Using the CLIMEX model we relate present-day insect distributions to current climate and then project the fitted climatic envelopes under future scenarios A2A and B2B (for HADCM3 model). In both scenarios, the situation with H. hampei is forecasted to worsen in the current Coffea arabica producing areas of Ethiopia, the Ugandan part of the Lake Victoria and Mt. Elgon regions, Mt. Kenya and the Kenyan side of Mt. Elgon, and most of Rwanda and Burundi. The calculated hypothetical number of generations per year of H. hampei is predicted to increase in all C. arabica-producing areas from five to ten. These outcomes will have serious implications for C. arabica production and livelihoods in East Africa. We suggest that the best way to adapt to a rise of temperatures in coffee plantations could be via the introduction of shade trees in sun grown plantations. The aims of this study are to fill knowledge gaps existing in the coffee industry, and to

draft an outline for the development of an adaptation strategy package for climate change on coffee production. An abstract in Spanish is provided as Abstract S1.

Tucker C. M., H. Eakin, and E. J. Castellanos. 2010. Perceptions of risk and adaptation: Coffee producers, market shocks, and extreme weather in Central America and Mexico. Global Environmental Change, 20:23-32.
Reference ID: 21335
Notes: #21335e
Abstract: This article explores the role of risk perception in adaptation to stress through comparative case studies of coffee farmers' responses to climatic and non-climatic stressors. We hypothesized that farmers associating these changes with high risk would be more likely to make adaptations than those who saw the events as part of normal variation. Nevertheless, we found that farmers who associated events with high risk were not more likely to engage in specific adaptations. Adaptive responses were more clearly associated with access to land than perception of risk, suggesting that adaptation is more a function of exogenous constraints on decision making than perception.

Camargo M. B. P. 2010. The impact of climatic variability and climate change on arabic coffee crop in Brazil. Bragantia, 69:239-247.
Reference ID: 21336
Notes: #21336e
Abstract: The climatic variability is the main factor responsible for the oscillations and frustrations of the coffee grain yield in Brazil. The relationships between the climatic parameters and the agricultural production are quite complex, because environmental factors affect the growth and the development of the plants under different forms during the growth stages of the coffee crop. Agrometeorological models related to the growth, development and productivity can supply information for the soil water monitoring and yield forecast, based on the water stress. A soil water balance during different growth stages of the coffee crop, can quantify the effect of the available soil water on the decrease of the final yield. Other climatic factors can reduce the productivity, such as adverse air temperatures happened during different growth stages. Solar radiation and relative humidity influence many physiological processes of the coffee tree but are not generally thought to play an important role as thermal and rainfall conditions in defining potential yield or ecological limitations for this crop. According to the last report of the Intergovernmental Panel on Climate Change (IPCC, 2007), the global temperature is supposed to increase 1.1ºC to 6.4ºC and the rainfall 15% in the tropical areas of Brazil. Some Global warming projections as presented by IPCC will cause a strong decrease in the coffee production in Brazil. According to the literature besides the reduction of suitable areas for coffee production, the crop will tend to move South and uphill regions. This review article analyze the effect that these possible scenarios would have in the agro-climatic coffee zoning in Brazil, and adaptive solutions, such as agronomic mitigations and development of cultivars adapted to high temperatures is considered.

Gross, M. Coffee Growers Feel The Heat. Current Biology 19[21], R965-R966. 2009.
Reference ID: 21337
Notes: #21337e
Abstract: Coffee and tea farmers already appear to be suffering from the effects of climate change.

Schroth G., P. Laderach, J. Dempewolf, S. Philpott, J. Haggar, H. Eakin, T. Castillejos, J. G. Moreno, L. S. Pinto, R. Hernandez, A. Eitzinger, and J. Ramirez-Villegas. 2009. Towards a climate change adaptation strategy for coffee communities and ecosystems in the Sierra Madre de Chiapas, Mexico. Mitigation And Adaptation Strategies For Global Change, 14:605-625.
Reference ID: 21338
Notes: #21338e
Abstract: The mountain chain of the Sierra Madre de Chiapas in southern Mexico is globally significant for its biodiversity and is one of the most important coffee production areas of Mexico. It provides water for several municipalities and its biosphere reserves are important tourist attractions. Much of the forest cover outside the core protected areas is in fact coffee grown under traditional forest shade. Unless this (agro)forest cover can be sustained, the biodiversity of the Sierra Madre and the environmental services it provides are at risk. We analyzed the threats to livelihoods and environment from climate change through crop suitability modeling based on downscaled climate scenarios for the period 2040 to 2069 (referred to as 2050s) and developed adaptation options through an expert workshop. Significant areas of forest and occasionally coffee are destroyed every year by wildfires, and this problem is bound to increase in a hotter and drier future climate. Widespread landslides and inundations, including on coffee farms, have recently been caused by hurricanes whose intensity is predicted to increase. A hotter climate with more irregular rainfall will be less favorable to the production of quality coffee and lower profitability may compel farmers to abandon shade coffee and expand other land uses of less biodiversity value, probably at the expense of forest. A comprehensive strategy to sustain the biodiversity, ecosystem services and livelihoods of the Sierra Madre in the face of climate change should include the promotion of biodiversity friendly coffee growing and processing practices including complex shade which can offer some hurricane protection and product diversification; payments for forest conservation and restoration from existing government programs complemented by private initiatives; diversification of income sources to mitigate risks associated with unstable environmental conditions and coffee markets; integrated fire management; development of markets that reward sustainable land use practices and forest conservation; crop insurance programs that are accessible to smallholders; and the strengthening of local capacity for adaptive resource management.

Lin B. B., I. Perfecto, and J. Vandermeer. 2008. Synergies between Agricultural Intensification and Climate Change Could Create Surprising Vulnerabilities for Crops. BioScience, 58:847-854.
Reference ID: 21339
Notes: H 15 #21339e
Abstract: An inevitable consequence of global climate change is that altered patterns of temperature and precipitation threaten agriculture in marry tropical regions, requiring strategies of human adaptation. Moreover, the process of management intensification in agriculture has increased and may exacerbate vulnerability to climate extremes. Although many solutions have been presented, the role of simple agroecological and agroforestry management has been largely ignored. Some recent literature has shown how sustainable management may improve agroecological resistance to extreme climate events. We comment specifically on a prevalent form of agriculture throughout Latin America, the coffee agroforestry system. Results from the coffee literature have shown that shade management in coffee systems may mitigate the effects of extreme temperature and precipitation, thereby reducing the

ecological and economic vulnerability of many rural farmers. We conclude that more traditional forms of agriculture can offer greater potential for adapting to changing conditions than do current intensive systems.

Lin B. B. 2007. Agroforestry management as an adaptive strategy against potential microclimate extremes in coffee agriculture. Agricultural and Forest Meteorology, 144:85-94.
Reference ID: 21340
Notes: #21340e
Abstract: Current climate change patterns may cause more extreme and variable climates in the future, threatening agricultural productivity in many areas of the world. Because many smallholder, rural farmers depend on subsistence, rainfed agriculture, priorities should be focused on coping mechanisms that protect these farmers from future vulnerabilities. This paper examines one possible adaptive strategy for coffee agriculture. A high (60-80%), medium (35-65%), and low (10-30%) shade coffee site were chosen in the Soconusco region of Chiapas, Mexico. Microclimate and soil moisture data were collected to examine the ability of shade tree cover in an agroforestry system to protect crop plants against extremes in microclimate and soil moisture fluctuation. Site and site by time effects were analyzed using linear mixed models to compare mean differences of microclimate measurements (temperature, relative humidity, and solar radiation) by site as well as by time of the day. Although there were not large differences in seasonal means for these factors, site by time effects show that temperature, humidity, and solar radiation fluctuations increase significantly as shade cover decreases. Soil data showed significantly larger fluctuations in soil moisture gain and loss in the low shade site respective of patterns of precipitation. Overall, the amount of shade cover was directly related to the mitigation of variability in microclimate and soil moisture for the crop of interest. The use of agroforestry systems is an economically feasible way to protect crop plants from extremes in microclimate and soil moisture and should be considered a potential adaptive strategy for farmers in areas that will suffer from extremes in climate.

Gay C., F. Estrada, C. Conde, H. Eakin, and L. Villers. 2006. Potential impacts of climate change on agriculture: A case of study of coffee production in Veracruz, Mexico. Climatic Change, 79:259-288.
Reference ID: 21341
Notes: #21341e
Abstract: This paper explores the relation between coffee production and climatic and economic variables in Veracruz in order to estimate the potential impacts of climate change. For this purpose, an econometric model is developed in terms of those variables. The model is validated by means of statistical analysis, and then used to project coffee production under different climatic conditions. Climate change scenarios are produced considering that the observed trends of climate variables will continue to prevail until the year 2020. An approach for constructing simple probability scenarios for future climate variability is presented and used to assess possible impacts of climate change beyond what is expected from changes in mean values.
The model shows that temperature is the most relevant climatic factor for coffee production, since production responds significantly to seasonal temperature patterns. The results for the projected climate change conditions for year 2020 indicate that

coffee production might not be economically viable for producers, since the model indicates a reduction of 34% of the current production.
Although different economic variables (the state and international coffee prices, a producer price index for raw materials for coffee benefit, the national and the USA coffee stocks) were considered as potentially relevant, our model suggests that the state real minimum wage could be regarded as the most important economic variable. Real minimum wage is interpreted here as a proxy for the price of labor employed for coffee production. This activity in Mexico is very labor intensive representing up to 80% of coffee production costs. As expected, increments in the price of such an important production factor increase production costs and have strong negative effects on production. Different assumptions on how real minimum wage could evolve for the year 2020 are considered for developing future production scenarios.

Eakin H., C. M. Tucker, and E. Castellanos. 2005. Market shocks and climate variability: The coffee crisis in Mexico, Guatemala, and Honduras. Mountain Research And Development, 25:304-309.
Reference ID: 21342
Notes: #21342e
Abstract: As a result of a dramatic decline in world coffee prices and the restructuring of both domestic and international institutions, coffee farmers have been facing one of the most difficult periods in sector history. In 2003, a comparative case study project (supported by the Small Grant Program of the Inter-American Institute for Global Change Research) in Guatemala, Mexico and Honduras explored the experiences and responses of coffee farmers to institutional reforms, market risk, and climate variability. Four communities were selected for study in the 3 countries in which household surveys and interviews were conducted. The impacts of the crisis and farmers' responses illustrate the potential obstacles that farmers confront with sudden and profound changes in production conditions, yet also suggest opportunities for interventions that might help farmers improve their resilience to future risk.

Assad E. D., H. S. Pintor, J. Jr. Zulio, and A. M. H. Avila. 2004. Climatic changes impact in agroclimatic zonning of coffee in Brazil: Impacto das mudanças climáticas no zoneamento agroclimático do café no Brasil. Pesquisa Agropecuaria Brasileira, 39:1057-1064.
Reference ID: 21343
Notes: #21343e
Abstract: According to the last report of the Intergovernmental Panel on Climate Change (IPCC). the global temperature is supposed to increase 1degreesC to 5.8degreesC and the rainfall 15% in the Tropical area. This paper analyses the effect that these possible scenarios would have in the agroclimatic zoning of the arabic coffee (Coffea arabica L.) main plantation areas in Brazil. The results indicated a reduction of suitable areas greater than 95% in Goias, Minas Gerais and S (a) over tildeo Paulo and about 75% for Parana in the case of a temperature increase of 5.8degreesC. These results presume that all the physiological characteristics of the crop will be the, same for the varieties analyzed and that the ideal climatic condition for economic development is mean annual temperatures between 18degreesC and 23degreesC.

Vargas M. M. M., C. I. Nicholls, S. M. Marquez, and S. Turbay. 2015. The categorization of nine coffee agroecosystems from the Porce river basin, Colombia, from an agroecological perspective: Caracterización de nueve agroecosistemas de café de la cuenca del río Porce, Colombia, con un enfoque agroecológico. Idesia(Arica), 33:69-83.
Reference ID: 21344
Notes: #21344e
Abstract: The purpose of this paper is to characterize nine coffee agroecosystems from the Colombian Andes with an agroecological approach. Attributes and indicators evaluated are grouped under three dimensions: economic, social and technical-productive. Indicators are sensitive to agroecosystem conditions and can be easily understood by farmers. Low productivity of coffee plantations and economic risk are identified as the main problems. The study found high food security in most of the farms despite deficiencies in coffee productivity. The methodology proposed could be adapted by other researchers for the characterization of peasant agroecosystems without forgetting that setting indicators should be a participatory process; indicators used in this work do not account for all internal and external conditions that affect agroecosystems but they highlight relevant factors for social reproduction of peasant families.

Henry R. J. 2014. Sequencing of wild crop relatives to support the conservation and utilization of plant genetic resources. Plant Genetic Resources, 12:S9-S11.
Reference ID: 21345
Notes: #21345e
Abstract: The re-sequencing of the genomes of wild crop relatives is a rapid method to determine the likely utility of the germplasm in crop improvement. The conservation of genetic resources both in situ and ex situ can be guided by information on the novelty of specific populations at the whole-genome and specific allele levels. The analysis of Australian wild relatives of rice, coffee, Macadamia and Eucalypts is being used to support crop improvement and enhance food and energy security. Rice populations that are novel sources of diversity in the A genome of rice have been characterized at the whole-genome level. This has demonstrated the novelty of these species and will support taxonomic revisions of the Oryza species. Variation in the genomes of plants from diverse environments defines strategies that might be employed to develop climate-resilient crop varieties. Eucalypt sequencing aims to support the selection of species and genotypes for use as new energy crops.

Manrique Chica O. and J. Rosique Gracia. 2014. Food Security and Food Safety in Households of Day Laborers in Certified and Non-Certified Coffee Farms at the Southwest of Antioquia - Colombia Seguridad E Inocuidad Alimentaria En Hogares De Jornaleros De Fincas Cafeteras Con Y Sin Certificación Del Suroeste De Antioquia - Colombia. Vitae, 21:20-29.
Reference ID: 21346
Notes: #21346e
Abstract: Background: Few studies have been produced about quality and safety of foods in coffee areas from Antioquia, before and after the change in coffee production models by introducing certified coffees. However, these products are valuable for their positive impact on the economy, quality of life and food security on the sectors involved in production. Objectives: To determine the effect of certification on food security and safety in day laborers households at the Southwest of Antioquia. Methods: We selected 79 households of resident day laborers (41 from

certified farms and 38 from non-certified) for comparative analysis. Samples of drinks (juice) in everyday use were collected for analysis by counting the most probable number (MPN) of total (TC) and fecal coliforms (FC), using the technique of Fluorocult LMX (Merck®, USA). It was applied the Latin American and Caribbean Food Security Scale (ELCSA) and a survey to assess the availability and access to food, economy, education, housing quality and nutritional status by the Body Mass Index (BMI). After identifying the variables that best represented the components of household food security, we performed an analysis of MDS (Multidimensional Scaling) to find associations between food security components and ELCSA levels. Results: No significant differences were found in food security in the ELCSA, by type of farm. The certified farms had a tendency to be associated to low TC contamination, low incomes and higher food and housing costs. The MDS showed that acceptable quality in total coliform was more associated to certification than to other variables, and FC contamination to mild insecurity. Conclusions: The certification in coffee farms is not significantly associated with household food security of day laborers working in such sites. Meanwhile, CF contamination can be considered as an indicator of mild food insecurity.

Bacon C. M., W. A. Sundstrom, M. E. Z. Gomez, V. E. Mendez, R. Santos, B. Goldoftas, and I. Dougherty. 2014. Explaining the 'hungry farmer paradox': Smallholders and fair trade cooperatives navigate seasonality and change in Nicaragua's corn and coffee markets. Global Environmental Change, 25:133-149.
Reference ID: 21347
Notes: #21347e
Abstract: Latin American smallholder coffee farmers linked with fair trade and organic markets are frequently cited as models for sustainable food systems. Yet many experience seasonal hunger, which is a very common, but understudied, form of food insecurity. Northern Nicaragua's highlands include wellorganized cooperatives, high rural poverty rates, and rain dependent farms, offering a compelling study area to understand what factors are associated with seasonal hunger. This participatory mixed methods study combines data from observations, interviews and focus groups with results from a survey of 244 cooperative members. It finds that seasonal hunger is influenced by multiple factors, including: (1) annual cycles of precipitation and rising maize prices during the lean months; (2) inter annual droughts and periodic storms; and (3) the long-term inability of coffee harvests and prices to provide sufficient income. Sampled households experienced an average of about 3 months of seasonal hunger in 2009. A series of five least squares regression models find the expected significant impacts of corn harvest quantity, farm area, improved grain storage, and household incomes, all inversely correlated with lean months. Unanticipated results include the finding that households with more fruit trees reported fewer lean months, while the predominant environmentally friendly farming practices had no discernable impacts. The presence of hunger among producers challenges sustainable coffee marketing claims. We describe one example of a partnership-based response that integrates agroecological farm management with the use of fair trade cooperative institutions to re-localize the corn distribution system. Increased investments and integrated strategies will be needed to reduce threats to food security, livelihoods, and biodiversity associated with the rapid spread of coffee leaf rust and falling commodity prices.

Kanyamurwa J. M., S. Wamala, R. Baryamutuma, E. Kabwama, and R. Loewenson. 2013. Differential returns from globalization to women smallholder coffee and food producers in rural Uganda. African Health Sciences, 13:829-841.
Reference ID: 21348
Notes: #21348e
Abstract: Background: Globalization-related measures to liberalize trade and stimulate export production were applied in Uganda in the late 1980s, including in the coffee production sector, to revitalize agricultural production, increase incomes to farmers and improve rural food security.
Objective: To explore the different effects of such measures on the health and dietary outcomes of female coffee and food small holder farmers in Uganda. Methods: We gathered evidence through a cross-sectional comparative interview survey of 190 female coffee producers and 191 female food producers in Ntungamo district. The study mostly employed quantitative methods of data collection, targeting the sampled households. We also utilized qualitative data; collected three months after the household survey data had been collected and their analysis had been accomplished. Using qualitative interviews based on an unstructured interview guide, extra qualitative information was collected from key informants at national, district and community levels. This was among other underlying principles to avoid relying on snapshot information earlier collected at household level in order to draw valid and compelling conclusions from the study. We used indicators of production, income, access to food and dietary patterns, women's health and health care. Of the two groups selected from the same area, female coffee producers represented a higher level of integration into liberalised export markets.
Results: Document review suggests that, although Uganda's economy grew in the period, the household economic and social gains after the liberalization measures may have been less than expected. In the survey carried out, both food and coffee producers were similarly poor, involved in small-scale production, and of a similar age and education level. Coffee producers had greater land and livestock ownership, greater access to inputs and higher levels of income and used a wider variety of markets than food producers, but they had to work longer hours to obtain these economic returns, and spent more cash on health care and food from commercial sources. Their health outcomes were similar to those of the food producers, but with poorer dietary outcomes and greater food stress.
Conclusions: The small-scale women farmers who are producing food cannot rely on the economic infrastructure to give them support for meaningful levels of production. However, despite having higher incomes than their food producing counterparts, the evidence showed that women who are producing coffee in Uganda as an export commodity cannot rely on the income from their crops to guarantee their health and nutritional wellbeing, and that the income advantage gained in coffee-producing households has not translated into consistently better health or food security outcomes. Both groups have limited levels of autonomy and control to address these problems.

ISP. The Planter July 2015. [91], 435-508. 2015. Kuala Lumpur, ISP Management Sdn Bhd.
Reference ID: 21349
Notes: S #21349 Vol 91 No 1072
Abstract: In this issue:
Raising Occupational Safety and Health in Plantation Sector
Oil Palm Plantings at High Altitudes

Enhancement of Land Preparation Techniques during Replanting Using GIS/UAV for Mechanisation and Optimum Planting Density
The Ladies- An Appreciation
Presentation of FISP Award
Book Review: Oil Palm- Best Management Practices for Yield Intensification

IPNI. Better Crops with Plant Food. Better Crops With Plant Food 99[3], 1-23. 2015.
Reference ID: 21350
Notes: S #21350

Sibelet N. and M. Montzieux. 2012. Resilience factors in the coffee sector of Kenya: From food security to product removal. Cahiers Agricultures, 21:179-191.
Reference ID: 21351
Notes: #21351e
Abstract: As in many countries, the coffee sector of Kenya was strongly affected by the international crises in coffee prices of 1998 to 2004, doubled of a strong inflation. Still, the agricultural advisory services continue to recommend monoculture of coffee to optimize quality. In 2008, the price increase of cereals and the inputs further reduced the purchasing power of the producers. Today, the actors in the coffee sector, concerned by the future of coffee culture in Kenya, question its profitability. The objective of this research is to understand the factors explaining the permanence of coffee in this context. During research undertaken in 2008-2010, 160 producers of three cooperatives located in the principal coffee producing zone of Mount Kenya were interviewed on their practices, activities and projects, agricultural or other. The results showed that the benefit of coffee is low, even worthless for the majority of the producers. However, the coffee-trees always present on the farms are part of a multifonctionnal and agroforestry system. Furthermore, where the coffee is multipurpose, it provides monetary income, employment, food safety and access to credit through the cooperative to pay for inputs and schooling. Considering the three studied zones, the results showed that the practices concerning coffee are related to the capacity of the cooperative to manage risk in case of crisis as well as other production opportunities. The study of agrarian dynamics, makes it possible to understand the phenomenon of coffee resilience in Kenya and highlights ideas to take into account when developing a focus based not solely on pure coffee culture but on a production set of the Mount Kenya area by also considering the dairy sector.

Lin B. B. 2010. The role of agroforestry in reducing water loss through soil evaporation and crop transpiration in coffee agroecosystems. Agricultural and Forest Meteorology, 150:510-518.
Reference ID: 21352
Notes: #21352e
Abstract: With increasing patterns of climate change and variability, water resources for agriculture may become more unpredictable. The possibilities of decreased precipitation and increased competition for water resources will be especially important for farmers who depend on rainfed agriculture. A study of coffee agroforestry systems in Southern Mexico (Chiapas, Mexico) was conducted to examine the ability of shade trees to maintain water availability for the coffee crop in a shade agroecosystem. Soil moisture, soil evaporation rates, and the evaporative transpiration potential of coffee plants were measured to examine the amount of water available to coffee plants and potential amount of water lost by the soil and

coffee plants in systems under varying levels of shade cover. Soil evaporation and evaporative demand for crop transpiration were compared in coffee systems under different levels of shade canopy during both the wet season and dry season between July 2004 and June 2005. With 60-80% shade cover, daily soil evaporation rates significantly decreased by 41% compared to the low shade site (10-30% shade), although high levels of soil moisture were maintained in the dry season with only 30-65% shade cover. Coffee transpiration demand was strongly affected by shade cover as shade cover affects microclimate and the radiant energy within the system. Microclimate factors (light, temperature, and air saturation vapor pressure deficit) showed strong correlations to evaporative demand as a result. Shade cover >= 0% showed significant reductions of 32% in evaporative transpiration demand when compared to the low shade site. The presence of shade cover in agroforestry systems is capable of reducing overall evaporative demand from soil evaporation and coffee transpiration, therefore offering a higher level of crop protection for farmers with agricultural vulnerability to reduced water resources.

Chandrashekara U. M. 2009. Tree species yielding edible fruit in the coffee-based homegardens of Kerala, India: their diversity, uses and management. Food Security, 1:361-370.
Reference ID: 21353
Notes: #21353e
Abstract: The homegardens of Kerala are known for the high diversity of their species in both cultivated and managed plant communities, with fruit trees as one of the more important components. A study was conducted to quantify the density and diversity of both cultivated and non-crop trees that yielded edible fruit (hereafter, fruit trees) in coffee-based homegardens of the State. Among 101 species of fruit trees from 25 homegardens, 46 were cultivated and the rest were non-crop species. Cluster analysis of their relative density differentiated three clusters (Homegarden Types) which demonstrated variation in their structural characteristics. Tree density, Shannon index of diversity and evenness index in Homegarden Type 1 were significantly higher ($P<0.05$) than in Homegarden Types 2 and 3. In the study area, the non-crop species most preferred for their fruits included Baccaurea courtallensis, Carissa carandus, Chrysophyllum roxburghii, Feronia elephantum, Flacourtia montana, Garcinia xanthochymus, Madhuca indica, Madhuca longifolia, Mimusops elengi, Zizyphus mauritiana and Zizyphus rugosa. Collection of fruits of cultivated species is primarily by special collection trips, whereas that of non-crop species is generally during casual visits by adults and children. In the study area, cultivated species were actively managed (eg. weeding, fertiliser application and pruning of branches) but for non-crop species management was relatively passive (toleration and protection). Contrary to the general fear at the global level that homegardens are losing their traditional characteristics and are being transformed into species-poor, cash-crop production systems, the homegardens of the present study are examples in which many traditional ecological features are being maintained. Recommendations, drawn from the results, for enhancing the economic value of homegardens and ensuring food security include tree improvement, domestication and sustainable cultivation of non-crop fruit trees in order to conserve diversity.

Eakin H., A. Winkels, and J. Sendzimir. 2009. Nested vulnerability: exploring cross-scale linkages and vulnerability teleconnections in Mexican and Vietnamese coffee systems. Environmental Science & Policy, 12:398-412.
Reference ID: 21354
Notes: #21354e
Abstract: Analyses of the vulnerability of farm populations and food systems to exogenous change, whether in relation to climatic extremes, market shocks, epidemics or other concerns, have typically been approached through a focus on the place of food production or the specific sub-sector exposed to stress. Relatively little attention has been paid to the ways in which national institutions, history and social expectations transform the same signals of global change into very different outcomes in distinct geographic contexts. The channels that convey signals of change from the global to the local may also work in reverse, connecting the responses and choices of households in one geographic context to outcomes and choices of other households in quite distant places. We draw from recent case studies of farm-level vulnerability and livelihood security in Mexico and Vietnam to demonstrate that coffee smallholders' independent responses to the risks and opportunities associated with global scale economic and environmental change, are teleconnected and thus can create feedbacks which in turn affect the present and future vulnerabilities of other smallholders around the globe.

Amede T. and R. J. Delve. 2008. Modelling Crop-Livestock Systems For Achieving Food Security And Increasing Production Efficiencies In The Ethiopian Highlands. Experimental Agriculture, 44:441-452.
Reference ID: 21355
Notes: #21355e
Abstract: An action research process was conducted with communities in Gununo, southern Ethiopia (2000-2003), to develop alternative cropping strategies for achieving their food security and cash needs. Farmers identified three major production objectives depending oil their household priorities and socio-economic status. In Group I, farmers are currently food insecure and want to produce enough food from their own farms. In Group II, they produce enough food but want to fulfil their financial needs. In Group III, farmers rely on off-farm activities and want to increase cash income. The current system mostly fulfils the nutritional requirement of Group II. Groups I and III were highly food deficit from their own farms, with production covering less than seven months per year and fulfilling <50% of the recommended daily allowances (RDA) for human nutrition. Using a linear programming optimization model, it teas possible to fulfil the RDA of Group I by reallocating the cropping area of maize, sweet potato, coffee and wheat to potato, enset and kale in proportions of 50, 29 and 15%, respectively. To satisfy both financial and nutritional needs of Group II, ail increase in the proportion of coffee and beans by about 29 and 7.3%, respectively; over the current land allocation was needed. This shift would triple their cash income. The cash income of Group III increased four-fold by full replacement of the cereals and root crops by coffee (48%) and teff (52%), though the total income was not enough to secure food security due to their small landholdings. Ill farms of Groups I and II, the shift to the suggested cropping will reduce soil erosion by about 40%, while it will have no effect oil farms of Group III. This shift will reduce the quantity and quality of livestock feed, except for Group I. Moreover, it will increase the farm crop water requirement 17.5 and 37% in Groups I and III (resource poor households) and reduce it ill resource rich households of Group II. These changes did not imply extra labour in any groups.

Whilst this model can optimize systems for food security and cash income, its research for development value is in identifying possible intensification strategics for farming systems and their implications on the farming systems, rather than generating practical recommendations for all cropping systems.

Ruf F. 2000. Socioeconomic factors modulating plantation replanting. Ocl-Oleagineux Corps Gras Lipides, 7:189-196.
Reference ID: 21356
Notes: #21356e
Abstract: The former's objective is to maintain or increase income and food security despite a land shortage. Replanting should enable farmers to face land shortages, forest shortages (the dissolution of forest rent - lower fertility, more weeds, more pests, etc.), aging orchards and the accompanying yield reduction and increased maintenance and harvest costs, risk food shortages and an opportunity to use new planting materials, labor and capital constraints may hamper replanting because farmers who replant neither benefit from forest rent nor from cheap access to land. Replanting may also confront a labor shortage because migration has slowed or children have been sent to school. In the intersection between family life cycles and tree life cycles, older farmers may lack the labor to replant, while young men may not always have access to land. Cut trees may have a cash value, which is a means to convert tree capital and labor to cash. Price factors directly trigger a replanting decision by comparing prices of a tree crop to those of an annual crop that can be intercropped, or by anticipating higher prices for the tree crop in the years to come. Price factors may indirectly trigger a replanting decision by lowering maintenance and inputs devoted to the established trees. A decline in yield and income could increase tree mortality which would make the replanting decision easier.

Guntzer F., C. Keller, and J. D. Meunier. 2012. Benefits of plant silicon for crops: a review. Agronomy For Sustainable Development, 32:201-213.
Reference ID: 21357
Notes: #21357e
Abstract: Since the beginning of the nineteenth century, silicon (Si) has been found in significant concentrations in plants. Despite the abundant literature which demonstrates its benefits in agriculture, Si is generally not considered as an essential element. The integration of Si in agricultural practices is, however, effective in a few countries. Silicon fertilization by natural silicates has the potential to mitigate environmental stresses and soil nutrient depletion and as a consequence is an alternative to the extensive use of phytosanitary and NPK fertilizers for maintaining sustainable agriculture. This review focuses on recent advances on the mechanisms of Si accumulation in plants and its behavior in soil. Seven among the ten most important crops are considered to be Si accumulators, with concentration of Si above 1% dry weight. New approaches using isotopes and genetics have highlighted the mechanisms of uptake and transfer of Si in planta. There is a general agreement on an uptake of dissolved silica as H4SiO4 and precipitation as amorphous silica particles (the so-called phytoliths), but the mechanism, either active or passive, is still a matter of debate. The benefits of Si are well demonstrated when plants are exposed to abiotic and biotic stresses. The defense mechanisms provided by Si are far from being understood, but evidences for ex planta and in planta processes are given indicating multiple combined effects rather than one single effect. Phytoliths that are located mainly in shoots of monocots return to the soil through litterfall if the plants are not harvested and contribute to the biogeochemical cycle of Si. According

to recent progress made on the understanding of the biogeochemical cycle of Si and the weathering process of silicate minerals, phytoliths may significantly contribute to the resupply of Si to plants. We suggest that straw of crops, which contains large amounts of phytoliths, should be recycled in order to limit the depletion of soil bioavailable Si.

Vasane S. R. and R. M. Kothari. 2008. An integrated approach to primary and secondary hardening of banana var. Grand Naine. Indian Journal of Biotechnology, 7:240-245.
Reference ID: 21358
Notes: #21358e
Abstract: For improving banana productivity, virus-indexed Grand Naine plantlets were used for primary and secondary hardening. Among nine combinations of bio-fertilizers (including VAM) used, GNP(2)V(1) medium comprising of peat fortified with nitrogen fixing and phosphate solubilizing microbes (each 1 g/plantlet) and VAM (2 g/plantlet) emerged as the optimal growth medium for primary hardening on the basis of statistically significant 98.9% survival, besides corroborating optimal morphological features (viz. root length, number of primary roots, % VAM colonization, height, girth, number of leaves, leaf area and chlorophyll content) at the end of primary hardening. For secondary hardening, among four combinations of bio-fertilizers and VAM used in conjunction with soil, press mud cake (PMC) and vermi-compost (VC), SNP2V1 medium comprising of soil, PMC and VC in a ratio of 1:1:1 (v/v/v) emerged as the optimal growth medium on the basis of statistically significant 97% survival, corroborated by optimal morphological features as above, along with uptake of macro- and micro-nutrients. The positive feedback by several monitoring parameters have left no doubt about the integrated outcome at the end of primary and secondary hardening.

Angeles D. E. 2008. Uptake of P-32 in papayas banana & pineapple grown in a polyculture system. Philippine Journal of Crop Science, 33:69-79.
Reference ID: 21359
Notes: #21359e
Abstract: A radiotracer study was conducted to determine the uptake of phosphorus in the main and secondary crops under papaya + pineapple and banana + pineapple intercropping systems using radiophosphorus. P-32 was applied to 11-month old papaya and banana in two lateral distances and depths. Each banana received 3.28 mCi and each papaya 4 mCi. The activity of P-32 in the achlorophyllous D leaves of pineapple, the blade of the 3(rd) leaf of banana, and the petiole of the leaf subtended by newly opened flower of papaya was determined in a scintillation counter. Results showed that banana in a pure stand had generally higher P-32 activity than under intercropping. Both banana and pineapple as intercrops benefited from P-32 applied to banana. In both pure stand and intercropping system, P-32 activity in banana was higher at 40-cm than 80-cm radius, as well as at 15 cm deep. As the distance from the trunk increased pineapple took in more P-32. Pineapple at the point of application had higher P-32 activity than at 30 cm inside or outside the point of application. Of the total P-32 absorbed 22% went to banana and 78% to pineapple. A similar result was obtained in the case of papaya. Higher activity was observed in papaya at 60-cm radius, 15-cm deep. Pineapple at the point of application had the highest P-32 activity. The vigorous growths of the stems and leaves as well as the roots of papaya and banana raised as intercrops are a clear proof of the favorable synergism of pineapple with the main crop. Competition for nutrients may exist and

reduce the growth of one of the crops in an intercropping system only under an insufficient supply of nutrients.

Diaz A., G. Cayon, and J. J. Mira. 2007. Calcium metabolism and its relationship with "maturity bronzing" in banana fruits. A review: Metabolismo del calcio y su relación con la "mancha de madurez" del fruto de banano. Una revisión. Agronomia Colombiana, 25:280-287.
Reference ID: 21360
Notes: #21360e
Abstract: The maturity bronzing in banana fruits is a physiological disorder caused by a low calcium uptake by the plant in dry season. Several scientific reports demonstrated the close relationship of the disease with the calcium deficiencies during drought seasons. The fertilization and behavior of calcium with respect to other soil nutrients contributed to the incidence of maturity bronzing, indicated that the incidence is reduced with calcium nitrate fertilizations. The role of calcium in plants, its participation in cellular division and extension, hydric balance of cells, signalling cascade as response to an external stimulus, and its structural functions in the cellular walls and membranes are analyzed. The role of calcium in banana culture, its mobility in soil, relationship with other bases, the process of Ca assimilation through the roots, and its relationship with the incidence of maturity bonzing of fruits are discussed.

Opfergelt S., D. Cardinal, C. Henriet, X. Draye, L. Andre, and B. Delvaux. 2006. Silicon isotopic fractionation by banana (Musa spp.) grown in a continuous nutrient flow device. Plant and Soil, 285:333-345.
Reference ID: 21361
Notes: #21361e
Abstract: The determination of the plant-induced Si-isotopic fractionation is a promising tool to better quantify their role in the continental Si cycle. Si-isotopic signatures of the different banana plant parts and Si source were measured, providing the isotopic fractionation factor between plant and source. Banana plantlets (Musa acuminata Colla, cv Grande Naine) were grown in hydroponics at variable Si supplies (0.08, 0.42, 0.83 and 1.66 mM Si). Si-isotopic compositions were determined on a multicollector plasma source mass spectrometer (MC-ICP-MS) operating in dry plasma mode. Results are expressed as delta Si-29 relative to the NBS28 standard, with an average precision of +/- 0.08 parts per thousand (+/- 2 sigma(D)). The fractionation factor (29)epsilon between bulk banana plantlets and source solution is -0.40 +/- 0.11 parts per thousand. This confirms that plants fractionate Si isotopes by depleting the source solution in Si-28. The intra-plant fractionation Delta Si-29 between roots and shoots amounts to -0.21 +/- 0.08 parts per thousand. Si-isotopi c compositions of the various plant parts indicate that heavy isotopes discrimination occurs at three levels in the plant (at the root epidermis, for xylem loading and for xylem unloading). At each step, preferential crossing of light isotopes leaves a heavier solution, and produces a lighter solution. Si-isotopic fractionation processes are further discussed in relation with Si uptake and transport in plants. These findings have important implications on the study of continental Si cycle.

Yano-Melo A. M., O. J. Saggins, and L. C. Maia. 2003. Tolerance of mycorrhized banana (Musa sp cv. Pacovan) plantlets to saline stress. Agriculture, Ecosystems & Environment, 95:343-348.
Reference ID: 21362
Notes: #21362e
Abstract: Arbuscular mycorrhizal fungi (AMF) are known to increase plant tolerance to abiotic stress, in particular soil salinity. Isolates of Acaulospora scrobiculata Trappe, Glomus clarum Nicolson & Schenck and Glomus etunicatum Becker & Gerdemann were investigated under glasshouse conditions. Inoculated banana plants (Musa sp. cv. Pacovan) showed higher nutrient contents and growth rates than the controls. G. clarum was particularly efficient as growth promoter, and improved the dry weight of root (80%), shoot (83%), and the total leaf area (60%) compared to non-inoculated plants. The salt tolerance of banana as measured by leaf number and plant height increased considerably in presence of Glomus isolates. Inoculation with specific AMF therefore constitutes an alternative method to reduce banana plant stress caused by soil salinization.

Lecompte F., H. Ozier-Lafontaine, and L. Pages. 2003. An analysis of growth rates and directions of growth of primary roots of field-grown banana trees in an andisol at three levels of soil compaction. Agronomie, 23:209-218.
Reference ID: 21363
Notes: #21363e
Abstract: In monocotyledons, soil exploration by the root system is mainly due to primary roots. Classical root observations, from soil cores or minirhizotrons, do not allow local root growth rates to be related directly to soil physical conditions around the roots. The pattern of growth of banana primary roots in an andisol under field conditions was determined by destructive, architecturally-based samplings of the root system over a four-month period at three levels of soil compaction. Primary root growth rates were estimated from morphological measurements, while soil porosity around growing roots was assessed by soil coring. In all treatments, root growth rates appeared to be variable with time, and a linear regression between the root growth rate and root apical diameter, soil porosity and the degree-day sum (base 14 degreesC) accounted for 92% of the observed variance. Primary root growth was reduced by nearly 40% in the most compacted soil. Above-ground plant growth was also affected after a few weeks. Primary root growth directions were not affected by soil compaction and roots appeared to curve toward the horizontal plane when ageing. These results highlight the variability of root growth in field conditions, even in uniform soil conditions, and suggest possibilities for the development of root growth models and models of root system architecture.

Bapat V. A., A. S. Nirale, V. M. Kulkarni, P. Suprasanna, and P. S. Rao. 2001. Studies on mineral nutrient uptake using tissue culture derived plants of banana (Musa sp). Journal of Plant Biochemistry and Biotechnology, 10:79-81.
Reference ID: 21364
Notes: H 8.6.2.1 #21364e
Abstract: Banana (Musa sp) plants regenerated from in vitro culture were employed to study varietal differences of P-32 uptake. The results demonstrated that the selected varieties exhibited considerable variation for absorption, translocation and transport index of PO4 uptake. Use of tissue cultured derived plants can be efficiently utilised to analyse varietal differences in P-32 uptake.

Rufyikiri G., S. Declerck, J. E. Dufey, and B. Delvaux. 2000. Arbuscular mycorrhizal fungi might alleviate aluminium toxicity in banana plants. New Phytologist, 148:343-352.

Reference ID: 21365

Notes: #21365e

Abstract: Some mycorrhizal plants exhibit greater resistance than nonmycorrhizal plants to aluminium toxicity. This has not yet been shown for banana despite its importance as a cash and food crop in tropical regions, although bananas are sensitive to aluminium stress. We studied the effects of the arbuscular mycorrhizal fungus Glomus intraradices in alleviating aluminium toxicity in the banana cultivar Grande Naine grown in a continuous-nutrient-flow cultivation system using dilute solution. The micropropagated plants, some of which were inoculated with arbuscular mycorrhizal fungus, were grown for 40 d in pots filled with sand, and continuously irrigated with a nutrient solution containing up to 180 muM of aluminium. Water and nutrient uptake were measured once a week for 24 h, and root arbuscular mycorrhizal fungal colonization, biomass production, and mineral content of roots and shoots were measured at harvest. The root arbuscular mycorrhizal fungal colonization was large, and not significantly influenced by aluminium treatment. The effects of aluminium on both mycorrhizal and nonmycorrhizal plants were: decrease in biomass production, water and nutrient uptake, and magnesium content of roots and shoots; greater aluminium content in roots than in shoots; and increase in potassium and phosphorus content, particularly in roots. A significant positive effect of arbuscular mycorrhizal fungi on plant growth was observed with aluminium treatment, and was most pronounced at the highest concentration. The benefits, compared with nonmycorrhizal plants, included: increase in shoot dry weight, uptake of water and of most nutrients, and in calcium, magnesium and phosphorus content, particularly in roots; decrease in aluminium content in root and shoot; and delay in the appearance of aluminium-induced leaf symptoms. These results indicate that arbuscular mycorrhizal fungi could be effective in alleviating aluminium toxicity to banana plants.

Turner D. W. and E. Lahav. 1985. Temperature Influences Nutrient Absorption and Uptake Rates of Bananas Grown in Controlled Environments. Scientia Horticulturae, 26:311-322.

Reference ID: 21366

Notes: #21366e

Abstract: We explored the influence of temperature on the concentration of nutrients in banana plants, the nutrient uptake rate, apparent root transfer coefficient (ga) and the relationship between accumulation of dry matter and nutrient. Young banana plants (*Musa* (AAA group, Cavendish sub-group) 'Williams') were grown at six temperature regimes (17/10–37/30°C) in sunlit growth chambers for 12 weeks. The amount of nutrient absorbed was influenced by the amount of growth made, but the link between the two differed from one element to another. Temperatures less than reduced the concentration of all elements in the whole plant, except Fe. Temperature influenced the root uptake rate of B 10-fold; K, Na, Ca, Fe and Zn 3–4-fold; and N, P, Mg, Mn, Cu, Cl 1–2-fold. Among the elements the highest recorded rate was 12 mg g^{-1} day^{-1} for K at . The optimum temperature for nutrient uptake rates differed among the elements. This was accounted for largely by greater growth at those temperatures of organs with high concentration of particular elements. The ga (an estimate of efficiency of uptake) of B varied 12-fold among treatments; K, Ca, Mg, Na, Mn, Zn and Cl varied 3–5- fold and N, P, Cu and Fe varied 2–3-fold.

The ratio of relative nutrient accumulation rate, R_m, to the relative growth rate, R_w, was most stable across temperatures for N and least stable for B and Na. However, the trend was for to increase as temperature rose, indicating an absorption of nutrients greater than might be expected from a change in growth rate as temperature increased, and a decreased efficiency in their utilization for plant growth.

Soares F. A. L., H. R. Gheyi, F. H. T. de Oliveira, P. D. Fernandes, A. N. Alves, and F. V. Silva. 2008. Accumulation, export and restitution of nutrients by 'Prata Ana' and 'Grand Naine' bananas. Ciência Rural, 38:2054-2058.
Reference ID: 21367
Notes: H 8.6.2 #21367e
Abstract: The knowledge about the content of nutrients in the harvested part of plants is important to assess the quality of product and the removal of the nutrients from the cultivated area. This research was carried out to evaluate the nutrients exported (rachis of the inflorescence + fruits), and restituted to the soil, in a banana plantation. The study was conducted during the period of June, 2004 to May, 2005, in an Inceptisol, in the municipality of Limoeiro do Norte, Ceara, where two blocks of samplings were planted with 'Grand Naine' and 'Prata Ana' cultivars. Starting from the 30 days after planting, at 45 days interval, plant samples were collected, harvesting four clumps in fall competition, chosen at random for analysis. The sequence of nutrients exported by the bunch in case of 'Prata Ana' was K>N>Ca>P>Mg while in Grand Naine cultivar the sequence was of K>Ca>N>P>Mg. At harvest time, in the clumps of cv. Prato And were accumulated on an average 2.2 times more nutrients in comparison to mother plant while in the plants of Grand Name such relation was 1.2 times. Independent of cultivar, the order of the amount of nutrients returned to the soil after the crop removal was K>Ca>N>Mg>P.

Silva E. B., B. P. de Souza, S. L. R. Donato, E. P. Amorim, F. P. de Carvalho, and M. D. Almeida. 2014. Deficiencies of Macronutrients on Nutritional Status of Prata Type Bananas Seedlings. Bioscience Journal, 30:82-92.
Reference ID: 21368
Notes: #21368e
Abstract: This work objective to evaluate the effect of macronutrient deficiencies no growth and nutritional status of banana seedlings type Prata. The treatments were two genotypes Prata-Ana and its hybrid PA42-44 grown in nutrient solution in the presence and absence of macronutrients. Leaf area, dry matter of roots, rhizome and leaves, and the macronutrient dry mass of each plant were evaluated after 100 days. With these results was calculated the indices: absorption, transport and utilization efficiency of macronutrientes. The deficiencies of N for Prata-Ana and Mg for PA42-44 hybrid were most limited the growth of genotypes. The nutrient accumulation corresponded to the following order N > K > Ca > P > Mg > S for the Prata-Ana and N > K > Ca > P > S > Mg for the PA42-44 hybrid, which reflect the plant requirements. The PA 42-44 hybrid showed higher absorption efficiency of all macronutrients, in complete solution. The treatments no differ regarding to the macronutrients transport efficiency, except the omission of Mg, where higher efficiency occurred in hybrid PA 42-44. The P, K, Ca, Mg and S omission in the nutrition of two banana genotypes results in increased utilization efficiency, compared with plants growing adequately.

Taulya G. 2013. East African highland bananas (Musa spp. AAA-EA) 'worry' more about potassium deficiency than drought stress. Field Crops Research, 151:45-55.
Reference ID: 21369
Notes: H 8.6.2 #21369e
Abstract: Drought stress, potassium (K) and nitrogen (N) deficiencies are major constraints to rain-fed East African highland banana (EAHB) production in Uganda. It was hypothesised that the reduction in fresh bunch mass and increase in dry matter (DM) allocation to corms with drought stress, K and N deficiency is additive. Individual plant measurements at harvest from two field trials in central and south western Uganda were analyzed to evaluate effects of cumulative rainfall (CRF) received 365 days from sucker emergence, mineral K and N inputs on EAHB bunch yields. Dry matter content in aerial shoot (leaves and pseudostems) relative to that in the subterranean corm was also analyzed to evaluate DM allocation plasticity due to drought stress, K and N deficiency. This was verified with allometric analysis using pre-harvest stage plants from farms of known K and N nutritional status and plants from a screen house drought stress pot trial in Uganda. Dry matter production and yields were mainly driven by K interacting with CRF. Within 12 months, K input (250-600 kg K ha(-1) yr(-1)) increased bunch yield from 8 to 15 Mg ha(-1) yr(-1) irrespective of whether dry (CRF < 1100 mm) or wet (CRF >= 1100 mm) conditions prevailed, possibly due to K-mediated osmotic adjustment under dry conditions. Without K input, wet conditions increased bunch yield from 6 to 8 Mg ha(-1) yr(-1) while dry conditions decreased it from 6 to 4 Mg ha(-1) yr(-1) within 12 months. Total DM and its distribution between the biomass structures followed similar trends. Nitrogen input (150-400 kg N ha(-1) yr(-1)) neither affected bunch yield nor DM allocation at harvest stage. At pre-harvest stage, reduction in DM allocation to the corm per unit increase in total DM was 14-22% significantly lower with N and/or K deficiency compared with that under sufficient K and N. Drought stress per se had no effect on DM allocation but enhanced DM allocation shifts due to K deficiency. Drought-stressed EAHB thus increase DM allocation to subterranean structures only if K-deficient, unlike responses reported for other plant species. Potassium nutrition is perhaps a more viable entry point for mitigation of drought stress in EAHB cropping systems than irrigation but this requires further agronomic and economic evaluation. It may be important to account for carbon allocated to osmotic adjustment for realistic simulation of water- and K-limited growth in EAHB.

Ndabamenye T., P. J. A. van Asten, G. Blomme, B. Vanlauwe, R. Swennen, J. G. Annandale, and R. O. Barnard. 2013. Ecological characteristics and cultivar influence optimal plant density of East African highland bananas (Musa spp., AAA-EA) in low input cropping systems. Scientia Horticulturae, 150:299-311.
Reference ID: 21370
Notes: #21370e
Abstract: Numerous studies have been conducted on the effects of plant density on growth and yield of dessert bananas in the humid tropics, but effects of plant densities in relations with ecological characteristics in low input East African highland banana (Musa spp., AAA-EA genome) cropping systems have not been reported. On-station field experiments were conducted in three contrasting agro-ecological sites of Rwanda (Kibungo low rainfall with medium soil fertility, Rubona high rainfall with low soil fertility and Ruhengeri high rainfall with high soil fertility) to explore germplasm x environment interactions. Five different plant densities (plants ha(-1)): 1428, 2500, 3333, 4444 and 5000 and two cooking ("Ingaju", "Injagi") and one beer ("Intuntu") cultivars were investigated. The effect of plant density on plant

performance (growth and yield) over two cropping cycles in low input systems was determined. The effects of site x cultivar and site x density interactions on yield traits were significant ($p<0.05$). Annual yield increased with increasing plant density but strongly depended on agro-ecological site (from 6.1 to 9.2 t ha(-1) yr(-1) at Kibungo, 9.5 to 21.5 t ha(-1) yr(-1) at Rubona and 7.0 to 25.0 t ha(-1) yr(-1) at Ruhengeri). Yields of beer cultivars increased with density, but those of cooking cultivars decreased. Maximum yields were attained at 4444 plants ha(-1) at Kibungo and Rubona whilst yields increased linearly beyond this level at Ruhengeri. Crop cycle duration was prolonged with increasing plant density. Relationships between bunch yield, the total above ground dry matter yields and soil chemical properties suggest that nutrient deficiencies were larger at Kibungo (e.g. K) and Rubona (e.g. K, P, Ca and Mg) compared with Ruhengeri, where yield correlated significantly with leaf area index (LAI). LAI increases up to 4, where 95% of solar radiation was intercepted by the crop canopy, indicating that increasing the LAI above 4 would have little effect on production. Evaporation was much greater at lower rainfall areas (e.g. Kibungo) and accompanied by negative annual water deficit (-135 mm yr(-1)) than at high rainfall areas (e.g. Ruhengeri) with positive water surplus (382 mm yr(-1)). Growing degree days from planting to bunch harvest were higher at Kibungo (3675 degrees C days) but much less at the Ruhengeri cooler site (1729 degrees C days), implying temperature is not restrictive at Ruhengeri. This study showed that the optimal density for bananas depends on water availability, soil fertility and cultivar, which serves as an entry point to maximize yield potential for the East African smallholder farmers rather than using a uniform blanket recommended density. We suggest that agronomic optimal plant density is lower (<4444 plants ha(-1)) in low rainfall (<1000 mm yr(-1)) and less fertile areas but seem to be higher (>5000 plants ha(-1)) in areas with high fertility which receive high rainfall (>1300 mm yr(-1)).

Wairegi L. W. I., P. J. A. van Asten, M. M. Tenywa, and M. A. Bekunda. 2010. Abiotic constraints override biotic constraints in East African highland banana systems. Field Crops Research, 117:146-153.
Reference ID: 21371
Notes: #21371e
Abstract: Banana is the primary food crop in Uganda, but yields are low due to a complex of abiotic and biotic constraints. However, quantitative information on the importance, interactions, and geographic distribution of yields and constraints is scanty. We monitored yields, biotic and abiotic constraints in 159 plots in Central, South and Southwest Uganda in 2006-2007. About half the plots were on-farm demonstrations that received fertilizer (average 71N, 8P, 32 K kg ha(-1) year(-1)) through a development project, the rest were ordinary farmer fields (i.e. controls). Fresh banana yields in controls were significantly ($P <= 0.05$) higher in Southwest (20 t ha(-1) year(-1)) compared with Central (12 t ha(-1) year(-1)) and South (10 t ha(-1) year(-1)). Demonstrations yielded 3-10 t ha(-1) year(-1) more than controls. Yield losses were calculated using the boundary line approach. In Central, yield losses, expressed as percentage of attainable yield, were mainly attributed to pests (nematodes 10% loss, weevils - 6%) and suboptimal crop management (mulch 25%). In South, poor soil quality (pH - 21%. SOM - 13%, N-total - 13%, and Clay - 11%) and suboptimal crop management (weeds - 20%) were the main constraints. In Southwest, suboptimal crop management (mulch 16%), poor soil quality (K/(Ca + Mg) - 11%) and low rainfall (5%) were the primary constraints. The study revealed that biotic stresses (i.e. pests, weeds) are particularly important in Central, whereas abiotic stresses (i.e. nutrient deficiencies, drought) dominate in South and

Southwest. This study concludes that (i) technologies currently available allow farmers to double yields and (ii) past research efforts have mistakenly neglected abiotic constraints.

Teixeira L. A. J., W. R. D. Santos, and O. C. Bataglia. 2002. The N and K diagnosis on banana plants using the diagnosis and recommendation integrated system (DRIS) and critical value approach: Diagnose nutricional para nitrogênio e potássio em bananeira por meio do sistema integrado de diagnose e recomendação (DRIS) e de níveis críticos. Revista Brasileira De Fruticultura, 24:530-535.
Reference ID: 21372
Notes: #21372e
Abstract: The Performance of DRIS and critical value approach (CVA) diagnostics were evaluated based on leaf analysis from a field experiment on a factorial design to study the yield response of banana to N and K applications during two crop seasons. The situations identified as deficient were classified as positives (+) and those diagnosed as sufficient, were classified as negatives (-). According to the response on yield due the application of N or K, the diagnostics were classified as true (V) or false (F). Four combinations were possible: V+, V-, F+ and F-. The efficiency for N diagnostics (%V+ and %V-) based on the critical value approach was 48%, while using the DRIS it was 69%. The efficiency for K diagnostics was 63% for both DRIS and CV methods. The relation between deficient diagnostics confirmed by positive response on yield under application of the nutrient and false positive cases (%V+¸%F+) for N was 1.5 for the DRIS and 0.68 for CVA. For the K deficiency diagnostics, the value of this relation was 1.67 for both methods. The net yield derived from N application based on correct diagnostics (48 cases) was 124 Mg ha-1 for DRIS and 20 Mg ha-1 for the CVA. For K, this variation was 70 Mg ha-1 for the DRIS and the CVA.

Hoffman R. B., F. H. T. de Oliveira, H. R. Gheyi, A. P. de Souza, and J. A. de Arruda. 2010. Accumulation of dry matter, absorption and exportation of micronutrients in banana (Musa spp.) varieties under irrigation. Ciencia E Agrotecnologia, 34:536-544.
Reference ID: 21373
Notes: H 8.6.2 #21373e
Abstract: To estimate the demand of micronutrients for the banana plants (Musa spp.), it is essential to know the amounts of dry matter and micronutrients accumulated in the plant and exported by the bunch. The objective of this study was to evaluate the accumulation of dry matter and micronutrients by six banana varieties under irrigation. Plants of Grande Naine, Pacovan, Pacovan-Apodi, Prata-Ana, Terrinha and Gross Michel varieties grown in double rows, with a density equivalent to 1,666 plants per hectare were sampled. At harvest four plants of each variety were selected for sampling of mother-plant, which was divided into rhizome, pseudostem, petiole, leaf blade, stalk and fruits. The plant parts were weighed to determine the fresh weight of each part and a sample of about 700 g of each part was collected to determine dry weight and contents of micronutrients. The samples were washed quickly with tap water and later with distilled water and placed in a greenhouse for pre-drying and afterwards conditioned in paper bags were put in an oven of forced circulation of air for obtaining the dry matter and subsequent determination of the contents of B, Cu, Fe, Mn and Zn. The varieties Pacovan, Prata Ana e Pacovan Apodi accumulated greater amounts of dry matter and micronutrients, when compared to the varieties Grande Naine, Gross Michel e

Terrinha, observing the following decreasing order of accumulation and export of micronutrients: Mn > Fe > B > Zn > Cu.

Teixeira L. A. J., F. C. B. Zambrosi, and J. E. B. Neto. 2007. Nutritional diagnosis in banana in the state of Sao Paulo (Brazil): Dris norms and critical levels: Avaliação do Estado Nutricional de Bananeiras do Subgrupo Cavendish no Estado de São Paulo: Normas Dris E Níveis Críticos de Nutrientes. Revista Brasileira De Fruticultura, 29:613-620.
Reference ID: 21374
Notes: H 8.6.2.1 #21374e
Abstract: Preliminary DRIS norms and leaf nutrient critical levels (NCL) for Cavendish bananas growing in plantations of Sao Paulo State (Brazil) are presented. DRIS norms and NCL were established from a data bank of leaf nutrient concentration (N, P, K, Ca, Mg, B, Cu, Fe, Mn and Zn) and yield of banana with 188 samples. Data bank comprises information from plants of Grand Naine and Giant Cavendish growing in irrigated and non-irrigated areas, with different sources and rates of fertilizers during five crop cycles. Despite of the great diversity of cropping conditions, the regression between nutrient balance index and fruit yield was significant (R(2)=0.60; p<0.0001). The NCLs were derived using multiple linear regressions relating to the foliar nutrient concentration with DRIS indices of all nutrients. These values were similar to those presented in the literature, except the NCL for K which the value for local conditions was lower.

Borges A. L. and R. C. Caldas. 2004. Nutrient levels in banana leaves, cultivar Pacovan, grown under irrigation: Teores de Nutrientes Nas Folhas de Bananeira, Cv. Pacovan, Sob Irrigação. Ciencia E Agrotecnologia, 28:1099-1106.
Reference ID: 21375
Notes: H 8.6.2 #21375e
Abstract: Chemical analyses of nutrient contents in leaves is possible to indicate the plant nutritional state, where the results is compared with a standard. For results interpretation it is necessary the establishment standard values that are based on correlation studies between nutrient concentration in the leaves and crop development or yield. The objective of this work was to establish critical levels of macro and micronutrients in banana leaves, cultivar Pacovan, grown under irrigation in the Petrolina-PE/Juazeiro-BA region. In selected banana orchards 20 plants were chosen for further evaluations. Leaf sample were collected at flowering for chemical analyses and bunch weight determined. Evaluations were carried out during two production cycles. Descriptive statistical analysis was performed considering four extracts of bunch weight (<= 10; > 10 and 15; > 15 and 20; > 20 kg), and plants that produced bunch 20 kg heavier express an ideal nutritional conditions. The nutrient levels determined for the banana cultivar Pacovan, grown under irrigation, in the Petrolina-Juazeiro region, were the following: 22-24 g of N/kg; 1,71,9 g of P/kg; 25-28 g of K/kg; 6,3-7,3 g of Ca/kg; 3,1-3,5 g of Mg/kg; 1,7-1,9 g of S/kg; 13-16 mg of B/kg; 6-7 mg of Cu/kg; 71-86 mg of Fe/kg; 315-398 mg of Mn/kg; and 12-14 mg of Zn/kg.

Gurav R. G. and J. P. Jadhav. 2013. A novel source of biofertilizer from feather biomass for banana cultivation. Environmental Science And Pollution Research, 20:4532-4539.
Reference ID: 21376
Notes: #21376e

Abstract: Feather waste is a promising protein biomass available as by-product from poultry processing was found to be rich in peptides, amino acids, and minerals like nitrogen, phosphorus, potassium, calcium, magnesium, iron, manganese, zinc, and copper. Soil and foliar application of these products, besides representing a sustainable solution to the problem of feather disposal, may also represent an effective strategy to tackle the environmental effluence. As a consequence, they were also found to be very attractive in elevating the protein, amino acids, reducing sugar, total chlorophyll, and proline content of plants. On the other side, fertilizing effect enhanced the antioxidant potential of banana fruit which was assessed using 2, 2-diphenyl-1-picrylhydrazyl, ferric reducing/antioxidant power, and N, N-dimethyl-p-phenylendiamine. This was associated with considerably higher antioxidant contents like total phenolics and flavonoids. Therefore, the application of this organic amendment could promote and improve the agro-ecosystem, human health; soil biological activities, and at the same time enhance the production of plant or products rich in bioactive substances.

Zucoloto M., J. S. D. Lima, R. I. Coelho, S. D. Silva, and G. S. de Souza. 2010. Estimation of Nutrients Foliar of Tree Banana 'Prata Ana' Using Cokrigagem: Estiva De Ca E Mg Foliares Por Meio De Ca E Mg Do Solo Em Bananeira 'Prata Anã' Utilizando Cokrigagem. Bioscience Journal, 26:835-842.
Reference ID: 21377
Notes: #21377e
Abstract: The objective of this study was to investigate the efficiency of the cokrigagem statistical method to estimate the Ca and Mg leaf of tree banana 'Prata Ana', using the Ca and Mg in the soil as auxiliary variables. Were collected around each plant four samples of soil layer from 0 - 0.2 m then homogenised to form a composite sample. For leaf analysis were collected from 10 to 25 cm from the inner leaf of the median, the third leaf from apex eliminating the midrib, from inflorescence of the plant in a regular grid, totaling 100 sampling points spaced 6 x 4 m. Obtained the margins of error associated with cokrigagem by comparing the estimated values with those determined in the laboratory. The results showed that the technique was able to estimate the nutrient content efficiently.

Rodrigues M. G. V., D. D. Pacheco, W. Natale, and J. T. A. da Silva. 2010. 'Prata-Ana' Banana Foliar Sampling: Amostragem Foliar Da Bananeira 'Prata-Anã'. Revista Brasileira De Fruticultura, 32:321-325.
Reference ID: 21378
Notes: #21378e
Abstract: For nutritional diagnosis of the banana it is necessary to standardize the tissue sampling to be used, since the mineral composition changes with the plant age, sampled leaf, among the several parts of the leaf, besides ecological conditions, variety differences and seasonal fluctuations of the elements. Therefore, the possibility of mistake in the interpretation is considerable. The Method of International Sampling of Reference (MEIR) for banana recommends to collect the third leaf of plants with bunches that present all of the visible hands and no more than three hands of open masculine flowers, leaving the internal half of a central grade of the limbus, without the central rib. There is some difficulty in following such recommendation for banana tree 'Prata-Ana' cultivated in the North of Minas Gerais, because it possesses high load and very dense foliar rosette that confuses the location of the sampled leaf. Moreover, usually the samples are removed with width different from the recommended 10 cm. Due to the sampling difficulties of the 'Prata-

Ana' banana and the fact that this cultivar, under irrigation, to be little studied when compared to those of the subgroup Cavendish, the present work aimed to determine the effect of the sampled leaf and the sample width on the mineral contents of the 'Prata-Ana' banana tree cultivated under irrigation in the North of Minas Gerais. In spite of the statistical variations, the foliar contents maintained themselves inside of the sufficiency grade, regardless of the sampled leaf position - 2(nd), 3(rd) or 4(th) leaf- or of the sample size - 10, 20 or 30 cm of width. This suggests that the leaf collection in the position above (second) or below (fourth) of the third recommended leaf, in a foliar width from 10 to 30 cm, does not alter a lot the foliar contents in relation to the indication by the MEIR, thus being tolerated as a possible sample variation for the tested position and foliar width.

Henriet C., L. Bodarwe, M. Dorel, X. Draye, and B. Delvaux. 2008. Leaf silicon content in banana (Musa spp.) reveals the weathering stage of volcanic ash soils in Guadeloupe. Plant and Soil, 313:71-82.
Reference ID: 21379
Notes: #21379e
Abstract: Several plant species accumulate silicon, which is taken up by roots in soil solution. The Si concentration in soil solution can be governed by silicate dissolution and formation, and thus soil constitution. Here, we study the Si leaf content of mature banana plants (Musa acuminata cv Grande Naine) cropped on soils derived from andesitic ash in Guadeloupe through standard foliar analysis. The soils strongly differ in weathering stage and total Si content. The most desilicated soils (Andosol-Nitisol Ferralsol) occur in the wettest areas, on the Eastern slopes (Es) of the volcano exposed to rain bearing winds. Least weathered soils (Andosol-Cambisol) occur on Western slopes (Ws). The average leaf Si concentration ranges from 2.7 to 3.9 g kg(-1) for bananas cropped in Es soils, and from 7.7 to 9.6 g kg(-1) in Ws soils. The leaf Si concentrations are lowest for the Es gibbsite-rich Andosols and Ferralsols. The leaf Si concentration is positively correlated with soil CaCl(2)-extractable Si content, soil Si content and total reserve in weatherable minerals. The silicon content of banana leaves thus reveals the weathering stage of volcanic ash soils in Guadeloupe.

Leonel S. and E. R. Damatto. 2007. The characterization of banana 'Maca' orchards in the Ribeirao do Sul/SP: Caracterização das Áreas de Cultivo da Bananeira Maçã na Região de Ribeirão do Sul/Sp. Ciencia E Agrotecnologia, 31:958-965.
Reference ID: 21380
Notes: #21380e
Abstract: The research aimed to characterize banana 'Maca' farmers of Ribeirao do Sul/SP region, regarding the technology applied to the crop and in the fruit yield. With the answers obtained, it was possible to establish some inferences in relation to the "Mal-do-Panama disease incidence and the mineral nutrition. It was observed that these farmers used manurig and liming without the use of the soil analyses and that they had never performed foliar analyses. Consequently, soil and leaves nutrients levels were not balanced for most of the evaluated plantation. The "Mal-do-Panama disease incidence was considered low or not present in 65% of the studied orchards.

da Silva J. T. A. and J. G. de Carvalho. 2006. Establishment of the dris norms for 'Prata' Ana' banana (AAB) under irrigation: Estabelecimento de Normas Dris Para Bananeira Prata Anã (Aab) Sob Irrigação. Ciencia E Agrotecnologia, 30:43-51.
Reference ID: 21381
Notes: #21381e
Abstract: The objective of this work was to establish the DRIS (diagnosis and recommendations integrated system) norms for the 'Prata' Ana' banana (AAB) cultivated in the semi-arid of the North of Minas Gerais state under irrigation. A total of 58 areas commercially cultivated with 'Prata' Ana' banana were selected. In each area, leaves samples were collected in three successive cycles of banana production in the initial phase of emission of the bunch, except for six areas, in which the collections were performed only in two successive cycles, totaling 168 leaves samples, which were analyzed for determination of the nutrients (N, P, K, Ca, Mg, S, B, Cu, Fe, Mn and Zn). Banana's bunches of the plants marked with paint were harvested and weighted. The areas were divided in high-yielding population (HYP) (>30 t ha(-1) year(-1)) and in low-yielding population (LYP) (<30 t ha(-1)year(-1)). The results of the leaves analyses and yield of each area formed a database. The average, the variance and the variation coefficient for the relationship two to two among nutrients tenors were calculated for HYP and LYP. The Norms DRIS were established using the results of the leaves analyses of coming samples of HYP. 55 relationship were selected among nutrients tenors that presented the largest reasons between the variances of LYP and HYP (s(1)(2)/s2(h)(2)).

Krave A. S., N. M. van Straalen, and H. W. van Verseveld. 2002. Potential nitrification and factors influencing nitrification in pine forest and agricultural soils in Central Java, Indonesia. Pedobiologia, 46:573-594.
Reference ID: 21382
Notes: #21382e
Abstract: Potential nitrification and factors controlling nitrifying activity in tropical pine orest and agricultural soils in Central Java, Indonesia were studied. Soils from three different pine forest sites and a fertilized coffee plantation were sampled monthly during the dry and wet period of 1997-1998. Both organic material (litter [L], and fragmented litter [F]) and mineral soil (M) up to 15 cm depth showed a high potential N-NO3- production. In the growth-medium used, the production of NO3- increased exponentially and was substantially higher than the net NO3- production in laboratory soil incubation experiments. Nitrifying populations assessed using the most-probable-number method were highly abundant in all soil layers, without significant differences between layers. However, net NO3- production in the L and F layers was significantly higher than that found in the M layers. High seasonal and temporal variations were observed for net NO3- production and nitrifying populations. This was most likely explained by soil moisture content, N-NH4+ content and soil pH. Denitrification might also be one of the major factors causing the high temporal nitrification variation due to high potential NO3- reduction and the fact that denitrifying populations were abundant in these soils. The fertilized coffee plantation soil showed nitrifying populations, potential nitrification and nitrifying activity that were significantly higher than that of the three pine forest soils, whereas litter removal activities at one site in a pine forest substantially reduced NO3- production. It is concluded that tropical pine forests and fertilized agricultural soils in Indonesia have a high potential for carrying out nitrification, which is due to a high abundance of nitrifying populations. Soil moisture content, pH and N-NH4+ availability are the major factors controlling nitrifying activity in the soil.

Shepherd K. D., E. Ohlsson, J. R. Okalebo, and J. K. Ndufa. 1996. Potential impact of agroforestry on soil nutrient balances at the farm scale in the East African Highlands. Fertilizer Research, 44:87-99.
Reference ID: 21383
Notes: #21383e
Abstract: There is much current interest in the potential role of agroforestry in the mitigation of nutrient depletion in Sub-Saharan Africa. Using data from farm surveys and trials, a static model of N and P flows was constructed for a standard farm system, representative of typical subsistence farms in humid parts of the East African Highlands. The model was used to explore the possible impact of improved agroforestry systems on nutrient budgets, to identify priorities for research. Soil nutrient balances in the standard farm system were -107 kg N and -8 kg P ha(-1) yr(-1). Agroforestry systems did not significantly reduce the N deficits except when a high proportion of the total biomass was returned to the soil, rather than removed from the farm. Agroforestry increased N input through biological N fixation and deep N uptake, but this was offset by a larger nutrient removal from the farm in harvested products, which increased from 38 kg N in the standard system to 169 kg N ha(-1) yr(-1) in an intensive dairy-agroforestry system. Agroforestry did not increase P inputs, and harvested P increased from 6 kg P in the standard farm system to 29 kg P ha(-1) yr(-1) in the dairy-agroforestry system. Thus, moderate P inputs, of 20 kg P ha(-1) yr(-1) were required to maintain soil P stocks.
N leaching from the field was the most significant nutrient loss from the farm system, with a range of 68 to 139 kg N ha(-1) yr(-1). The capture of subsoil N by deep-rooted trees in agroforestry systems substantially increased N-use efficiency, providing 60 kg N ha(-1) yr(-1) in the dairy-agroforestry system. The budgets were sensitive to N mineralization rates in subsoils, N losses from soils and manures, and effectiveness of deep-rooted plants in subsoil N capture, for which there is little data from the region. Therefore, high priority should be given to research in these areas. The current model can not account for important feedback mechanisms that would allow analysis of the long-term effects of nutrient budgets on nutrient availability and plant productivity. Dynamic models of farm nutrient budgets that include such interactions are needed to further assess the sustainability of farming systems.

Haileslassie A., J. Priess, E. Veldkamp, D. Teketay, and J. P. Lesschen. 2005. Assessment of soil nutrient depletion and its spatial variability on smallholders' mixed farming systems in Ethiopia using partial versus full nutrient balances. Agriculture, Ecosystems & Environment, 108:1-16.
Reference ID: 21384
Notes: #21384e
Abstract: Soil fertility depletion in smallholder farms is one of the fundamental biophysical causes for declining per capita food production in Ethiopia. In the present study, we assess soil nutrient depletion and its spatial variability for Ethiopia and its regional states, using nutrient balances as a tool. Data on crop production, fertilizer use and land management practices were collected from the Agricultural sample survey, which was carried out by the Central Statistics Authority (CSA) for the production year 1999/2000. We used a Geographic Information System (GIS) to process, and analyze spatially referenced information like soil properties, precipitation and land use types. We calculated nutrient balances for N, P and K from five nutrient fluxes entering and five nutrient fluxes leaving cultivated lands of smallholders. Some of the fluxes (e.g. leaching, denitrification and wet deposition) were estimated using transfer functions. Erosion was estimated by universal soil loss

equation (USLE) and landscape process modelling at multi-dimensions and scales (LAPSUS). At the national level, full nutrient balance results indicate a depletion rate of 122 kg N ha(-1) yr(-1), 13 kg P ha(-1) yr(-1) and 82 kg K ha(-1) yr(-1). Soil nutrient stocks in all regional states were decreasing with the exception of areas under permanent and vegetable crops. In the analysis, soil erosion was the major cause for nutrients depletion, but this flux shows significant variability between different estimates and was highly uncertain. We calculated that the contribution of erosion to N losses was 70%, while its contribution to P and K losses were 80% and 63%, respectively. Nutrient losses under permanent and vegetable cropping were caused mainly by residues removal, harvested products and leaching, while losses under cereals and other annuals were dominated by erosion.

Van den Bosch H., J. N. Gitari, V. N. Ogaro, S. Maobe, and J. Vlaming. 1998. Monitoring nutrient flows and economic performance in African farming systems (NUTMON).: III. Monitoring nutrient flows and balances in three districts in Kenya. Agriculture, Ecosystems & Environment, 71:63-80.
Reference ID: 21385
Notes: #21385e
Abstract: A nutrient balance study was carried out for 26 farms in three different districts in Kenya. Balances for the major nutrients nitrogen, phosphorus and potassium were calculated for individual activities within the farms and for the entire farms, using Farm-NUTMON, a research tool that combines calculation of nutrient flows and balances with economic farm analysis. Four flows into the farm (chemical fertilizer, organic fertilizer and feeds, atmospheric deposition, nitrogen fixation), six flows out of the farm (farm products, other organic outputs, leaching, gaseous losses, erosion and human excreta) and six internal flows (consumption of external feeds, household waste, crop residues, grazing, animal manure, and home consumption of farm products) were considered. Data on fertilizer use, use of organic materials, yields, home consumption and the management of residues, manure and household waste were gathered by interviewing the farmer. Assumptions for deposition, leaching and gaseous losses were made by using empirical relationships based on literature data (transfer functions). Erosion was estimated relating the overall slopes of the farms to soil loss figures. The mean balance of all farms was -71kg N, +3kg P and -9kg$Kha^{-1}yr^{-1}$, with large variations between farms and little variation between districts. Emissions (leaching, gaseous losses and erosion) were estimated to be much higher than immissions (atmospheric deposition and N-fixation). Inflows and outflows at field level were much higher for cash crops than for food crops. Soil nutrient mining under napier grass (*Pennisetum purpereum*) was severe from high estimated losses in the napier-livestock-manure cycle. Based on an evaluation of the results of this case study, recommendations were made for improvement to the approach. Developing a sustainability indicator for soil fertility requires the nutrient balance to be linked to the actual soil nutrient stocks and other soil quality indicators.

Mahrizal, L. L. Nalley, B. L. Dixon, and J. S. Popp. 2014. An optimal phased replanting approach for cocoa trees with application to Ghana. Agricultural Economics, 45:291-302.
Reference ID: 21386
Notes: #21386e
Abstract: This study solves for the optimum replacement rate (ORR) and initial replacement year (IRY) of cocoa trees (Theobroma cacao) in Ghana to maximize net

present value and achieve steady state by employing a phased replanting approach. The annual ORR is 5%-7% across the three production systems studied: Low Input, Landrace Cocoa, High Input, No Shade Amazon Cocoa, and High Input, Medium Shade Cocoa. The optimal IRY ranges from year 5 to year 9 as a function of cocoa prices, fertilizer prices, labor prices, and percentage yield loss due to disease outbreaks. Deterministic results project economic gains that exceed currently practiced replacement approaches by 5.57%-14.67% across production systems with reduced, annual income volatility. The method applied in this study can be used to increase cocoa yields and stabilize income over time, and facilitate substantial quality of life improvements for many subsistence cocoa farmers in Ghana and around the world.

Pushparajah E. 1999. Notes on Agricultural Science I (Soils): Technical Education Scheme, The Incorporated Society of Planters, Kuala Lumpur.
Reference ID: 21387
Notes: S 1 #21387

C & CI. C&CI: Coffee and Cocoa International July 2015. Foxwell, D. editor. [42], 1-50. 2015. UK, C & CI.
Reference ID: 21388
Notes: Serial S #21388 Vol 42 No 3

Pushparajah E. 1999. Notes On Agricultural Science III (Soils): Technical Education Scheme, The Incorporated Society Of Planters, Kuala Lumpur.
Reference ID: 21389
Notes: S 1 #21389
Abstract: Fertilizers and Manures
Balanced Crop Nutrition
Nutrient Cycling
Soil and Water Conservation/Drainage

Anonymous. 2015. Accion de Formacion: Manejo Agroindustrial del cultivo de la palma de aceite para su aprovechamiento y su produccion sostenible (Training action : Agroindustrial cultivation of palm oil for its use management and sustainable production). Pages 1-42 SENA, SAC, FEDEPALMA, CENIPALMA.
Reference ID: 21390
Notes: S 8.1.1 #21390 > S 8.1.1 #21269
Abstract:
New Strategies for Oil Palm Disease Control through Plant Pathogen Research
Soil Microbial Communities: The Cause and Solutions of Plant Diseases
Environmental Impacts of Oil Palms Products: What Can We Learn From Life Cycle Assessments?
Use of Remote Sensors to Detect Ganoderma Infection
Selected Precision Agriculture Studies in Oil Palm: A 10-Year Study Fresh Fruit Bunches Classification at the Palm Oil Mill Using Advanced Techniques and Technology
Machine Vision Application in Indonesian Oil Palm Industry
How can Ultra-Detailed Process Monitoring become Feasible in Oil Palm Industry by Using Near Infrared Spectroscopy?
Maintenance Management Performance Evaluation: Measuring of Overall Equiment Effectiveness in Malaysian Palm Oil Mills

Second Generation Biofuels from Oil Palm Biomass
Oil Palm Byproducts as Biomass Commodities
The Current State of Palm Oil Agroindustry in Indonesia
Palm Oil Agro-Industry and The Traditional Sector in Africa
Oil Palm Agro-Industry in America
The Market for Certified Sustainable Products and Applicability of Standards Map Tools
Ferrero's Path in the Palm Oil Sector

The Incorporated Society of Planters 1996. Examination Syllabus: Technical Education Scheme, The Incorporated Society of Planters, Kuala Lumpur.
Reference ID: 21391
Notes: S General #21391

Anonymous. 2014. Nutrients for Sweet Success. Fertilizers for Sugar Crops.
Reference ID: 21392
Notes: H 8.3 #21392

Chua C. K., T. Oberthur, S. Cook, C. H. Lim, C. R. Donough, J. Cock, H. Sugianto, and Y. L. Lim. 2015. IPNI's Vision of Sustainable Oil Palm Intensification in 2020 and Beyond.
Reference ID: 21393
Notes: H 8.1.1.11 #21393

Oberthur T. and C. R. Donough. 2011. Sustainable Intensification with Best Management Practices (BMP): Oil Palm In Southeast Asia. Pages 1-4.
Reference ID: 21394
Notes: H 8.1.1.6 #21394 slide presentation for PIPOC 15-17 November 2011 KLCC, Kuala Lumpur

Wielgoss A., T. Tscharntke, A. Rumede, B. Fiala, H. Seidel, S. Shahabuddin, and Y. Clough. 2014. Interaction complexity matters: disentangling services and disservices of ant communities driving yield in tropical agroecosystems. Proceedings of the Royal Society B-Biology Sciences, 281.
Reference ID: 21395
Notes: #21395e
Abstract: Owing to complex direct and indirect effects, impacts of higher trophic levels on plants is poorly understood. In tropical agroecosystems, ants interact with crop mutualists and antagonists, but little is known about how this integrates into the final ecosystem service, crop yield. We combined ant exclusion and introduction of invasive and native-dominant species in cacao agroecosystems to test whether (i) ant exclusion reduces yield, (ii) dominant species maximize certain intermediate ecosystem services (e. g. control of specific pests) rather than yield, which depends on several, cascading intermediate services and (iii) even, species-rich ant communities result in highest yields. Ants provided services, including reduced leaf herbivory and fruit pest damage and indirect pollination facilitation, but also disservices, such as increased mealybug density, phytopathogen dissemination and indirect pest damage enhancement. Yields were highest with unmanipulated, species-rich, even communities, whereas ant exclusion decreased yield by 27%. Introduction of an invasive-dominant ant decreased species density and evenness and resulted in 34% lower yields, whereas introduction of a non-invasive-dominant

species resulted in similar species density and yields as in the unmanipulated control. Species traits and ant community structure affect services and disservices for agriculture in surprisingly complex ways, with species-rich and even communities promoting highest yield.

Ofori-Boateng K. and B. Insah. 2014. The impact of climate change on cocoa production in West Africa. International Journal of Climate Change Strategies and Mangement, 6:296-314.
Reference ID: 21396
Notes: #21396e
Abstract: Purpose - The study aimed at examining the current and future impact of climate change on cocoa production in West Africa. Design/methodology/approach - A translog production function based on crop yield response framework was used. A panel model was estimated using data drawn from cocoa-producing countries in West Africa. An in-sample simulation was used to determine the predictive power of the model. In addition, an out-sample simulation revealed the effect of future trends of temperature and precipitation on cocoa output. Findings - Temperature and precipitation play a considerable role in cocoa production in West Africa. It was established that extreme temperature adversely affected cocoa output in the sub-region. Furthermore, increasing temperature and declining precipitation trends will reduce cocoa output in the future. Practical implications - An important implication of this study is the recognition that lagging effects are the determinants of cocoa output and not coincident effects. This finds support from the agronomic point of view considering the gestation period of the cocoa crop.
Originality/value - Although several studies have been carried out in this area, this study modeled and estimated the interacting effects of factors that influence cocoa production. This is closer to reality, as climatic factors and agricultural inputs combine to yield output.

Trognitz B., E. Cros, S. Assemat, F. Davrieux, N. Forestier-Chiron, E. Ayestas, A. Kuant, X. Scheldeman, and M. Hermann. 2013. Diversity of Cacao Trees in Waslala, Nicaragua: Associations between Genotype Spectra, Product Quality and Yield Potential. Plos One, 8.
Reference ID: 21397
Notes: #21397e
Abstract: The sensory quality and the contents of quality-determining chemical compounds in unfermented and fermented cocoa from 100 cacao trees (individual genotypes) representing groups of nine genotype spectra (GG), grown at smallholder plantings in the municipality of Waslala, Nicaragua, were evaluated for two successive harvest periods. Cocoa samples were fermented using a technique mimicking recommended on-farm practices. The sensory cocoa quality was assessed by experienced tasters, and seven major chemical taste compounds were quantified by near infrared spectrometry (NIRS). The association of the nine, partially admixed, genotype spectra with the analytical and sensory quality parameters was tested. The individual parameters were analyzed as a function of the factors GG and harvest (including the date of fermentation), individual trees within a single GG were used as replications. In fermented cocoa, significant GG-specific differences were observed for methylxanthines, theobromine-to-caffeine (T/C) ratio, total fat, procyanidin B5 and epicatechin, as well as the sensory attributes global score, astringency, and dry fruit aroma, but differences related to harvest were also

apparent. The potential cocoa yield was also highly determined by the individual GG, although there was significant tree-to-tree variation within every single GG. Non-fermented samples showed large harvest-to-harvest variation of their chemical composition, while differences between GG were insignificant. These results suggest that selection by the genetic background, represented here by groups of partially admixed genotype spectra, would be a useful strategy toward enhancing quality and yield of cocoa in Nicaragua. Selection by the GG within the local, genetically segregating populations of seed-propagated cacao, followed by clonal propagation of best-performing individuals of the selected GG could be a viable alternative to traditional propagation of cacao by seed from open pollination. Fast and gentle air-drying of the fermented beans and their permanent dry storage were an efficient and comparatively easy precondition for high cocoa quality.

Deheuvels O., J. Avelino, E. Somarriba, and E. Malezieux. 2012. Vegetation structure and productivity in cocoa-based agroforestry systems in Talamanca, Costa Rica. Agriculture, Ecosystems & Environment, 149: 181-188.
Reference ID: 21398
Notes: #21398e
Abstract: In the humid tropics, the remaining forest patches are increasingly isolated within an expanding agricultural matrix. There, a significant area consists of complex agroforestry systems with high structural and functional plant diversity. These anthropogenic habitats are gaining increasing conservation value as deforestation progresses. Cocoa-based agroforests provide habitats for some forest dependent species and play a largely undocumented role in providing other ecosystem services. The high variability of their botanical composition and structure is poorly described and its relevancy in assessing ecosystem services has not yet been investigated. We characterized the structure and productivity of 36 cocoa agroforests in Talamanca, Costa Rica. These agroforestry systems (AFS) were chosen to maximize contrasts in terms of biophysical context, botanical composition and management practices. Results showed significant differences in the vegetation structure that enabled us to distinguish four main clusters: complex and high density canopy AFS, high cocoa density AFS, high Musa density AFS and complex and low density canopy AFS. Changes in vegetation structure reflected differences in the farmers' strategies but did not affect the overall cocoa yield (136 kg ha(-1) year(-1)) or the aboveground fresh plant volume (400 m(3) ha(-1)). Cocoa yield per tree in the high Musa density AFS cluster was 454.5 g per cocoa tree, which was significantly twice as much as in lower cocoa density clusters, suggesting that structure affects productivity through spatial distribution more than through botanical composition. These results open new perspectives to improve cocoa orchards' structural complexity and their relative ecosystem services without affecting their overall productivity. Further investigations and additional samplings are needed to fully understand the mechanisms involved.

Carr M. K. V. and G. Lockwood. 2011. The Water Relations And Irrigation Requirements Of Cocoa (Theobroma Cacao L.): A Review. Experimental Agriculture, 47:653-676.
Reference ID: 21399
Notes: #21399e
Abstract: The results of research into the water relations of cocoa are reviewed in the context of drought mitigation and irrigation need. Background information on the centres of production of the cocoa tree, and the role of water in crop development

and growth processes, is followed by reviews of the effects of water stress on stomatal conductance, leaf water status and gas exchange, together with drought tolerance, crop water use and water productivity. Leaf and shoot growth occur in a series of flushes, which are synchronized by the start of the rains following a dry season (or an increase in temperature), alternating with periods of 'dormancy'. Flowering is inhibited by water stress but synchronous flowering occurs soon after the dry season ends. Roots too grow in a rhythmic pattern similar to that of leaf flushes. Roots can reach depths of 1.5-2.0 m, but with a mass of roots in the top 0.2-0.4 m, and spread laterally > 5 m from the stem. Stomata open in low light intensities and remain fully open in full sunlight in well-watered plants. Partial stomatal closure begins at a leaf water potential of about -1.5 MPa. Stomatal conductance is sensitive to dry air, declining as the saturation deficit increases from about 1.0 up to 3.5 kPa. Net photosynthesis and transpiration both consequently decline over a similar range of values. Little has been published on the actual water use of cocoa in the field. Measured ETc values equate to < 2 mm d(-1) only, whereas computed ETc rates of 3-6 mm d(-1) in the rains and < 2 mm d(-1) in the dry season have also been reported. Despite its sensitivity to water stress, there is too a paucity of reliable, field-based published data of practical value on the yield responses of cocoa to drought or to irrigation. With the threat of climate change leading to less, or more erratic, rainfall in the tropics, uncertainty in yield forecasting as a result of water stress will increase. Social, technical and economic issues influencing the research agenda are discussed.

Moser G., C. Leuschner, D. Hertel, D. Holscher, M. Kohler, D. Leitner, B. Michalzik, E. Prihastanti, S. Tjitrosemito, and L. Schwendenmann. 2010. Response of cocoa trees (Theobroma cacao) to a 13-month desiccation period in Sulawesi, Indonesia. Agroforestry Systems, 79:171-187.
Reference ID: 21400
Notes: #21400e
Abstract: In South-east Asia, ENSO-related droughts represent irregularly occurring hazards for agroforestry systems containing cocoa which are predicted to increase in severity with expected climate warming. To characterize the drought response of mature cocoa trees, we conducted the Sulawesi Throughfall Displacement Experiment in a shaded (Gliricidia sepium) cocoa agroforestry system in Central Sulawesi, Indonesia. Three large sub-canopy roofs were installed to reduce throughfall by about 80% over a 13-month period to test the hypotheses that (i) cocoa trees are sensitive to drought due to their shallow fine root system, and (ii) bean yield is more sensitive to drought than leaf or stem growth. As 83% of fine root (diameter < 2 mm) and 86% of coarse root biomass (> 2 mm) was located in the upper 40 cm of the soil, the cocoa trees examined had a very shallow root system. Cocoa and Gliricidia differed in their vertical rooting patterns, thereby reducing competition for water. Despite being exposed for several months to soil water contents close to the conventional wilting point, cocoa trees showed no significant decreases in leaf biomass, stem and branch wood production or fine root biomass. Possible causes are active osmotic adjustment in roots, mitigation of drought stress by shading from Gliricidia or other factors. By contrast, production of cocoa beans was significantly reduced in the roof plots, supporting reports of substantial reductions in bean yields during ENSO-related drought events in the region. We conclude that cocoa possesses traits related to drought tolerance which enable it to maintain biomass production during extended dry periods, whereas bean yield appears to be particularly drought sensitive.

Groeneveld J. H., T. Tscharntke, G. Moser, and Y. Clough. 2010. Experimental evidence for stronger cacao yield limitation by pollination than by plant resources. Perspectives in Plant Ecology, Evolution and Systematics, 12:183-191.
Reference ID: 21401
Notes: #21401e
Abstract: Both pollination and resource limitation may cause low fruit:flower ratios in plants, but pollen and resource limitation have never been contrasted in commercially important crop species. Here we experimentally investigated the relative effect of pollen limitation and resource limitation in Theobroma cacao. In Central Sulawesi, Indonesia, we applied different relative levels of hand pollination (10%, 40%, 70% and 100% of available flowers up to 2 m height) to mature cacao trees in two separate experiments encompassing (1) different light (shade roofs) and nitrogen (fertilizer application) treatments, and (2) water availability (throughfall displacement) treatments. None of the resource availability treatments had a significant effect, while number of mature pods and yield increased non-linearly with pollination intensity up to 200% of current yield levels. The largest benefits were reached by increasing pollination from 10% to 40%, with non-significant increases beyond that level. Despite an increase of fruit abortion with pollination intensity, T. cacao yield is determined, at least on the short term, by the number of flowers pollinated. This suggests pollination deficit in crops can be very large and that a better knowledge of pollen and resource limitation to devise adequate pollinator management strategies may be critical for increasing production. (C) 2010 Rubel Foundation, ETH Zurich.

Marcano M., S. Morales, M. T. Hoyer, B. Courtois, A. M. Risterucci, O. Fouet, T. Pugh, E. Cros, V. Gonzalez, M. Dagert, and C. Lanaud. 2009. A genomewide admixture mapping study for yield factors and morphological traits in a cultivated cocoa (Theobroma cacao L.) population. Tree Genetics & Genomes, 5:329-337.
Reference ID: 21402
Notes: #21402e
Abstract: The selection of productive varieties of modern Criollo cocoa, showing fine aromatic qualities in their beans, is of major interest for some producing countries, such as Venezuela. Cultivated populations of Modern Criollo or Trinitario varieties may be suitable for admixture mapping analysis, as large blocks of alleles derived from two identified divergent ancestors, recently admixed, are still preserved, after a few generations of recombination, similar to experimental mapping progenies. Two hundred and fifty-seven individuals from a cultivated population of Modern Criollo were selected and analysed with 92 microsatellite markers distributed along the genome. This population exhibited a wide range of variability for yield factors and morphological features. Population structure analysis identified two main subgroups corresponding to the admixture from the two ancestors Criollo and Forastero. Several significant associations between markers and phenotypic data (yield factors and morphological traits) were identified by a least squares general linear model (GLM) taking into account the population structure and the percentage of admixture of each individual. Results were compared with classical QTL analyses previously reported for other cacao populations. Most markers associated to quantitative traits were very close to QTLs detected formerly for the same traits. Associations were also identified between markers and several qualitative traits including the red pigmentation observed in different organs, mainly associated to common markers in linkage group 4.

Jagoret P., E. Bouambi, T. Menimo, I. Domkam, and F. Batomen. 2008. Analysis of the diversity of cocoa cropping systems. Case of the Central Cameroon. Biotechnologie Agronomie Societe Et Environnement, 12:367-377.
Reference ID: 21403
Notes: #21403e
Abstract: Little is known about the cultural practices adopted by cocoa farmers in Central Cameroon. In order to bridge that knowledge gap, 1,428 farms were surveyed in four divisions of Central province, which differed through the prevailing type of cocoa cultivation. Fanner typologies were established, based on their cultural practices for cocoa growing. Three scales of investigation were considered: province, division and village. This study confirmed the diversity of cocoa growing systems existing in Central Cameroon. A multidimensional exploratory analysis revealed that the links between the variables considered varied substantially from one division to another, though the degree of intensification in inputs and labour were the main determinants of cocoa yields. Four to five categories of farmers, which differed from each other depending on the variables studied, were found for each scale of investigation. In methodological terms, the classification method adopted to establish the typologies confirmed its efficiency. It showed that data analysis on a village scale relativized the results observed on a division scale, by making it possible to identify the cocoa growing system dominating a given village. This approach therefore enabled a better appreciation of similarities between the study zones, similarities which administrative or geographical zoning tended to hide. It suggested that it is necessary to assist farmers taking into account the diversity of situations.

Guest D. 2007. Black pod: Diverse pathogens with a global impact on cocoa yield. Phytopathology, 97:1650-1653.
Reference ID: 21404
Notes: #21404e
Abstract: Pathogens of the Straminipile genus Phytophthora cause significant disease losses to global cocoa production. P. megakarya causes significant pod rot and losses due to canker in West Africa, whereas R capsici and R citrophthora cause pod rots in Central and South America. The global and highly damaging P. palmvora attacks all parts of the cocoa tree at all stages of the growing cycle. This pathogen causes 20 to 30% pod losses through black pod rot, and kills up to 10% of trees annually through stem cankers. P. palmivora has a complex disease cycle involving several sources of primary inoculum and several modes of dissemination of secondary inoculum. This results in explosive epidemics during favorable environmental conditions. The spread of regional pathogens must be prevented by effective quarantine barriers. Resistance to all these Phytophthora species is typically low in commercial cocoa genotypes. Disease losses can be reduced through integrated management practices that include pruning and shade management, leaf mulching, regular and complete harvesting, sanitation and pod case disposal, appropriate fertilizer application and targeted fungicide use. Packaging these options to improve uptake by smallholders presents a major challenge for the industry.

Olaiya A. O., J. A. Fagbayide, L. A. Hammed, and M. O. Aliyu. 2006. Comparison of potential pod yield and loss in old and rehabilitated cocoa. African Journal of Agricultural Research, 1:189-193.
Reference ID: 21405
Notes: #21405e
Abstract: A field study was carried out between 1999 and 2001 to comparatively evaluate the potential pod yield and losses in old and rehabilitated cacao plots. Two plots made up of an old and a rehabilitated plots were chosen and four trees were randomly selected as experimental unit at four different locations within each of the plots to serve as the replicates. The experimental units were then laid out in a randomized complete block design. Data on total fruit set (TFS), number of damaged pods (DMP), number of diseased pods (DSP), number of Cherelle wilted pods (CWP) and number of fermentable pods FMP) were collected over two years and subjected to ANOVA and correlation analysis. The result showed that pod loss to cherelle wilt was 34.9% and to diseases 22.3% while the damaged pods amounted to 11.5% in the old plot. In the rehabilitated plot, damage due to mirid infestation was responsible for about 27.4% pod loss followed by cherelle wilt of 25.6% and diseased pods 11.7%. The total number of fermentable pods of 19.8% and 41.6 were obtained in both old and rehabilitated plots respectively. The result showed that TFS was significantly ($P < 0.01$) improved by rehabilitation though damage due to insect infestation and pod loss to cherelle wilt still accounted for the loss of over 50% TFS.

Pang J. T. Y. 2006. Yield efficiency in progeny trials with cocoa. Experimental Agriculture, 42:289-299.
Reference ID: 21406
Notes: #21406e
Abstract: Yield efficiency of cocoa, defined as yield over a period of time divided by the increment in trunk cross-sectional area over that period, was estimated in four factorial matings in Sabah, Malaysia, evaluated at a single planting density. The parents were 18 seedlings of Upper Amazon Forastero type, broadly representative of Peruvian Amazon material, and 15 clones of Trinitario type, selected from cultivated cocoa in Ecuador, Trinidad and Papua New Guinea. Both the Upper Amazon and Trinitario parents varied in general combining ability (gca) for yield efficiency, with strong evidence of additive inheritance of the trait. Some of the Upper Amazon parents showed higher yield efficiency than many of the Trinitarios. Correlations between gcas for yield efficiency and yield were inconsistent. This is thought to be because the parents differed markedly in optimal planting density, which is higher for many of the Upper Amazons with high gca for yield efficiency than it is for some of the Trinitarios. At the current stage of cocoa breeding, selection for adaptation to planting density is a higher priority than selection for yield efficiency.

Muhamad R. and M. Way. 1995. Damage and Crop Loss Relationships of Helopeltis-Theivora, Hemiptera, Miridae and Cocoa in Malaysia. Crop Protection, 14:117-121.
Reference ID: 21407
Notes: #21407e
Abstract: Miridae cause serious crop loss of cocoa worldwide yet the relationship between feeding damage and survival of cherelles and pods is inadequately understood, particularly in terms of timing of damage and also of other sequential mortalities that occur throughout development from the flower bud to the ripe pod

stage. Five post-flowering developmental stages were used as a basis for assessing crop loss in relation to Helopeltis theivora feeding damage in Peninsular Malaysia. These include 'cherelle initiates', which invariably abscind after only one H. theivora feeding lesion. Subsequently, cherelles may die and wilt but do not abscind. Cherelle wilt was strongly linked to time and number of feeding lesions, such that older cherelles tolerated notably more damage than was needed to kill young cherelles. Pods from surviving severely damaged cherelles were smaller and contained smaller seeds although the number of seeds per pod was unaffected. However, yield was most affected by H. theivora-associated death of cherelles. Growing pods were killed by artificially created intense short-term attack by H. theivora but this is unlikely in nature where there may be much greater extended damage throughout development of a pod that survives. The yield of full-sized pods was unaffected by artificially imposed very severe attack. An experiment on possible compensation for cherelles killed by H. theivora indicated that the number and weight of seeds per pod is already determined at the early cherelle stage. A life table of survivorship from the flower bud to the ripe pod stage showed very large mortalities of buds and flowers but, in terms of survival to ripe pods, the crucial proportional mortality is during the mirid-susceptible cherelle stage.

Amoah F., B. Nuertey, K. Baidooaddo, K. Oseibonsu, and T. Asamoah. 1995. Underplanting Oil Palm With Cocoa in Ghana. Agroforestry Systems, 30:289-299.
Reference ID: 21408
Notes: #21408e
Abstract: Mature oil palms at the Oil Palm Research Institute at Kusi, Ghana were underplanted with cocoa to study the feasibility of mixed cropping of the two crops under West African conditions. The oil palm trees used in this trial were planted in 1970 and had achieved maximum canopy formation. Three triangular spacings of the oil palms used were 8.7, 9.9 and 10.5 m. The cocoa was underplanted in June 1988 at a spacing of 2.4 m triangular using mixed hybrids. There were no significant differences in oil palm yield between plots with cocoa and the controls. There was no appreciable damage to the cocoa trees from falling palm fronds and fruits during harvesting or pruning. Cocoa seedling growth and yield were significantly better under the oil palm spaced at 9.9 or 10.5 m triangular than under oil palm spaced at 8.7 m triangular.

Egbe N. and S. Adenikinju. 1990. Effect of Intercropping on Potential Yield of Cacao in South Western Nigeria. Café Cacao Thé, 34:281-284.
Reference ID: 21409
Notes: #21409e
Abstract: The authors of this article examined the yields of certain experimental plantations (CRIN, Ibadan, Nigeria) in which cocoa was interplanted with either Cola nitida, Elaeis guineensis or Terminalia ivorensis. All the plots consisted of cv. Amazonian F3. Annual cocoa yields were recorded in plantations in which cocoa was grown alone and in plantations associated with one of the three plants cited above for a ten-year period, from the tenth post-planting year onwards. According to the results of this study the cocoa/oil palm association was the most beneficial, the cocoa producing 67 % more than in monoculture.

Oladokun M. and N. Egbe. 1990. Yields Of Cocoa Kola Intercrops In Nigeria. Agroforestry Systems, 10:153-160.
Reference ID: 21410
Notes: #21410e
Abstract: The yields of two intercropped cocoa/kola plots at the Cocoa Research Institute of Nigeria, Ibadan, (W8/1 and C3/1), were compared with the yields of monoculture plots (N4/A and W1/2). It was found that 1.75 ha of monoculture plot gave the same crop yield (kg/ha) as 1.00 ha of mixed crop. The cocoa component started fruiting earlier than kola and also continued to yield annuall so there was no crop failure in any year.

Glendinning D. R. 1966. Further Observations On Relationship Between Growth And Yield In Cocoa Varieties. Euphytica, 15:116-127.
Reference ID: 21411
Notes: #21411e
Abstract: Yields of cocoa varieties are positively correlated with the rate of trunk diameter increase prior to commencement of bearing, the correlation persisting over the years and not deriving only from faster-growing varieties being first into bearing. However yields seem to be more closely correlated, over early and intermediate years, with the difference between the rate of trunk diameter increase while in bearing and that in the pre-bearing period. Over these years there is a negative relationship between yields and the current rates of trunk diameter increase. Once varieties are well into bearing, current trunk diameters have little influence on yield. The rate of trunk diameter increase slows down until, in later years of bearing, it is almost nil. Then yields may be very closely correlated with the rates of diameter increase before bearing, which in effect are the same as the reductions in increment rates. A difference between varieties of 1.2 cms. per annum in the pre-bearing rate of trunk diameter increase seems to be roughly equivalent to a difference in yielding capacity of 1,600 lbs. dry cocoa per acre per annum.

Lockwood G. 1976. Comparison Of Growth And Yield During A 20 Year Period Of Amelonado And Upper Amazon Hybrid Cocoa In Ghana. Euphytica, 25:647-658.
Reference ID: 21412
Notes: #21412e
Abstract: Progeny trials were planted at Tafo in 1952 and 1954 to compare 3 selfed local-Trinitarios, 1 outcrossed and 3 sibbed Upper Amazon progenies and 13 hybrids between Amelonado or local-Trinitarios and Upper Amazons; 1 trial included West African Amelonado. The Amazon hybrids and the outcrossed Amazon were particularly vigorous and precocious and maintained a yield advantage for 20 years. The 13 hybrids were similar in yield potential, but varied in net yield following differential losses from pod diseases, mainly caused by *Phytophthora palmivora*. Disease losses were lowest on one of the sibbed Amazons and the outcrossed Amazon and lower on Amelonado than on any of the 7 hybrids tested with it; in both trials losses were lower on Amelonado hybrids than on Trinitario hybrids. There was wide variation in both size and growth rates of mature trees and no consistent relationship between continued growth and crop. It seemed that later yields were not prejudiced by the precocity of Amazon hybrids, the yields from all types fluctuated together. Because the differences in disease losses are likely to be accentuated under farmer's conditions. Amelonado hybrids are preferable to local-Trinitario hybrids. The results also suggest that commercially acceptable pure Upper Amazon varieties could be developed.

Jagoret P., J. Kwesseu, C. Messie, I. Michel-Dounias, and E. Malezieux. 2014. Farmers' assessment of the use value of agrobiodiversity in complex cocoa agroforestry systems in central Cameroon. Agroforestry Systems, 88:983-1000.
Reference ID: 21413
Notes: #21413e
Abstract: Agroforestry systems in humid tropical areas are complex multispecies cropping systems whose value for farmers is often hard to assess. We present the findings of a participatory assessment that we applied to cocoa agroforestry systems. This assessment, adapted from the pebble distribution method, was used to quantify the value given by farmers to each species of their cocoa agroforestry system according to the attributed uses. A tree inventory in 50 cocoa agroforests was carried out in central Cameroon. Overall, 122 non-cocoa tree species were inventoried. The mean species richness was 23 species per plot and the mean Shannon index was 2.42, for a mean density of 180 non-cocoa trees ha(-1) and 1,511 cocoa trees ha(-1). Cocoa farmers defined seven different uses for tree species, including Theobroma cacao. 81 % of the species (including cocoa trees) had one to seven uses whereas the highest use value was given to T. cacao, with a mean score of 23.6 %. Then, in descending order, the 10 non-cocoa species with the highest use values were Dacryodes edulis, Persea americana, Elaeis guineensis, Citrus sinensis, Mangifera indica, Milicia excelsa, Cola nitida, Citrus sp., Ricinodendron heudelotii, and Terminalia superba. The frequency of non-cocoa species was significantly and positively correlated with their use value (R-2 = 0.914). Our results showed that technical innovations designed to improve cocoa agroforestry systems should take into account farmers' knowledge to propose them systems so as to be able to more effectively address their expectations.

Pedelahore P. 2014. Farmers accumulation strategies and agroforestry systems intensification: the example of cocoa in the central region of Cameroon over the 1910-2010 period. Agroforestry Systems, 88:1157-1166.
Reference ID: 21414
Notes: #21414e
Abstract: Agroforestry is often portrayed as one of the ways towards ecological intensification of agricultural systems. This intensification process allows rural households to sustainably increase cash revenues and capital accumulation capacity. Many research studies have focused on the technical and economic improvement of agroforestry systems (AFS). However, it is equally important to study this the other way around, hence assessing the impact of the strategies and accumulation trajectories of farmers on the intensification of AFS. The present study aims at characterizing the various accumulation strategies of farmers and assessing their relationships with AFS intensification. The study involved semi-structured interviews of 82 cocoa farmers representative of the diversity of cocoa AFS farms in Central Cameroon. The results demonstrate that the successful accumulation strategies are the ones mainly based on the development of activities and revenues of off farm and of urban origin. This capital of urban origin has led to the strong emergence of large farms (from 5 to 30 ha). Due to the influx of financial capital and the adoption of improved agricultural techniques, these large farms achieve cocoa yields much higher (512 kg/ha) than smaller farms (<2 ha, 214 kg/ha) or medium farms (2-5 ha, 338 kg/ha). Nonetheless, the preliminary data collected in the present study indicate that the higher cocoa yields achieved by large farms does not necessarily translate into a sustainable improvement of the overall productivity (i.e. cacao as well as other products originating form AFS) or that of the labor.

Kone M., S. Konate, K. Yeo, P. K. Kouassi, and K. E. Linsenmair. 2014. Effects of management intensity on ant diversity in cocoa plantation (Oume, centre west Cote d'Ivoire). Journal of Insect Conservation, 18:701-712.
Reference ID: 21415
Notes: #21415e
Abstract: Anthropogenic habitat modifications, including conversion of forest to agricultural production cause losses of native species. In this study we examined the losses suffered by ant communities in relation to the intensity of management in cocoa plantations established in former tropical forest. An extensive sampling protocol consisting of pitfall trapping, leaf litter sampling, soil sampling and hand sampling was used to characterize ant species richness and composition in the native forest and compare it with three cocoa farms differing in their management intensity. Species richness was negatively correlated with management intensity and differed greatly between management practices and the forest. Two subfamilies (Myrmicinae and Amblyoponinae) showed a significant negative correlation with agricultural intensification probably because their species are constrained to living in forest like habitat. The species composition differed greatly between management practices and the forest. Intensively and moderately managed cocoa plantations were most dissimilar to the forest. In contrast, forest ants were well represented in the least intensively managed plantation. Overall, the findings of this study show that only slightly managed cocoa plantations sustain an ant diversity that comes close to that of the forest. This also holds true for cocoa plantations on former agricultural, and thus previously heavily used, land. The findings may help in the conservation of biodiversity as management practices most likely to sustain forest like ant communities have been identified.

Jagoret P., I. Michel-Dounias, D. Snoeck, H. T. Ngnogue, and E. Malezieux. 2012. Afforestation of savannah with cocoa agroforestry systems: a small-farmer innovation in central Cameroon. Agroforestry Systems, 86:493-504.
Reference ID: 21416
Notes: H 9 #21416e
Abstract: Cocoa cultivation is generally considered to foster deforestation. Contrary to this view, in the forest-savannah interface area in Cameroon, farmers have planted cocoa agroforestry systems on Imperata cylindrica grasslands, a soil-climate zone generally considered unsuitable for cocoa cultivation. We undertook a survey to understand the agricultural and ecological bases of this innovation. Age, cropping history and marketable cocoa yield were assessed in a sample of 157 cocoa plantations established on grasslands and 182 cocoa plantations established in gallery forests. In a sub-sample of 47 grassland cocoa plantations, we inventoried tree species associated with cocoa trees and measured soil organic matter levels. Marketable cocoa yields were similar for the two types of cocoa plantations, regardless of their age: 321 kg ha(-1) in cocoa plantations on grasslands and 354 kg ha(-1) in cocoa plantations in gallery forests. Two strategies were used by farmers to eliminate I. cylindrica prior to the establishment of cocoa plantations, i.e., cropping oil palms in dense stands and planting annual crops. Farmers then planted cocoa trees and fruit tree species, while preserving specific forest trees. The fruit tree and forest tree densities respectively averaged 223 and 68 trees ha(-1) in plantations under 10 years old, and 44 and 27 trees ha(-1) in plantations over 40 years old, whereas the cocoa tree density remained stable at 1,315 trees ha(-1). The Shannon-Weaver index increased from 1.97 to 2.26 over the same period although the difference was not statistically significant. The soil organic matter level was 3.13 % in old cocoa

plantations, as compared to 1.7 % in grasslands. In conclusion, our results show that the occupation of grasslands by cocoa agroforestry systems is both an important example of ecological intensification and a significant farmer innovation in the history of cocoa growing.

Oyekale A. S. and A. O. Adepoju. 2012. Determinants of Agricultural Intensification in Southwest Nigeria. Life Science Journal-Acta Zhengzhou University Overseas Edition, 9:370-376.
Reference ID: 21417
Notes: #21417e
Abstract: Declining agricultural production in many developing countries has prompted increased use of some inputs while continuous cropping prevails. This study analysed the factors promoting different forms of agricultural intensification in southwestern Nigeria. Data collected from randomly selected farmers in selected states in southwestern Nigeria were used. Results show that farmers from Osun State have the highest indices of intensification with respect to land use intensity, fertilizer use intensity and crop diversification. The censored regression showed that lost working days, use of fertilizers, crop rotation, and having more inherited land increased land use intensity while use of organic manure, minimum tillage and poverty reduced crop diversification index. Fertilizer use intensity increased with the use of minimum tillage and household size while hired and family labour use intensity increased with household size. It was recommended that in the face of increasing land degradation, farmers' access to fertilizer must be increased and efforts to reduce their poverty level must be promoted, among others.

Feintrenie L., S. Schwarze, and P. Levang. 2010. Are Local People Conservationists? Analysis of Transition Dynamics from Agroforests to Monoculture Plantations in Indonesia. Ecology and Society, 15.
Reference ID: 21418
Notes: #21418e
Abstract: Cash crops are developing in the once forested areas of Indonesia in parallel with market and economic improvements. Perennial crops such as coffee, cocoa, and rubber were first planted in estates by private or public companies. Local people then integrated these crops into their farming systems, often through the planting of agroforests, that is, intercropping the new cash crop with upland rice and food crops. The crop was generally mixed with fruit trees, timber, and other useful plants. A geographic specialization occurred, driven by biophysical constraints and market opportunities, with expansion of cocoa in Sulawesi, coffee in Lampung, and natural rubber in eastern Sumatra. However, during the past three decades, these agroforests have increasingly been converted into more productive monoculture plantations. A common trajectory can be observed in agricultural landscapes dominated by a perennial cash crop: from ladang to agroforests, and then to monoculture plantations. This process combines agricultural expansion at the expense of natural forests and specialization of the land cover at the expense of biodiversity and wildlife habitats. We determined the main drivers of agricultural expansion and intensification in three regions of Indonesia based on perception surveys and land use profitability analysis. When the national and international contexts clearly influence farmers' decisions, local people appear very responsive to economic opportunities. They do not hesitate to change their livelihood system if it can increase their income. Their cultural or sentimental attachment to the forest is not sufficient to prevent forest conversion.

de Souza Junior J. O., Q. A. D. Carmello, and G. A. Sodre. 2011. Potting Mix And Phosphate Fertilization For Production Of Rooted Cocoa Cuttings. Revista Brasileira De Ciencia Do Solo, 35:151-159.
Reference ID: 21419
Notes: #21419e
Abstract: The effect of potting mix and phosphate fertilization on the production of rooted cocoa tree cuttings was evaluated and recommended rates and critical foliar P levels were determined based on a factorial 5 x 5 + 1 experiment: five potting medium (coconut fiber - CF and Plantmax (R) mix), five P rates at planting (0 to 800 mg dm(-3)) and an additional P treatment (applied on the 30(th) day). Each plot contained 27 cuttings, of which 12 rooted cuttings were evaluated. From the 62(nd) clay onwards, Nand K fertilization was weekly applied as well as a P fertilization on the 120(th) clay (20 mg dm(-3)), to all treatments. The diameter, height, leaf area, shoot and root (fine and thick) dry matter, nutrient concentration and content in plants were evaluated on the 150(th) clay. Cutting mortality was not influenced by the treatments. Phosphorus top dressing increased P assimilation and absorption, but not the growth of the rooted cuttings. The biometric and nutrition variables responded to treatments; best results were obtained with 30-55 % of CF and P rates between 136 and 275 mg dm(-3). The foliar critical level of P was 1.75 g kg(-1).

de Souza Junior J. O. and Q. A. D. Carmello. 2008. Forms and doses of urea to fertilize clonal cocoa tree cuttings cultivated in substrate: Formas de adubação e doses de uréia para mudas clonais de cacau cultivadas em substrato. Revista Brasileira De Ciencia Do Solo, 32:2367-2374.
Reference ID: 21420
Notes: #21420e
Abstract: Nitrogen is the mineral nutrient required most by plants. There are, however, no studies on N fertilization calibration for rooted cocoa tree cutting production on substrate and frequent irrigation. The objective of this study was to compare the efficiency of urea fertilization on substrate and leaves for rooted cocoa tree cutting and to define N recommendable doses and foliar critical N level. The experiment was set up in a rooted cutting breeding nursery of the Cocoa Biofactory Institute, in Ilheus, Bahia, in July 2006, involving 10 treatments (two fertilization treatments and five urea doses), in random blocks with four repetitions. Each plot consisted of 12 rooted cocoa cuttings in plastic tubes, containing 288 cm^3 substrate (50 % coconut fiber and 50 % Plantmax®). The substrate was limed with 3.20 kg m-3 and fertilized with 2.68 kg m-3 of single superphosphate. The treatments were applied between the 82nd and 138th day, with the following weekly N doses to the substrate (0, 20, 40, 60 and 80 mg dm-3) and to the leaves (0.0, 2.25, 4.5, 9.0 and 13.5 g L-1). For all treatments, fertilization was supplemented with P, K, S, Zn and B via substrate. On the 145th day, the plants were harvested to evaluate diameter, height, leaf area, shoot dry matter (SDM), nutrient concentration in the diagnostic leaf and nutrient content in the shoot. The biometric and nutrient variables responded to treatments. Adding urea to the substrate led to the maximum yield, exceeding foliar fertilization for SDM, height and leaf area. The N doses recommended to obtain 99 % of the maximum yield varied, according to the biometric variable, from 43 to 76 mg dm-3 for fertilization on substrate and from 9.1 to 11.7 g L-1 for foliar fertilization. The critical foliar N level to obtain 99 % of the maximum yield of SDM by foliar fertilization was 23.1 g kg-1 N.

Zaia F. C., A. C. da Gama-Rodrigues, E. F. da Gama-Rodrigues, and R. C. R. Machado. 2008. Organic Phosphorus In Soils Under Cocoa Agrosystems. Revista Brasileira De Ciencia Do Solo, 32:1987-1995.
Reference ID: 21421
Notes: #21421e
Abstract: Understanding the soil organic P (Po) cycle is important to improve the P fertilization management in low-input tropical agricultural systems. The aim. of this study was to evaluate Po content and labile P fractions, and microbial biomass P in soils under different cocoa agroecosystems. Mean total Po was 193 mg kg(-1) and accounted for 7.8 to 36.3 % of the total extracted P. Mean, labile Po was 15 mg kg(-1) and accounted for 33.1 to 81.9 % of the total labile P. In cocoa agrosystems, the total Po, labile Po and microbial P contents were lower in the Oxisol than in the Inceptsol group. In the Oxisol group, in soils under cocoa agrosystems, the total Po, microbial P and available P contents were higher and the labile Po lower than in the soil under natural forest. Available P was positively correlated with Po (total, labile and microbial), and total Po was positively related to microbial P. The labile Po fraction was far higher in, the labile inorganic fraction, especially in the Oxisol group.

de Souza Junior J. O., Q. A. D. Carmello, and J. C. Faria. 2008. Chemical characteristics of leachate from phosphorus-fertilized substrates during rooting of cocoa tree cuttings. Revista Brasileira De Ciencia Do Solo, 32:1573-1581.
Reference ID: 21422
Notes: #21422e
Abstract: Fertilization and irrigation is intensively used for seedling production in substrate, which can result in high nutrient losses. Phosphorus (P) is heavily used in the preparation of the potting mix, but studies on nutrient losses are scarce. The objective of this study was to evaluate the chemical attributes in leachate from potting mix during rooting of cocoa tree cuttings under intermittent irrigation and P fertilization in a 5 x 5 factorial, complete randomized block design with three replications. The factors consisted of five substrates (20, 35, 50, 65 and 80 % volume of coconut fiber (CF) completed with Plantmax (R)) and five triple superphosphate - TSP rates (P2O5 = 0; 0.23; 0.46; 0.92 and 1.84 g dm(-3)). The plot consisted of two tubes (288 cm(3)), with one herbaceous cocoa cutting per tube. Total leachate of 28 days was collected and measured, while electric conductivity (EC) and pH were analyzed in three weekly samples. The nutrients P, Ca, Mg and K were quantified in weekly average samples and the data subjected to regression analysis. Over the course of time, the pH in the leachate increased and CE decreased. Increasing TSP doses, reduced the pH and increased the EC of the leachate. The higher the CF proportion, the faster and higher were pH and EC variations. Nutrients content and amount in leachate from all substrates tested decreased soon after starting the study. TSP supply increased leaching of all nutrients. Ca, Mg and K losses were proportional to their availability in the substrate. Leaching of supplemented P ranged from 39 to 74 % and was inversely proportional to the phosphate adsorption capacity of the substrates.

Krauss U. and W. Soberanis. 2002. Effect of fertilization and biocontrol application frequency on cocoa pod diseases. Biological Control, 24:82-89.
Reference ID: 21423
Notes: #21423e
Abstract: Three native and two commercial biocontrol agents (Clonostachys rosea

and Trichoderma spp.) were evaluated against the cocoa diseases moniliasis, witches' broom, and black pod. Antagonists were applied either separately or as mixed inoculum in comparison with a copper fungicide and a nontreated control. Cultural control (weekly removal of diseased pods) was practiced in all treatments. Field trials were conducted on neglected cocoa farms in eastern Peru from 1998 to 2000. The fungicide treatment and C. rosca strain G-4 did not reduce disease. The other single-strain antagonists reduced moniliasis. Additionally, Trichoderma longibrachialum and Trichoderma stromaticum reduced witches' broom and Trichoderma virens reduced black pod. With strain mixtures, yield increases of up to 15% were obtained. A mixture of four antagonists was superior to mixtures of two or three antagonists with respect to multiple disease control and yield. Biocontrol in combination with cultural control was more economical than cultural control alone; chemical control was least economical. Fertilisation improved yields by 11% independent of the disease control measure and compensated for the additional costs with net returns improving by 9%. Increasing application frequencies of a mixed biocontrol inoculum improved moniliasis and witches' broom control linearly. Moniliasis exhibited a stronger response. Witches' broom was significantly lower than the nontreated control only if ten applications were administered in two-week intervals. This application frequency increased yields by 15%. It was followed by three applications adjusted to the production cycle (yield increase: 12%). Three adjusted applications were the most economical biocontrol strategy under the conditions of eastern Peru. Net returns were increased by 12%. Recommendations for technology transfer are presented.

Cicuzza D., Y. Clough, S. S. Tjitrosoedirdjo, and M. Kessler. 2012. Responses of terrestrial herb assemblages to weeding and fertilization in cacao agroforests in Indonesia. Agroforestry Systems, 85:75-83.
Reference ID: 21424
Notes: #21424e
Abstract: Terrestrial herbs are important ecological components in tropical agroforests, but little is known about how they are affected by agricultural management. In cacao agroforests of Central Sulawesi, Indonesia, we studied the change in herb species richness, cover, and biomass over 3 years in 86 subplots subjected to high and low weeding frequency as well as fertilized and non-fertilized treatments. We recorded 111 species with rapid changes in species composition between the 3 years. Species richness increased sharply in the 2nd year, presumably as a result of changes in the management with the experimental regimes, and decreased in the 3rd, probably due to competitive exclusion. Species richness, cover, and biomass were all significantly higher in the infrequently weeded plots than in the frequently weeded ones, but there were only slight responses to the fertilization treatment. An indicator species analysis recovered 45 species that were typical for a given year and a further eight that were typical for certain treatments, but these species showed no clear patterns relative to their ecology or biogeography. We conclude that the herb assemblages in cacao agroforests are quite resilient against weeding, but that the cover of species shifts rapidly in response to management.

Falque M. 1994. Pod And Seed Development And Phenotype Of The M1 Plants After Pollination And Fertilization With Irradiated Pollen In Cacao (Theobroma-Cacao L). Euphytica, 75:19-25.
Reference ID: 21425
Notes: #21425e
Abstract: In order to try to induce parthenogenesis, Theobroma cacao L. pollen of the clone K5 was gamma-irradiated at 0, 50, 70 and 90 Gy and used to pollinate flowers of the clones IMC67 and T85/799. Fruit survival rate 30 days after pollination decreased as pollen irradiation dose increased. LD50 was about 70 Gy for IMC67 and 75 Gy for T85/799. Pods obtained from irradiated pollen were smaller, ripened slower, and contained a lower number of beans than the controls. In many beans obtained after pollination with irradiated pollen, albumen was still present at maturity, and the embryo was either absent or abnormal and reduced in size, while control beans contained a well-developed embryo and almost no visible albumen. No haploid was obtained. Morphologic mutants were obtained from TMC67 pollinated with 50 Gy-irradiated K5 pollen, and some of them had inherited paternal alleles of enzymic markers without showing the axil-spot dominant character. Accidental self-fertilization of the two self-incompatible clones through mentor pollen effect, was observed in rare cases.

Ofori-Frimpong K. and D. L. Rowell. 1999. The decomposition of cocoa leaves and their effect on phosphorus dynamics in tropical soil. European Journal of Soil Science, 50:165-172.
Reference ID: 21426
Notes: #21426e
Abstract: Higher-yielding varieties of cocoa make heavier demands on phosphorus resources in soils and so it is important that the role of leaf litter in cycling P is understood. Fresh cocoa leaves and leaf litter were incubated moist with a soil inoculum for 80 days when between 16 and 33% of the mass was lost. Materials containing large amounts of P or incubated with added inorganic P initially decomposed more rapidly than those containing smaller amounts, indicating that decomposition was limited by lack of P. Fresh leaves had half of their P in an acid-soluble (0.1 M H2SO4) form, most of which was also water soluble, whereas in the litters about a third was acid-soluble. During incubation, P-rich materials showed an increase in the acid-soluble fraction and a decrease in water-soluble P. Litters with small concentrations of P simply lost P from the acid-soluble into the non-soluble organic fraction, and no water-soluble P remained after 80 days.
A soil from a cocoa-growing site fertilized with P contained almost four times as much biomass P as the non-fertilized control (30 and 8 mg kg(-1) soil, respectively), the amounts of bicarbonate-extractable P being 32 and 4 mg kg(-1). Soils from these and one other cocoa-growing site (8 mg kg(-1) biomass P, 7 mg kg(-1) bicarbonate-extractable P) were incubated either alone, with cocoa litter, or with cocoa litter plus inorganic P. In the soil that had the small amount of NaHCO3-extractable P (4 mg kg(-1)) addition of litter caused the biomass P to increase from 8 to 16 mg kg(-1) after 1 week's incubation, the increase being larger than the amount of P added in the litter, but in the other two soils biomass P was not increased. Addition of inorganic P had no effect on biomass P in any of the soils.
Decomposing litter may compete with the crop for P, but addition of fertilizer P may increase the rate of mineralization of organic P in the litter. Suitable management of fertilizer P should allow the rate of release of P from the litter to be adjusted to suit crop demands.

Sujatha S. and R. Bhat. 2013. Impact of drip fertigation on arecanut-cocoa system in humid tropics of India. Agroforestry Systems, 87:643-656.
Reference ID: 21427
Notes: #21427e
Abstract: A 5-year field trial was conducted on a laterite soil to evaluate the effects of organic and inorganic fertigations in arecanut sole and arecanut-cocoa land use systems at Vittal, India. Arecanut registered similar yield levels in sole and arecanut-cocoa cropping situations (3,022-3,117 kg ha(-1)). Fertigation of 75 % NPK, vermicompost extract (VCE) 20 % N and VCE (10 and 20 % N)+25 % NPK registered the same yield levels (3,029-3,375 kg ha(-1)). Dry bean yield of cocoa was at par with fertigation of 75 % NPK and 20 % N VCE + 25 % NPK (291-335 kg ha(-1)). Fertigation @ 75 % NPK increased the yield of cocoa by 52 % over VCE alone. The productivity per unit area (kg ha(-1)) was significant and higher by 12 % in arecanut-cocoa system (3,450) than arecanut sole (3,090). Productivity was similar to fertigation of 75 % NPK, 20 % N VCE and VCE (10 or 20 % N) + 25 % NPK (3,316-3,665 kg ha(-1)). Leaf nutrient status of arecanut and cocoa indicated lower levels of N and K and above normal levels of Ca, Mg and micronutrients. The results indicate that drip fertigation increases the productivity, but precision application of N and K is required for sustaining the yields.

Sodre G. A., M. T. Venturini, D. O. Ribeiro, and P. C. L. Marrocos. 2012. Extract From The Bark Of Cocoa Fruit As Potassium Fertilizer On Growth Of Cocoa Seedlings. Revista Brasileira De Fruticultura, 34:881-887.
Reference ID: 21428
Notes: #21428e
Abstract: Considering the importance of the bark of cocoa as the main crop residue in cocoa farms, the objective of this study was to make analysis of nutrients from the organic extract obtained by washing the compost of the bark and to evaluate the effect of this extract as potassium fertilizer in soils and growth of cocoa seedlings. The experiment was conducted in a greenhouse with application of extract in the soil, growing in plastic tubes and seedlings of cocoa. The experimental design was in randomized blocks with three replications and experimental units consisting of nine plants grown individually in plastic tubes. The treatments were five K levels: zero, 125, 250, 500 and 1000 mg K dm(-3) of soil. After 120 days of the extract application in the soil, it was found that pH, base saturation and Ca, Mg, K, Zn and Mn available increased while the content of Al and Fe were reduced. The results also showed that the dose 1000 mg K dm(-3) of soil unbalanced the ratio K/Mg and K/Ca in leaves with reduced growth of seedlings. The application of bark extract increased significantly the available of K in the soil and concentration in plants. Cocoa seedlings showed growth in responses to different levels of K and, considering the easily of manufacture and applying the extract of the cacao bark, there is possible of the use as a source of K in the production of cocoa seedlings.

Ruf F., G. Schroth, and K. Doffangui. 2015. Climate change, cocoa migrations and deforestation in West Africa: What does the past tell us about the future? Sustainability Science, 10:101-111.
Reference ID: 21429
Notes: H 15 #21429e
Abstract: Cocoa farming has been a major driver of deforestation in West Africa, notably in Cte d'Ivoire, the world's leading cocoa producer. Cocoa has been a "pioneer crop" that was grown after forest clearing, and instead of replanting aging

plantations, farmers usually migrated to the forest frontiers to establish a new cocoa farm. During the second half of the twentieth century, the cocoa frontier moved from the drier east to the wetter southwest of the country, fueled by massive immigration of prospective cocoa farmers from the savanna. It has been argued that the climate gradient was a major driver of these east-west migrations and that cocoa farmers, by replacing forest with farm land over vast areas, contributed to the further drying of the climate in a positive feedback cycle. If this were the case, then a hotter and drier future climate would likely continue to push cocoa farmers into the wetter southwest of the sub-continent, with the last forest reserves of southwestern Cte d'Ivoire and Liberia as the only remaining destinations. Based on an analysis of long-term rainfall measurements in major cocoa growing areas of Cte d'Ivoire and interviews with cocoa farmers about their history and motives of migration, we argue that climate and drought have been supporting factors, but not usually the main drivers of cocoa migrations, which were mostly a response to the perceived availability of forest land for planting. We also show that the observed decrease in rainfall in the cocoa regions during the 1970s and 1980s was not primarily a response to local deforestation related to cocoa farming, although deforestation may have caused microclimatic changes. Climate extremes like the 1982/3 drought have also triggered adaptations of farming practices like replanting and crop diversification. To prevent cocoa farming from continuing to act as a driver of deforestation in a hotter climate, governments and supply chain actors should discourage forest frontier dynamics and should help cocoa farmers adapt to environmental change by adopting more intensive and diversified farming practices, building on farmers' own risk mitigation and adaptation strategies.

Wanger, T. C. Pollination curbs climate risk to cocoa. Nature 511[7508], 155. 2014.
Reference ID: 21430
Notes: #21430e

Kongsager R., J. Napier, and O. Mertz. 2013. The carbon sequestration potential of tree crop plantations. Mitigation And Adaptation Strategies For Global Change, 18:1197-1213.
Reference ID: 21431
Notes: H 15 #21431e
Abstract: Carbon (C) conservation and sequestration in many developing countries needs to be accompanied by socio-economic improvements. Tree crop plantations can be a potential path for coupling climate change mitigation and economic development by providing C sequestration and supplying wood and non-wood products to meet domestic and international market requirements at the same time. Financial compensation for such plantations could potentially be covered by the Clean Development Mechanism under the United Nations Framework Convention on Climate Change (FCCC) Kyoto Protocol, but its suitability has also been suggested for integration into REDD + (reducing emissions from deforestation, forest degradation and enhancement of forest C stocks) currently being negotiated under the United Nations FCCC. We assess the aboveground C sequestration potential of four major plantation crops - cocoa (Theobroma cacao), oil palm (Elaeis guineensis), rubber (Hevea brasiliensis), and orange (Citrus sinesis) - cultivated in the tropics. Measurements were conducted in Ghana and allometric equations were applied to estimate biomass. The largest C potential was found in the rubber plantations (214 tC/ha). Cocoa (65 tC/ha) and orange (76 tC/ha) plantations have a much lower C content, and oil palm (45 tC/ha) has the lowest C potential, assuming that the yield is

not used as biofuel. There is considerable C sequestration potential in plantations if they are established on land with modest C content such as degraded forest or agricultural land, and not on land with old-growth forest. We also show that simple C assessment methods can give reliable results, which makes it easier for developing countries to partake in REDD + or other payment schemes.

Damnyag L., O. Saastamoinen, D. Blay, F. K. Dwomoh, L. C. N. Anglaaere, and A. Pappinen. 2013. Sustaining protected areas: Identifying and controlling deforestation and forest degradation drivers in the Ankasa Conservation Area, Ghana. Biological Conservation, 165:86-94.
Reference ID: 21432
Notes: #21432e
Abstract: Although protected areas in Africa contain possibly the highest repositories of carbon and thus can play a role in mitigating the effects of climate change through carbon sequestration, they are threatened due to increasing levels of deforestation and forest degradation (DFD). However, little information is available on the on-site causes of DFD in these areas. This paper estimates the levels of DFD and identifies the drivers in the Ankasa Conservation Area (ACA) in Ghana as a case study. A survey was used to identify both direct and underlying factors that promote the DFD. The extent of deforestation was estimated using satellite images. The survey data were analyzed using rankings and ordinal logistic regression techniques, while digital image classification and change detection were used to analyze land cover changes. The results show that DFD occurred at a higher rate in the periphery of the ACA compared to the core-protected and the farthest areas. Agricultural and wood harvesting activities were the main direct causes of DFD. Poverty and large in-migrations of people for cocoa farming were important underlying economic and population growth factors. To address these problems and enable ACA to contribute more to biodiversity conservation and climate change mitigation, the community resource management institutions should be fully adopted and strengthened and priority given to livelihood improvement and ecosystem services provision in the periphery of the ACA.

Ramirez-Villegas J., M. Salazar, A. Jarvis, and C. E. Navarro-Racines. 2012. A way forward on adaptation to climate change in Colombian agriculture: perspectives towards 2050. Climatic Change, 115:611-628.
Reference ID: 21433
Notes: #21433e
Abstract: Policy measures regarding adaptation to climate change include efforts to adjust socio-economic and ecologic systems. Colombia has undertaken various measures in terms of climate change mitigation and adaptation since becoming a party of the Kyoto protocol in 2001 and a party of the United Nations Framework Convention on Climate Change (UNFCCC) in 1995. The first national communication to the UNFCCC stated how Colombian agriculture will be severely impacted under different emission scenarios and time frames. The analyses in this document further support that climate change will severely threaten the socioeconomics of Colombian agriculture. We first query national data sources to characterize the agricultural sector. We then use 17 Global Circulation Model (GCM) outputs to quantify how Colombian agricultural production may be affected by climate change, and show the expected changes to years 2040-2069 ("2050") under the A2 scenario of the Intergovernmental Panel on Climate Change Special Report on Emissions Scenarios (SRES-A2) and the overall trends in both precipitation and temperature to 2100. We

then evaluate expected changes within different regions and measure the proportion of area affected within each crop's distributional range. By 2050, climatic change in Colombia will likely impact 3.5 million people, 14 % of national GDP corresponding to agriculture, employment of 21 % of the population, agro-industries, supply chains, and food and nutritional security. If no adaptation measures are taken, 80 % of crops would be impacted in more than 60 % of their current areas of cultivation, with particularly severe impacts in high value perennial and exportable crops. Impacts also include soil degradation and organic matter losses in the Andes hillsides; likely flooding in the Caribbean and Pacific coasts; niche losses for coffee, fruit, cocoa, and bananas; changes in prevalence of pests and diseases; and increases in the vulnerabilities of non-technically developed smallholders. There is, however, still time to change the current levels of vulnerability if a multidisciplinary focus (i.e., agronomic, economic, and social) in vulnerable sectors is undertaken. Each sub-sector and the Government need to invest in: (1) data collection, (2) detailed, regionally-based impact assessments, (3) research and development, and (4) extension and technology transfer. Support to vulnerable smallholders should be given by the state in the form of agricultural insurance systems contextualized under the phenomenon of climate change. A national coordination scheme led by (but not restricted to) the Ministry of Agriculture and Rural Development (MADR) with the contributions of national and international institutions is needed to address agricultural adaptation.

Moraes W. B., W. C. Jr. de Jesus, L. A. Peixoto, W. B. Moraes, E. L. Furtado, L. G. da Silva, R. A. Cecilio, and F. R. Alves. 2012. An analysis of the risk of cocoa moniliasis occurrence in Brazil as the result of climate change: Análise do risco de ocorrência da monilíase em cacaueiro no Brasil face às mudanças climáticas globais. Summa Phytopathologica, 38:30-35.
Reference ID: 21434
Notes: #21434e
Abstract: The aim of this study was to evaluate the potential risk of moniliasis occurrence and the impacts of climate change on this disease in the coming decades, should this pathogen be introduced in Brazil. To this end, climate favorability maps were devised for the occurrence of moniliasis, both for the present and future time. The future scenarios (A2 and B2) focused on the decades of 2020, 2050 and 2080. These scenarios were obtained from six global climate models (GCMs) made available by the third assessment report of Intergovernmental Panel on Climate Change (IPCC). Currently, there are large areas with favorable climate conditions for moniliasis in Brazil, especially in regions at high risk of introduction of that pathogen. Considering the global warming scenarios provided by the IPCC, the potential risk of moniliasis occurrence in Brazil will be reduced. This decrease is predicted for both future scenarios, but will occur more sharply in scenario A2. However, there will still be areas with favorable climate conditions for the development of the disease, particularly in Brazil's main producing regions. Moreover, pathogen and host alike may undergo alterations due to climate change, which will affect the extent of their impacts on this pathosystem.

Ninnon C., T. Janniyom, P. Thongkam, and T. Akesomtharames 1998. How To Use Fertilizer For Oil Palm, Faculty of Environment, Songklanakarin University, =IPNI, Thailand.
Reference ID: 21435
Notes: S 8.1.1.1 #21435

Oyekale A. S. 2012. Climate Change and Cocoa Production Efficiency Losses in Ondo East Local Government, Nigeria. Life Science Journal-Acta Zhengzhou University Overseas Edition, 9:726-732.
Reference ID: 21436
Notes: #21436e
Abstract: Effect of climate change on cocoa agriculture cannot be underestimated. This study assessed efficiency differentials in cocoa production under with and without climate change scenarios. The data were collected using multi-stage sampling method. Data were analyzed with simple descriptive statistics and stochastic frontier approach. The results show that cocoa farmers are ageing (mu = 54 years) and many owe small farms (mu = 9.15 ha). Also, production input elasticities when under normal climate are all positive, while those for chemical and spraying hour are negative when there is climate change. Return to scale under climate change is higher (2.097075) than without climate change (1.825603), although lower output under the former still implies low productivity. Average production efficiency with climate change is 65.14 percent while it is 83.75 percent without climate change. The study recommended development of viable and cost effective chemicals to curtail increasing incidence of pests and diseases as a result of climate change, among others.

Oyekale A. S. and O. Oladele. 2012. Determinants of climate change adaption among cocoa farmers in southwest Nigeria. Journal of Food Agriculture & Environment, 10:1562-1567.
Reference ID: 21437
Notes: #21437e
Abstract: Cocoa production in Nigeria is vulnerable to climate change. This study analyzed the factors influencing different climate change adaptation choices by cocoa farmers in southwest Nigeria. We sampled 515 farmers from three cocoa producing states, using the multistage sampling procedure. We analyzed cocoa farmers' climate change adaptation choices with Probit regression. All the farmers have noticed climate change and 78.72% noted excessive rainfall in 2011. Years of education, age of farmers and cocoa land areas significantly reduces ($p<0.10$) the probability of engaging in crop diversification. It, however, increases with male headship, household size, member sick, age of cocoa, ownership of radio and bicycle. Also, years of education, number of cocoa farms and cocoa farm distance reduces the chance of noting weather ($p<0.10$). It also increases with member sick, ownership of radio, car, mobile phone and extension contact. The chance of adequately spraying cocoa pods significantly reduces ($p<0.10$) with number of cocoa farms and increases with farming as primary occupation, member sick, age of cocoa trees, ownership of radio, motorcycle, car, and mobile phone. We recommended that effort to address climate adaptation among cocoa farmers should be gender sensitive, among others.

Hodge J. M. 2009. Colonial Foresters versus Agriculturalists: The Debate over Climate Change and Cocoa Production in the Gold Coast. Agricultural History, 83:201-220.
Reference ID: 21438
Notes: #21438e
Abstract: This article draws attention to the unfolding debate concerning forest cover loss, climatic change, and declining cocoa production in the Gold Coast (Colonial Ghana) during the early twentieth century. It argues that, although desiccationist theory was prevalent, its acceptance among colonial authorities in the Gold Coast was far from hegemonic. There were important dissenting colonial voices, particularly among agriculturalists, who argued that declining cocoa yields were due to plant diseases, most notably cocoa swollen shoot disease. It was based on the latter's non-environmental model of disease transmission, rather than the premises of desiccation science, that the government's postwar "cutting out campaign" of cocoa was predicated. Nevertheless, the foresters' correlation of the deterioration of cocoa areas with fears of desiccation was not without its effects on state practice, providing the rationale for an accelerated program of forest reservations in the 1930s.

Belsky J. M. and S. F. Siebert. 2003. Cultivating cacao: Implications of sun-grown cacao on local food security and environmental sustainability. Agriculture and Human Values, 20:277-285.
Reference ID: 21439
Notes: #21439e
Abstract: The reasons why upland farmers on the Indonesian island of Sulawesi are engaged in a cacao boom and its long term implications are addressed in the context of protected area management regulations, and political and economic conditions in Post-Suharto, Indonesia. In the remote case study village of Moa in Central Sulawesi, we found that while few households cultivated cacao in the early 1990s, all had planted cacao by 2000. Furthermore, the vast majority cultivate cacao in former food-crop focused swidden fields under full-sun conditions. Farmers cultivate cacao to establish property rights in light of a land shortage driven in part by the prohibition of farming and forest product collecting in a nearby national park, and to secure a future source of income, a concern that has been exacerbated by Indonesia's economic crisis. However, conversion of swidden fields to sun-grown cacao constrains future food production opportunities, increases susceptibility to drought stress and potential soil nutrient and organic matter losses, and increases household dependence on a commodity that is subject to extreme price volatility. These factors raise significant concerns for local food security and agricultural sustainability.

Oluyole K. A., O. A. Oni, B. T. Omonona, and K. O. Adenegan. 2009. Food security among cocoa farming households of Ondo State, Nigeria. Journal of Agricultural and Biological Science, 4:7-13.
Reference ID: 21440
Notes: #21440e
Abstract: In Nigeria, it has been documented that cocoa farmers devote most of their resources in cocoa production to the detriment of food crop production because they derive more income from cocoa. There is, however, a dearth of information about the consequence of this practice on the food security status of cocoa farming households. In this study, the food security status of cocoa farming households in Ondo State was examined. Multistage sampling technique was used to select 200

respondent households from the study area in 2007. Information was collected from the respondents with the aid of a structured questionnaire, and the data obtained were analysed using descriptive statistics, a Food Security Index Surplus/Shortfall Index and a Probit model. Considering a food security line of N2500.50 per month per adult equivalent, 43% of the total sampled households were food secure while 57% were food insecure. Food secure households exceeded the calorie requirements by 12% while food insecure households fell short of calorie requirements by 9%. A unit increase in farming experience of the household head ($P<0.05$), output of roots and tubers ($P<0.05$), output of cereals ($P<0.05$) and output of cocoa ($P<0.01$) increases the probability of a household to be food secure by 0.0088, 0.00021, 0.000087 and 0.00049, respectively, while a unit increase in household size ($P<0.01$) and age of the household head ($P<0.1$) decreases the probability of a household to be food secure by 0.23 and 0.000074, respectively. A high percentage of households was food insecure, hence, cocoa farming households in the study area could be said to be food insecure.

Oluyole K. A. 2011. Food security status among cocoa growing households in Ondo and Kwara states of Nigeria: a discriminant analysis approach. Africal Journal of Food, Agriculture, Nutrition and Development, 11:5646-5660.
Reference ID: 21441
Notes: #21441e
Abstract: Cocoa, being a cash crop is mostly cultivated among cocoa farmers without giving much consideration to the cultivation of food crops. There is, however, little evidence on the translation of the income from cocoa production into improved food security by cocoa farmers. This study therefore examined the food security status of cocoa farming households in Nigeria. A simple purposive random sampling technique was used to select 100 cocoa farmers from each of Ondo and Kwara states of Nigeria, thus making a total of 200 respondents used for the study. Information was collected from the respondents with the aid of a structured questionnaire and the data obtained from the information were analysed with Descriptive Statistics, Food Security Index, Surplus/Shortfall Index and Discriminant Analysis. The mean age for the households' head was 53±16.27 years while the mean household size was 7±4.24 persons per household. The mean per capita food consumption was 2063.15±1343.55 kilocalories and the mean monthly farm income was N27,536.50±29161.74. With food security line of N1,959.00, 44.0% of the sampled households in the study area were able to meet the recommended calorie intake of 2450 Kilocalories per capita per day. The food secure households exceeded the calorie requirement by 0.03% while the food insecure households fell short of the recommended calorie intake by 0.02%. An increase in the value of association membership of household head, off-farm income, farming experience of household head and number of meals taken per day ($p<0.05$) would improve the food security status of households and hence would shift the households to food security while an increase in the value of household size and per capita non-food expenditure ($p<0.05$) would worsen the food security status of households and therefore shift the household to food insecurity. The study recommended that there is a need for an enlightenment programme on birth control and that government can subsidize the price of food items as this will reduce the cost of procuring food items by households thus enabling households to be able to increase the number of meals taken per day. Also, cocoa farming households are encouraged to ensure that income from cocoa is partly used to address food insecurity at household level.

Posada R. H. and E. Sieverding. 2014. Arbuscular mycorrhiza in Colombian coffee plantations fertilized with coffee pulps as organic manure. Journal of Applied Botany and Food Quality, 87:243-248.
Reference ID: 21442
Notes: #21442e
Abstract: The distribution of arbuscular mycorrhizal (AM) fungal structures in roots, in soil surrounding roots and in amended coffee pulps (CP) was investigated in 12 coffee plantations in Colombia. Fresh CP had been added to plants 6-10 months before sampling. The questions were whether soil chemical and physical parameter and soil depth had an effect on mycorrhiza. Root colonization rates with AM increased in CP amended-plants ($F = 7.75$, $P<0.001$) as compared to a non-amended control. Significantly more roots, CP and AM root colonization were found in the upper soil layer ($F = 41.24$, 9.54, 6.60 respectively, $P<0.001$), while root external mycelium and CP colonization with AM were not affected by soil depth ($F = 14.82$, $P>0.05$). External mycelium length differed between locations ($F = 5.89$, $P<0.001$) and was inversely correlated with soil water content ($r = -0.655$, $P = 0.02$). External mycelium length per AM colonized root was higher in the lower soil layer ($F = 14.82$, $P<0.05$). Soil aeration seemed to be an important physical characteristic for mycorrhiza development in and around coffee roots. Higher mycorrhiza colonization in CP amended-plants might be an adaptive strategy for nutrients acquisition, and AM external mycelium that colonizes CP might take up nutrients directly during CP decomposition.

Hong L. W., D. W. Yan, W. C. Liu, H. G. Chen, and Y. T. Lu. 2013. Time For Coffee controls root meristem size by changes in auxin accumulation in Arabidopsis. Journal of Experimental Botany, 65:275-286.
Reference ID: 21443
Notes: #21443e
Abstract: Roots play important roles in plant survival and productivity as they not only anchor the plants in the soil but are also the primary organ for the uptake of nutrients from the outside. The growth and development of roots depend on the specification and maintenance of the root meristem. Here, we report a previously unknown role of TIME FOR COFFEE (TIC) in controlling root meristem size in Arabidopsis. The results showed that loss of function of TIC reduced root meristem length and cell number by decreasing the competence of meristematic cells to divide. This was due to the repressed expression of PIN genes for decreased acropetal auxin transport in tic-2, leading to low auxin accumulation in the roots responsible for reduced root meristem, which was verified by exogenous application of indole-3-acetic acid. Downregulated expression of PLETHORA1 (PLT1) and PLT2, key transcription factors in mediating the patterning of the root stem cell niche, was also assayed in tic-2. Similar results were obtained with tic-2 and wild-type plants at either dawn or dusk. We also suggested that the MYC2-mediated jasmonic acid signalling pathway may not be involved in the regulation of TIC in controlling the root meristem. Taken together, these results suggest that TIC functions in an auxinPLTs loop for maintenance of post-embryonic root meristem.

Mora A. and J. Beer. 2013. Geostatistical modeling of the spatial variability of coffee fine roots under Erythrina shade trees and contrasting soil management. Agroforestry Systems, 87:365-376.
Reference ID: 21444
Notes: #21444e

Abstract: Spatial relationships between root length density of Coffea arabica (coffee RLD) and soil nutrient- related factors at plot scale in a coffee- Erythrina poeppigiana system was studied by geostatistics. In a 24 x 29 m area, (organic and conventional management), coffee and Erythrina fine roots and soil chemical properties were sampled on an irregular grid in the topsoil. A factor analysis explained 83 % of the total variation of the soil attributes. Soil factors were identified: Chemical fertility (CF), Micronutrients, Organic matter, and Acidity (Ac). Based on the spherical model, all the attributes presented a strong spatial structure. The scale of spatial correlation for CF was lesser than for Ac, but similar to coffee RLD. Erythrina RLD had a short-range variation. Patchy areas of high spots of coffee RLD were greater in organic plot. Cross-semivariogram analysis estimated a correlation between soil factors and coffee RLD over a scale of 5.50 m; but 4.23 m with Erythrina RLD. Nutrients linked to P, Zn, exchangeable bases and acidity soil affected the scale of spatial aggregation pattern of coffee RLD. The spatial response of coffee RLD suggests a differential nutrient uptake strategy for acquiring soil nutrients induced by the quality of organic and inorganic fertilizer inputs. The fact that coffee RLD had higher scale of spatial variation than Erythrina RLD and a negative spatial correlation indicate that pruned Erythrina trees are not so competitive for acquiring shared nutrients in an agroforestry system.

da Cunha A. C. M. C. M., L. M. de Oliveira, E. C. Caballero, H. E. P. Martinez, P. C. R. Fontes, and P. R. G. Pereira. 2012. Growth and nutrient uptake of coffee seedlings cultivated in nutrient solution with and without silicon addition: Crescimento e absorção de nutrientes pelo cafeeiro cultivado em solução nutritiva com e sem adição de silício. Revista Ceres, 59:392-398.
Reference ID: 21445
Notes: #21445e
Abstract: In recent years, the application of silicon (Si) in crops, including coffee, has become a common practice. The objective of this study was to assess the silicon uptake by coffee seedlings and its effects on plant growth, water and macro and micronutrient uptake. The research was conducted using nutrient solution in a greenhouse at the Departamento de Fitotecnia da Universidade Federal de Viçosa, in a completely randomized design with two treatments (with and without silicon) and three replications. Each plot consisted of three plants grown in a 800 mL vessel containing the treatment solutions. At every three days, water consumption, the concentration of OH - and the depletion of Si and K were assessed in the nutrient solutions. After 33 days, the plants were assessed with regard to their fresh and dry weight of leaves, roots and stem, shoot height and total length of the plant (shoot and root). Number of leaves and internodes, and the content and accumulation of silicon, macro, and micronutrients were also determined. The consumption of water, the amount of potassium uptake and, biomass accumulation were greater in plants grown in solution without silicon addition. However, the concentration of OH- in the solution and the amount of silicon uptake were greater in plants grown in solution with added silicon. Silicon accumulation was greater in leaves than in stem and roots. Silicon decreased coffee plant accumulation of phosphorus, potassium, calcium, zinc, copper and iron.

dos Santos J. S., M. L. P. dos Santos, and M. M. Conti. 2010. Comparative Study of Metal Contents in Brazilian Coffees Cultivated by Conventional and Organic Agriculture Applying Principal Component Analysis. Journal of the Brazilian Chemical Society, 21:1468-1476.
Reference ID: 21446
Notes: #21446e
Abstract: The aim of this study was to evaluate of availability of nutrients and toxic elements in green coffees produced in traditional, technological and transitional organic farms in Southwest Bahia-Brazil. Levels of the nutrients minerals were determined directly in samples of soils and coffee tissues from four farms by flame atomic absorption spectrometry (FAAS) and toxic elements (Cr, Ni, Cd and Pb) by inductively coupled plasma optical emission spectrometry (ICP OES). The application of statistical methods (cluster and principal components analysis) revealed the importance of the conversion period to guarantee a product genuinely organic during the change to organic agriculture. On the other hand, the study of correlations between agricultural methods and metals concentrations in coffee suggested that Cd, Cu, Zn and other toxic elements contained in some inorganic fertilizers used in the traditional and technological coffee farms may cause an increase of toxic metals concentration in the crop soil, be taken up by plants, and passed on in the food chain.

Pozza A. A. A., J. G. de Carvalho, P. T. G. Guimares, F. C. Figueiredo, and A. R. Araujo. 2009. Effect of Calcium Silicate Supply and the Nutritional Efficiency of Coffee Cultivars. Revista Brasileira De Ciencia Do Solo, 33:1705-1714.
Reference ID: 21447
Notes: #21447e
Abstract: Silicon is classified as a beneficial nutrient and can improve the nutritional dynamics of plants, although it is not considered an essential nutrient for plants. In an experiment in a randomized block design, three coffee cultivars (Catuai, Mundo Novo and Icatu) were planted in plastic tubes, combined with six doses of calcium silicate (T(0)=0, T(1)=0.063, T(9)=0.125, T(3)=0.25, T(4)=0.5 and T(5)=1.0 g dm(-3) substrate), to compare the nutritional efficiency of the cultivars in response to silicon fertilization. Cultivar Icatu showed the higher uptake efficiency (UE) of Cu, Zn, Fe, and Si, and efficiency of use (EU) of N, K, Ca, B, and Mn, but the later did not differ from Mundo Novo cultivar (N, Ca, and Mn). The efficiency of translocation (ET) was higher for N, S, Zn, and Fe. For Catuai the uptake efficiency of P, K, B, and Mn was higher, but did not differ from Mundo Novo for P, K and Mn. The Catuai's s efficiency of use for Mg, S, Cu, Zn, Fe, and Si was higher, probably because of a better ET of these nutrients, with exception of Fe and Si. The cultivar Mundo Novo was the most efficient in N, K, Ca, Mg, Mn and Si uptake, had the higher EU of P and Mn, and the highest ET of K, Ca, B, Mn, and Si.

Herpin U., T. V. Gloaguen, A. F. da Fonseca, C. R. Montes, F. C. Mendonca, R. P. Piveli, G. Breulmann, M. C. Forti, and A. J. Melfi. 2007. Chemical effects on the soil-plant system in a secondary treated wastewater irrigated coffee plantation - A pilot field study in Brazil. Agricultural Water Management, 89:105-115.
Reference ID: 21449
Notes: #21449e
Abstract: Wastewater reuse in agriculture is recognized worldwide as an alternative water and/or nutrient source. In this study, secondary treated wastewater (STW) from an anaerobic/ facultative pond system at the city of Lins (Sao Paulo State,

Brazil) was used over 3 years and 7 months to irrigate coffee (Coffea arabica L.). The soil type was Typic Haplustox and the crops were fertilized according to regional agronomical recommendations. Soil and leaf samples from three sampling campaigns were used to study effects on chemical quality parameters, macronutrients and Na within the soil-plant system.
Due to high Na contents of the STW applied, Na concentrations showed increases throughout the soil profile compared to untreated soil conditions. Both, low C/N ratio of STW and fertilizer amendments stimulated soil microbial activity and encouraged nitrification and mineralization of wastewater organic components and soil organic matter (SOM) causing significant decreases of SOM and cation exchange capacity (CEC). Over time exchangeable sodium percentages (ESP) in the topsoil decreased due to Na exchange mainly by Ca and Mg, resulting in increasing exchangeable calcium percentage (ECP) and exchangeable magnesium percentage (EMP) associated with lower soil sodicity. Exchanged Na and available soluble Na from STW led to both elevated ESP at depth by soil migration and high plant uptake. The superficial increase of ECP and EMP favored continuous replenishment of Ca and Mg in the soil solution leading to increasing plant contents over time. The plant Ca, Mg and K contents remained high after fertilization stop and continued STW irrigation. This is expected to be rather a short-lived effect due to a reduction of the essential cation store through constantly provided Na and insufficient supply of essential cations via STW, associated with decrease of SOM and CEC and higher sodicity risk, suggesting the need of continued fertilizer use for soil maintenance. On the other hand, the plant contents of P, N and S dropped back to deficient values when irrigated solely with STW mainly due to insufficient replenishment by STW and the anion exchange complex (AEC) indicating moreover the need to continue fertilization to maintain anion levels in soil for optimum plant growth. The study revealed that STW can effectively increase water resources for irrigation, however, innovative and adapted fertilizer/STW management strategies are needed to diminish sodicity risks and to sustain adequate and balanced nutritional conditions in the soil-plant system.

Leite V. M., P. H. Brown, and C. A. Rosolem. 2007. Boron translocation in coffee trees. Plant and Soil, 290:221-229.
Reference ID: 21450
Notes: #21450e
Abstract: Boron deficiency in coffee trees (Coffea arabica) is widespread, however, responses to B fertilizer have been erratic, depending on the year, method, and time of application. A better understanding of B uptake, distribution, and remobilization within the plant is important in developing a rational fertilization program. Field and greenhouse experiments were conducted to study B distribution and remobilization in coffee trees. Boron was provided either in the nutrient solution or sprayed on the leaves of trees grown under adequate or transient B deficiency. There was clear evidence for B translocation via symplast (remobilization) to coffee grains, even in well-nourished plants. When 10 B was present in the nutrient solution during most part of fruit filling, from 33 to 40% of the B found in coffee fruits was absorbed during this period, depending on the timing and duration of the B deficiency treatment. In the field, when B was sprayed once on the leaves, around 4% of the fruit B was derived from the foliar fertilizer. Boron remobilization within coffee trees is limited in well nourished plants, but it can be significant during periods of temporary B deficiency in plants otherwise well nourished with B. The implications of these findings for B fertilization practice, are discussed.

Rosolem C. A., L. V. S. Sacramento, and D. M. T. Oliveira. 2005. Kinetics of zinc uptake and anatomy of roots and leaves of coffee trees as affected by zinc nutrition. Journal of Plant Nutrition, 28:2101-2112.
Reference ID: 21452
Notes: #21452e
Abstract: Zinc (Zn) uptake kinetics and root and leaf anatomy were studied in coffee trees grown in nutrient solutions with or without Zn. Leaves and roots were sampled and cuts were made in the medium part of the leaves and in root tips and observed under an optical microscope. Plants grown without Zn showed an increase in root and in root stele diameter. There was also an increase in epidermis thickness and in the cross-sectional area of the cortex and stele due to Zn deficiency, but the diameter of xylem vessels was decreased. An increase in root cortex and stele diameter provided for an increased surface for nutrient uptake. Accordingly, C(min) was decreased from 13.8 to 3.4 mu mol L(-1) and V(max) increased from 0.50 to 2.1 mu mol cm(-2) h(-1) .

Hurchanik D., D. P. Schmitt, N. V. Hue, and B. S. Sipes. 2004. Plant nutrient partitioning in coffee infected with Meloidogyne konaensis. Journal of Nematology, 36:76-84.
Reference ID: 21453
Notes: #21453e
Abstract: Two experiments were conducted to assess nutrient partitioning in coffee (Coffea arabica cv. Typica land race Guatemala) infected with Meloidogyne konaensis. Nutrient levels were quantified from soil, roots, and leaves. In the first experiment, 500-cm(3) aliquants of a Kealakekua Andisol were infested with four initial population densities of M. konaensis ranging from 0 to 1,500 freshly hatched second-stage juveniles. Coffee plants (similar to3 months old) were transplanted into the soil and grown for 25 weeks. Plants responded to nematode infection with decreases ($P < 0.05$) in concentrations of Ca, Mg, P, and B and increases ($P < 0.05$) in concentrations of Mn, Cu, Zn, and Ca/B in the roots was decreased ($P < 0.05$) by nematode infection even though concentrations of Mn and Cu increased ($P < 0.05$) in the roots. Concentrations of Ca and Mg also decreased ($P < 0.05$) in the leaves, whereas the concentrations of Zn increased ($P < 0.05$). In the second experiment, the soil was amended with Zn at 0 or 5 mg/kg soil and infested with M. konaensis at 0, 100, 1,000 or 10,000 eggs/1,200 cm(3) soil. Three-month-old coffee seedlings of similar height were weighted and transplanted into pots and then placed in a greenhouse and grown under 50% shade for 23 weeks. Concentrations of P, K, Ca, Mg, Mn, B, and Zn increased in roots of nematode-free plants growing in Zn-amended soil. The beneficial effects due to the Zn amendment were not apparent in nematode-infected plants. Mb, B, and Zn uptake by coffee roots and P and B concentrations in coffee leaves responded similarly. Management of M. konaensis is necessary to achieve optimal nutrient management in coffee.

Tomaz M. A., S. R. Silva, N. S. Sakiyama, and H. E. P. Martinez. 2003. Efficiency of uptake, translocation and use of calcium, magnesium and sulphur in young Coffea arabica plants under the influence of the rootstock. Revista Brasileira De Ciencia Do Solo, 27:885-892.
Reference ID: 21454
Notes: #21454e
Abstract: Studies into the nutritional efficiency of grafted coffee plants is essential for the selection of graft/rootstock combinations for a maximum development and

production. Our objective was the evaluation of the influence of rootstocks on the efficiency of uptake, translocation and use of Ca, Mg, and S in young Coffee arabica L. plants in hydroponic cultivation. The experiment was conducted in a greenhouse and lasted 170 days, using sand as substratum and circulating nutritive solution. Four genotypes of Coffea arabica L. were utilized as grafts: varieties Catuai Vermelho IAC 15 and Oeiras MG 6851, and lines H 419-10-3-1-5 and H 514-5-5-3. Four non-grafted plants and four rootstocks, which comprised three genotypes of Coffea canephora Pierre et Froenher (Apoata LC 2258, Conillon Muriae-1, and Robustao Capixaba (EMCAPA 8141)) and one genotype of Coffea arabica L. (Mundo Novo IAC 3764), were also studied. The experimental layout was a randomized block design with four replicates. Means of the non-grafted plants and graft/rootstock combinations were compared. The efficiency of uptake, translocation and use of Ca, Mg and S in the young coffee plants varied with the graft/rootstock combinations. Only the translocation efficiency of Ca was not altered by the graft/rootstock combination. Rootstocks Apoata LC2258 and Mundo Novo IAC 376-4 brought forth an enhanced use efficiency of Mg and dry, matter yield in line H 514-5-5-3, and Mundo Novo IAC 376-4 an improved use efficiency of Ca and S.

Reis R. A. Jr. and H. E. P. Martinez. 2002. Zn addition and Zn and P uptake, translocation and utilization by coffee cultivars: Adição de Zn e absorção, translocação e utilização de Zn e P por cultivares de cafeeiro. Scientia Agricola, 59:537-542.
Reference ID: 21455
Notes: #21455e
Abstract: The increasing nutrient requirement of coffee varieties, specially of micronutrients, is claiming for a better understanding of the dynamics of these nutrients in the soil-plant system. Having this in mind a greenhouse experiment in a completely randomized design, 3 × 2 factorial scheme and three replications was conducted to evaluate the effect of three Zn levels (0.4 , 1.3 and 2.3 mumol L-1) and two coffee species (Coffea arabica cv. Catuaí and Coffea canephora cv. Conilon) on: (i) growth characteristics; (ii) Zn and P contents; and (iii) Zn and P uptake, translocation and utilization efficiencies. Plants were grown in complete nutrient solution along 50 days, when they were transferred to three Zn levels. Plants were harvested and separated in leaves, stem and roots 114 days after the transference. Stem height, leaf area, dry matter yield, Zn and P contents, and Zn and P uptake, translocation and utilization efficiencies were evaluated. The largest growth characteristics were observed with 2.3 mumol L-1. The highest Coffea arabica cv Catuaí Zn contents suggest that this species has higher Zn demand than Coffea canephora cv. Conilon. Conilon cultivar showed the lowest Zn uptake and translocation efficiencies and the highest Zn utilization efficiency; what reflects its lower Zn demand. The Zn-P interaction was not observed with the Zn levels employed in this experiment.

Bundt M., S. Kretzschmar, W. Zech, and W. Wilcke. 2015. Seasonal dynamics of nutrients in leaves and xylem sap of coffee plants as related to different soil compartments. Plant and Soil, 197:157-166.
Reference ID: 21456
Notes: #21456e
Abstract: The northwestern province of Costa Rica is a marginal coffee growing area. At the onset of the rainy season low redox potentials probably induce the mobilization of soil Mn resulting in enhanced plant uptake of Mn. To test this

hypothesis we monitored from April to the end of June 1995 the mobile Mn in the soil and nutrient and Mn concentrations in leaves and xylem sap of coffee plants. Every 2 weeks we took aggregate and bulk soil samples. The aggregates were mechanically separated into interior and exterior, air-dried and all soil samples were extracted with 1 M NH(4)NO3. We also extracted the field moist soil with distilled water. In addition, the 3rd and the youngest pair of coffee leaves and xylem sap were sampled and analyzed. According to the results of leaf analyses the nutrient supply of the coffee plants in general seemed to be balanced. However, Mn concentrations of 223 mg kg(-1) in the 3rd leaf pair at 18 April were above the optimum and the youngest leaves indicated Fe deficiency, but senescent leaves accumulated Fe and overcame the deficiency. Manganese concentrations in the xylem sap showed a pronounced maximum 2 weeks prior to a similar maximum of mobile Mn in the aggregate exterior. But in general the temporal variation of nutrient concentrations (especially Ca and Mg) in the plants are well correlated with the easily extractable nutrient concentrations in bulk soil. Probably due to its specific absorption and high rates of redistribution within the plant, K in the soil extracts did not correlate with plant concentrations. Element concentrations of youngest leaves could not be correlated with soil concentrations and are not considered to be an adequate tool for monitoring current nutrient uptake. Since plant element concentrations did not correlate with the aggregate interior, plants probably cannot use that nutrient source efficiently.

Vaast P., R. J. Zasoski, and C. S. Bledsoe. 1996. Effects of vesicular-arbuscular mycorrhizal inoculation at different soil P availabilities on growth and nutrient uptake of in vitro propagated coffee (Coffea arabica L) plants. Mycorrhiza, 6:493-497.
Reference ID: 21457
Notes: #21457e
Abstract: In a pot experiment, the growth and the nutrient status of in vitro propagated coffee (Coffea arabica L.) microcuttings were investigated for 5 months following vesicular-arbuscular mycorrhizal (VAM) inoculation with either Acaulospora melleae or Glomus clarum at four soil P availabilities. Control plants remained P-deficient even at the highest soil P availability while mycorrhizal plants were P-sufficient at all soil P availabilities. Growth of control plants was only improved at the highest soil P availability. In P-deficient soil, neither of the two VAM species improved plant growth. Plant growth increased by 50% following inoculation with either A. melleae or G. clarum when P availability went from deficient to low. No further plant growth improvement was induced by either VAM species at intermediate and high soil P levels. Nevertheless, growth of plants inoculated with C. clarum was still significantly greater than that of non-mycorrhizal plants at the highest soil P availability. Root colonization by G. clarum increased with increasing soil P availability while root colonization by A. mellea decreased with soil P level increasing above low P availability. Soil P availability also affected Zn nutrition through its influence on VAM symbiosis. With increasing soil P availability, foliar Zn status increased with G. clarum or decreased with A. mellea in parallel to root colonization by VAM. This study demonstrates the beneficial effects of VAM inoculation on in vitro propagated Arabica coffee microcuttings, as shown previously for seedlings. This study also demonstrates differences in tolerance to soil P availability between VAM species, most likely resulting from their differing abilities to enhance coffee foliar P status.

Vaast P. and R. J. Zasoski. 1992. Effects of VA-Mycorrhizae and Nitrogen-Sources on Rhizosphere Soil Characteristics, Growth and Nutrient Acquisition of Coffee Seedlings (Coffea-arabica L). Plant and Soil, 147:31-39.
Reference ID: 21458
Notes: #21458e
Abstract: Effects of N sources (ammonium, nitrate and ammonitrate) and VA mycorrhizae (Glomus intraradices) on rhizosphere soil characteristics (pH, exchangeable acidity, exchangeable cations, inorganic N concentrations) growth and nutrient acquisition of coffee seedlings (Coffea arabica L. cv guatemala) were investigated in a pot study with an acid soil (Red Bluff Loam) sterilized by autoclaving. Ammonium addition decreased rhizosphere pH while nitrate and ammonitrate additions both increased rhizosphere pH. Mycorrhizae induced a higher pH, a lower exchangeable acidity and higher values of exchangeable cations in the rhizosphere. Ammonium addition resulted in a lower mycorrhizal infection than the two other N sources. Mycorrhizal plants grew better and accumulated more N, Ca and Mg than non-mycorrhizal plants.

Lehmann J. and T. Muraoka. 2001. Tracer methods to assess nutrient uptake distribution in multistrata agroforestry systems. Agroforestry Systems, 53:133-140.
Reference ID: 21459
Notes: #21459e
Abstract: Separate assessment of nutrient uptake by individual plants in mixed cropping with trees is impossible without tracer techniques. The different N-15-to-N-14 isotope ratio of atmospheric and soil N can be used to study the contribution of biologically fixed N to the nutrition of associated trees. In most cases, the assessment of nutrient uptake distribution is an appropriate way of evaluating how to improve the transfer of biologically fixed N. Radioisotopes (e.g., P-32), stable isotopes (e.g., N-15) and rare elements (e.g., Sr) can be used to determine relative root activity distribution by applying the tracer to different soil depths or distances from trees. A broadcast application of the tracer instead of point application makes it possibe to calculate uptake values per unit area. The direct determination of nutrient pathways with such robust experiments offers considerable advantages for improving nutrient use efficiency and complementarity in multistrata agroforestry systems.

Bustos A. P., H. A. J. Pohlan, and M. Schulz. 2008. Interaction between coffee (Coffea arabica L.) and intercropped herbs under field conditions in the Sierra Norte of Puebla, Mexico. Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS), 109:85-93.
Reference ID: 21460
Notes: #21460e
Abstract: Caffeine released from decaying seeds and leaves accumulates in a soluble form in the soil. The compound is known to inhibit mitosis, reduce the access of nutrients and water to surrounding plants which is one of limiting problems in intercropped coffee plantations. The allelopathic interactions between coffee (Coffea arabica L.) and mint (Mentha piperita L.), basil (Ocimum basilicum L.), oregano (Origanum vulgare L.) and sage (Salvia officinalis L.) could be a diversification alternative and extra income activity for coffee growers outside the harvest period that could cope with high levels of caffeine in the soil. We tested the interaction of the proposed system (2004 - 2005) in rural area of Puebla State, Mexico. The results demonstrate that intercropping sage, spearmint, basil and oregano stimulate the

plagiotropic growth of Coffea arabica, plants most effectively in young production systems, through volatile essential oils. Intercropping basil, sage, spearmint and oregano in coffee plantations seems to be a promising approach for higher income and increasing yield and quality production in coffee farms.

Tomaz M. A., H. E. P. Martinez, N. S. Sakiyama, C. D. Cruz, and A. A. Pereira. 2006. Absorption, translocation and utilization of zinc, copper and manganese in grafted seedlings of Coffea arabica. Revista Brasileira De Ciencia Do Solo, 30:377-384.
Reference ID: 21461
Notes: #21461e
Abstract: There are complexes feedback mechanisms involving the relationship rootstock/scion, which can positively or negatively affect the plant nutrient efficiency use. The goal of the present work was to evaluate the efficiency of uptake, translocation and utilization of Zn, Cu and Mn in coffee seedlings. The experiment was carried out in a greenhouse over 170 days using circulating nutrient solution in pots with sand medium. Four Coffea arabica L. genotypes were used as grafts: Catuai Vermelho IAC 15 and Oeiras MG 6851, and the hybrids 'H 419-10-3-1-5' and 'H 514-5-5-3'. Three genotypes of Coffea canephora Pierre et Froenher were used as rootstocks: Apoala LC 2258, Condon Muriae-1 and RC EMCAPA 8141 (recombination among clones of the variety Robustao Capixaba - EMCAPA 8141), one line of C. arabica: Mundo Novo MC 376-4, and four additional non-grafted plants. The experiment was in a randomized block design with 20 treatments, four replications and one plant per plot. The nutritional efficiency of the coffee seedlings for Zn, Cu and Mn varied according to the graft/rootstock combination. Progeny 'H 514-5-5-3' proved to be the most effective regarding Zn, Cu and Mn utilization and dry matter yield when combined with the rootstocks Apoata LC 2258 and Mundo Novo LAC 376-4. Catuai Vermelho IAC 15 was more effective for Cu and Mn utilization when combined with Apoata LC 2258.

Partelli F. L., H. D. Vieira, P. H. Monnerat, and A. P. Viana. 2006. Comparison of two DRIS methods for diagnosing nutrients deficiencies in coffee trees. Pesquisa Agropecuaria Brasileira, 41:301-306.
Reference ID: 21462
Notes: #21462e
Abstract: The objective of this work was to compare the nutritional diagnoses by DRIS and DRIS with the incorporation of dry matter (modified DRIS), under four criteria: all ratios between nutrients, nutrient ratios with larger variance ratio, smaller coefficient of variation, and nutrient ratios with values greater than one. Leaf concentrations of N, P, K, Ca, Mg, S, B, Cu, Fe, Mn and Zn, and the productivity of 56 organic crops of 'Conilon' coffee of the State of Espirito Santo, Brazil, were used. The frequency of the nutrient whose index was the most negative and the most positive, the correlation between the nutrient and its index, and the correlation between productivity and nutrient balance index were evaluated. DRIS and DRIS modified (DRIS-M) had provided similar diagnoses, and the four criteria of DRIS indices calculation changed the order of nutrients limitation in coffee trees. DRIS-M presents a little higher correlation between the productivity and the nutrient balance index, as well as, between nutrient concentration and its DRIS index.

Silva S. A., J. S. S. Lima, and E. L. Bottega. 2013. Yield mapping of arabic coffee and their relationship with plant nutritional status. Journal of Soil Science and Plant Nutrition, 13:556-564.
Reference ID: 21463
Notes: #21463e
Abstract: The aim of this study was to model the spatial variability of the nutritional status of arabic coffee using leaf macro and micronutrient contents and relate it to drop in bean yield, bark percentage and crop yield. The experiment was conducted in a plantation of arabic coffee variety Catuai located in the Zona da Mata of Minas Gerais State. Leaf nutrient contents, cherry coffee production, drop in bean yield, yield of benefited coffee and bark percentage were determined. Data were analyzed using classical statistical methods to find the relationship between nutrients and yield variables and then examined by geostatistical analysis. The yield variables and leaf nutrients that were found related showed spatial dependence without random distribution. Nutritional imbalance was detected in the studied coffee crop expressed by the deficiency or excess of some nutrients in the plant tissue. Ca provided the smallest drop in bean yield while the leaf contents of B and Zn had an opposite effect on the production and yield of coffee.

Franca A. C., M. A. M. Freitas, L. D'Antonino, C. M. T. Fialho, A. A. Silva, M. R. Reis, and C. P. Ronchi. 2010. Nutrient Content in Arabica Coffee Cultivars Subjected to Glyphosate Drift. Planta Daninha, 28:877-885.
Reference ID: 21464
Notes: #21464e
Abstract: The effects of glyphosate on the foliar levels of nutrients in three coffee cultivars (Coffea arabica) were evaluated in this work. A factorial (3 x 5) was used in a randomized block design with four replications, with treatments consisting of three coffee varieties: Catucai Amarelo (2 SL), Oeiras (MG-6851) and Topazio (MG-1190) and five glyphosate doses (0, 57.6, 115.2, 230.4 and 460.8 g ha-1). At 45 and 120 DAA, leaves (third pair) from plagiotrophic branches were collected from the medium part of the plants. Glyphosate intoxication symptoms were characterized by chlorosis and leaf narrowing for the three coffee varieties. There was a reduction in foliar levels of N, P, K, Cu and Zn at 45 DAA, and N, K, Mn and Zn at 120 DAA, in coffee plants treated with glyphosate, regardless of the cultivar used. Cultivar Topazio showed the greatest reductions in the foliar levels of Fe and Mn, at 45 DAA and P and Fe, at 120 DAA, when treated with glyphosate.

Farnezi M. M. D., E. B. Silva, and P. T. G. Guimarães. 2009. Nutritional Diagnosis of Coffee Plantations in the Upper Jequitinhonha Valley, Minas Gerais State, Brazil: DRIS Norms and Critical Nutrient Ranges. Revista Brasileira De Ciencia Do Solo, 33:969-978.
Reference ID: 21465
Notes: #21465e
Abstract: In the Diagnosis and Recommendation Integrated System (DRIS), norms for coffee in the Upper Jequitinhonha Valley, Minas Gerais, Brazil, have not been established yet. The lack of these norms hinders the application of the DRIS to the coffee plantations in the region. The foliar diagnosis, based on the DRIS and on critical reference ranges, stands out among the tools that allow an efficient use of fertilizers. This study aimed to determine DRIS norms as well as to establish values of the critical nutrient ranges of reference for the nutritional diagnosis of coffee in the Upper Jequitinhonha Valley, by the DRIS. The foliar concentrations of N, P, K, Ca,

Mg, S, B, Cu, Fe, Mn, and Zn in 52 coffee plantations were determined in two cropping years (2005 and 2006). To establish DRIS norms 23 plantations were chosen, with yields higher than or equal to 30 sacks of coffee grain per hectare in each harvest. The critical nutrient ranges for the DRIS were obtaind by determinig the frequency with which each nutrient content of the plantations in two harvests was deficient, adequate or excessive according to the cited standards and sufficiency ranges reported in the literature. The DRIS norms were established for coffee in the region of the Upper Jequitinhonha Valley and used to propose appropriate critical ranges. For this purpose, the following values were proposed: for N (2.25-2.79 kg dag(-1)), P(0.18-0.22 kg dag(-1)), K(1.72-2.10 kg day(-1)), Ca(1.26-1.51 kg dag(-1)), Mg(0.29-0.35 kg day(-1)), S(0.13-0.32 kg day(-1)), B(83.8-96.3 mg kg(-1)), Cu(5.7-9.3 mg kg(-1)), Fe (67.5 - 116.2 mg kg(-1)), Mn (219-422 mg kg(-1)), and for Zn (17.4-30.0 mg kg(-1)). In regional coffee plantations with inadequate nutrition deficiencies of P, K, S, B, Cu, Mn, and Zn were observed as well as excessive contents of Ca, Mg and Fe.

Rosolem C. A. and V. M. Leite. 2007. Coffee leaf and stem anatomy under boron deficiency. Revista Brasileira De Ciencia Do Solo, 31:477-483.
Reference ID: 21466
Notes: #21466e
Abstract: Boron deficiency in coffee is widely spread in Brazilian plantations, but responses to B fertilizer have been erratic, depending on the year, form and time of application and B source. A better understanding of the effects of B on plant physiology and anatomy is important to establish a rational fertilization program spice B translocation within the plant may be affected by plant anatomy. In this experiment, coffee plantlets of two varieties were grown in nutrient solutions with B levels of 0.0 (deficient), 5.0 mu M (adequate) and 25.0 mu M (high). At the first symptoms of deficiency, leaves were evaluated, the cell walls separated and assessed for B and Ca concentrations. Scanning electron micrographs were taken of cuts of young leaves and branch tips. The response of both coffee varieties to B was similar and toxicity symptoms were not observed. Boron concentrations in the cell walls increased with B solution while Ca concentrations were unaffected. The Ca/B ratio decreased with the increase of Bin the nutrient solution. In deficiency of B, vascular tissues were disorganized and xylem walls thinner. B-deficient leaves had fewer and deformed stomata.

Ronchi C. P., F. M. DaMatta, K. D. Batista, G. A. B. K. Moraes, M. E. Loureiro, and C. Ducatti. 2006. Growth and photosynthetic down-regulation in Coffea arabica in response to restricted root volume. Functional Plant Biology, 33:1013-1023.
Reference ID: 21467
Notes: #21467e
Abstract: Coffee (Coffea arabica L.) plants were grown in small (3-L), medium (10-L) and large (24-L) pots for 115 or 165 d after transplanting (DAT), which allowed different degrees of root restriction. Effects of altered source : sink ratio were evaluated in order to explore possible stomatal and non-stomatal mechanisms of photosynthetic down-regulation. Increasing root restriction brought about large and general reductions in plant growth associated with a rising root : shoot ratio. Treatments did not affect leaf water potential or leaf nutrient status, with the exception of N content, which dropped significantly with increasing root restriction even though an adequate N supply was available. Photosynthesis was severely reduced when plants were grown in small pots; this was largely associated with non-

stomatal factors, such as decreased Rubisco activity. At 165DAT contents of hexose, sucrose, and amino acids decreased in plants grown in smaller pots, while those of starch and hexose-P increased in plants grown in smaller pots. Photosynthetic rates were negatively correlated with the ratio of hexose to free amino acids, but not with hexose content. Activities of acid invertase, sucrose synthase, sucrose-P synthase, fructose-1,6- bisphosphatase, ADP-glucose pyrophosphorylase, starch phosphorylase, glyceraldehyde-3-P dehydrogenase, PPi : fructose-6-P 1-phosphotransferase and NADP : glyceraldehyde-3-P dehydrogenase all decreased with severe root restriction. Glycerate-3-P : Pi and glucose-6-P : fructose-6-P ratios decreased accordingly. Photosynthetic down-regulation was unlikely to have been associated directly with an end-product limitation, but rather with decreases in Rubisco. Such a down-regulation was largely a result of N deficiency caused by growing coffee plants in small pots.

Partelli F. L., H. D. Vieira, and A. N. da Costa. 2005. Nutrition diagnosis in organic and conventional conilon coffee crop in the State of Espírito Santo, using the DRIS: Diagnóstico nutricional em cafeeiro conilon orgânico e convencional no Espírito Santo, utilizando o DRIS. Ciência Rural, 35:1456-1460.
Reference ID: 21468
Notes: #21468e
Abstract: The objective of this work was to accomplish the nutritional diagnosis in conilon coffee crop cultivated in organic and conventional systems in the North of the Espírito Santo State to compare different limit indexes of diagnose in order to consider the lower and upper nutrient levels by use of foliar contents and the yield of 40 coffee crops under the conventional cultivation and 56 coffee crops under the organic cultivation. The calculations of the indexes were made through the method DRIS including the incorporation of the dry matter. Four indexes of diagnose were used for considering the nutrient as limiting. The nutrients that showed deficiency in the organic coffee crops were Mn, P, Fe and Cu. In the conventional coffee crop, Mn, N and P were the nutrients limiting. Lower index of absolute value will be able to identify with accuracy the nutrients as limiting. The first limit nutrient does not have its position modified when using different indices thresholds.

Hurchanik D., D. P. Schmitt, N. V. Hue, and B. S. Sipes. 2003. Relationship of Meloidogyne konaensis population densities to nutritional status of coffee roots and leaves. Nematropica, 33:55-64.
Reference ID: 21469
Notes: #21469e
Abstract: The relationship of population densities of Meloidogyne konaensis to nutritional status of roots and leaves of coffee in a commercial field in the Kona district on the island of Hawaii was assessed. The clustered spatial pattern of M. konaensis was inversely related to concentrations of K+Ca+Mg in the coffee roots. Other inverse relationships existed between the numbers of M. konaensis and concentrations of Mg (roots), Cu (roots and leaves), and Al (roots). From February (first flush of flowering) to May (early stage of fruit development), concentrations of P, K, Mg, K+Ca+Mg, Cu, B decreased in the coffee roots and Zn and Al concentrations decreased in the coffee leaves. The association between foliar nutrient deficiencies in trees associated with high population densities of the nematode is an indication that the nematode is inciting the deficiencies.

Cardoso I. M., P. van der Meer, O. Oenema, B. H. Janssen, and T. W. Kuyper. 2003. Analysis of phosphorus by (PNMR)-P-31 in Oxisols under agroforestry and conventional coffee systems in Brazil. Geoderma, 112: 51-70.
Reference ID: 21470
Notes: #21470e
Abstract: Phosphorus (P) is the primary limiting nutrient for crop production in highly weathered tropical soils. The deficiency is mainly caused by strong adsorption of H2PO4- to Al- and Fe-(hydr)oxides, which turns large proportions of total P into a form that is unavailable to plants. Soil management modifies P dynamics. Some plants, including trees used in agroforestry systems, are known to accelerate P cycling. The objective of this paper was to use phosphorus 31 nuclear magnetic resonance ((PNMR)-P-31) to evaluate the inorganic (Pi) and organic P (Po) compounds in Oxisol from two agroforestry (15 and 19 years old) and two conventional (full-sun, monoculture, ca. 15-20 and 20-24 years) coffee systems at three different depths (2-3, 10-15 and 40-60 cm). We hypothesised that the amounts of (1) organic P and (2) diester are higher in agroforestry fields than in conventional coffee fields and (3) the organic P and the diester decrease less with depth in the agroforestry systems than in the conventional systems. The soils were sampled from on-farm experiments in the Atlantic Coastal Rainforest, Brazil. The soil P was extracted with NaOH 0.5 M + EDTA 0.1 M. Resin chelex-X 100 was used to remove the paramagnetic ions. The total P in the NaOH-EDTA extract was measured through ICP and the Pi by the ammonium molybdate-ascorbic acid method. Po was calculated as the difference between total P and Pi. The amount of Po was higher, the decrease of Po with depth was more sharp and the Po/total P was lower in the conventional systems than in the agroforestry systems. Based on literature and standards, (PNMR)-P-31 signals were interpreted as inorganic orthophosphate, orthophosphate monoester (inositol phosphates and mononucleotides), orthophosphate diester (phospholipids, nucleic acids and teichoic acid) and pyrophosphates. The proportion of organic P (Po) was on average 47%, consisting of monoester (95%) and diester (5%). The amounts of diester phosphates did not differ between systems, but the proportion of diester to total spectra areas was higher and the decrease of diester with depth was less in the agroforestry than in the conventional systems. The proportions of inorganic P to total P consisted on average of 45% orthophosphate and 8% pyrophosphate. Our results suggest that agroforestry systems influence the dynamics of P through the conversion of part of the inorganic P into organic P. The effect was higher in deeper layers. Because the rate of cycling is higher for organic P than for inorganic P and for diester than for monoester, and because the P in deep layers is normally less available to crop plants, agroforestry would maintain larger fractions of P available to agricultural crops, thereby reducing P losses to the unavailable pools. The rate and the impacts of these changes on P cycling and efficiency of P use of the crops in the long-term need to be further examined and understood, for full evaluation of the importance of agroforestry in soil P utilisation.

Cardoso I. M., B. H. Janssen, O. Oenema, and T. W. Kuyper. 2003. Phosphorus pools in Oxisols under shaded and unshaded coffee systems on farmers' fields in Brazil. Agroforestry Systems, 58:55-64.
Reference ID: 21471
Notes: #21471e
Abstract: Phosphorus (P) is a primary limiting nutrient for crop production in weathered tropical soils. The deficiency is mainly caused by sorption of phosphate

onto Al- and Fe- (hydr)oxides. We hypothesise that the distribution of soil P among various pools is influenced by land use. Our objective was to characterise the soil inorganic (Pi) and organic P (Po) pools and to compare the various pools at different depths in agroforestry (shaded) and monocultural (unshaded) coffee cultivation systems. The study was carried out in the Atlantic Coastal Rainforest domain, Brazil, with Oxisols as the dominant soil type. Soils were collected from four farmers' coffee (Coffea arabica L.) fields, two agroforestry and two monocultural systems. Three profiles were sampled per field, at depths of 2-3, 10-15 and 40-60 cm. A simplified sequential P fractionation was carried out, using resin, 0.5M NaHCO3, 0.1 M NaOH, 1 M HCl and concentrated HCl as extractants. Sum-P (resin, NaHCO3, NaOH, 1 M HCl and concentrated HCl) ranged from 370 to 830 mg kg(-1). Concentrated HCl extracted the largest portion (74%), followed by NaOH (22.5%). Labile (sum of resin, NaHCO3 and NaOH) P ranged from 13 to 40% of Sum-P. The major part (62%) of the labile fraction was Po. In the agroforestry fields, the amount of Po decreased less with depth and the percentage of Po in labile pools was higher than in monocultural fields. This suggests that agroforestry maintains larger fractions of P available to agricultural crops by influencing the dynamics of P through the conversion of part of the Pi into Po, thereby reducing P losses to the unavailable pools.

Ramalho J. C., M. C. Rebelo, M. E. Santos, M. L. Antunes, and M. A. Nunes. 1995. Effects of Calcium Deficiency on Coffea Arabica, Nutrient Changes and Correlation of Calcium Levels With Some Photosynthetic Parameters. Plant and Soil, 72:87-96.
Reference ID: 21472
Notes: #21472e
Abstract: Calcium deficiency was induced in hydroponically grown 1.5-years-old coffee plants with 12-14 pairs of leaves. Calcium was given in the form of Ca(NO3)(2): 5, 2.5, 0.1, 0.01 and 0 mM. After 71 days of Ca-treatment root and shoot as well as total biomass were decreased by severe Ca-deficiency. However, a stronger decrease was observed for shoot growth as revealed by the increase in the root/shoot ratio. New leaves were affected showing decreases in the total leaf area and in Leaf Area Duration (LAD). After 91 days of deficiency, leaf protein concentration decreased (by about 45%) in the top leaves while nitrate reductase activity (NRA) and NO3 content showed no significant changes. Total nitrogen and mineral concentrations (P, K, Ca, Mg and Na) were also determined in leaves and roots. With the decrease in calcium concentration in Ca-deficiency conditions, we observed concomitant increases in the concentrations of K+, Mg2+ and Na+ in leaves (maximal changes of 32% for K+, 96% for Mg2+ and 438% for Na+) and in roots (108% for K+, 86% for Mg2+ and 38% for Na+). Accordingly, the ratio between elements changed, including the ratio N/P, showing a non-equilibrium in the balance of nutrients. Significant correlations were obtained between Ca2+ concentration and some photosynthetic parameters. Ca-deficiency conditions would increase the loss of energy as expressed by the rise in q(E) and decrease the photochemical efficiency, which confirms the importance of this element in the stabilization of chlorophyll and in the maintenance of good photochemical efficiency at PS II level.

Mazzafera P. 1999. Mineral Nutrition and Caffeine Content in Coffee Leaves. Bragantia, 58.
Reference ID: 21473
Notes: #21473e
Abstract: The effect of nutrient supply on the caffeine content of coffee (*Coffea arabica* L.) leaves was investigated. Seeds were germinated in nutrient-agar media

lacking N, P, K, Ca, Mg, S, Zn, B or Mo. The control treatment contained all essential nutrients. The caffeine concentration was determined seven months after seed sowing when the seedlings have 3 to 4 pair of leaves. The omission of K induced the highest caffeine content in the leaves (24.5 $g.kg^{-1}$). Caffeine in the control treatment was 21.9 $g.kg^{-1}$. Absence of P induced the lowest content, 17.5 $g.kg^{-1}$.

Nagao M. A., K. D. Kobayashi, and G. M. Yasuda 1986. Mineral deficiency symptoms of coffee., Honolulu (HI) University of Hawaii, Hawaii.
Reference ID: 21474
Notes: #21474e
Abstract: When plants are grown without adequate essential nutrients, characteristic deficiency symptoms result. Recognizing these visual symptoms can aid growers in assessing the nutritional status of their coffee crops and applying corrective measures. This study provides descriptions and photographs of mineral deficiency symptoms of the Guatemalan, Caturra, and Maragogipe (Java) coffee cultivars. Mineral nutrient concentrations in leaves of deficient and normal (control) plants are also given.

Tesfaye S. G., M. R. Ismail, M. F. Ramlan, M. Marziah, and H. Kausar. 2014. Effect of Soil Drying on Rate of Stress Development, Leaf Gas Exchange and Proline Accumulation in Robusta Coffee (Coffea Canephora Pierre Ex Froehner) Clones. Experimental Agriculture, 50:458-479.
Reference ID: 21475
Notes: #21475e
Abstract: Seasonal drought stresses as a result of changes in global climate and local weather conditions are among the major factors adversely affecting growth and productivity of Robusta coffee (Coffea canephora pierre ex froehner) in many areas producing the crop. It is believed that there exists a wide range of genetic variability among Robusta coffee clones for traits associated with drought tolerance. Therefore, in an attempt to determine differences among Robusta coffee clones for some growth, physiological and biochemical parameters and identify drought-tolerant materials, 12 months old seedlings of six clones (IC-2, IC-3, IC-4, IC-6, IC-8 and R-4) were subjected to two treatments: well-watered control and drought-stressed (soil drying) by withholding irrigation for three weeks in a rain shelter at University Putra Malaysia, Malaysia. The rate of stress development, expressed as extent of wilting and damage to leaves, was considerably higher for clones IC-8, IC-4, R-4 and IC-2 than for IC-3 and IC-6 during the stress period. Leaf water potential (LWP), stomatal conductance (g(s)) and rate of net photosynthesis (P-N) progressively decreased but leaf proline (LP) concentration substantially increased with time of exposure of the plants to soil drying. There was a considerable difference between coffee clones for the rate of change in these parameters. All the clones except IC-6 and IC-8 showed a negative carbon balance with the most negative value for R-4 at the end of the stress period. Six days after rewatering, LWP, g(s) and P-N increased rapidly while LP concentration decreased and reached a level equivalent to those of well-watered plants, especially for clones IC-3 and IC-6. Among the drought-stressed plants, IC-6 and IC-3 had still significantly higher shoot growth, total dry matter yield and root to shoot ratio than did IC-2, IC-4, IC-8 and R-4. In general, clones IC-6 and IC-3 exhibited quite a better performance in almost all the parameters considered in this study and seemed to be less sensitive to drought stress. Hence, drought tolerance attributes in these clones could be linked to a more effective osmotic adjustment due to more rapid accumulation of LP and probably some morphological parameters,

such as increased root-to-shoot ratio. However, further analyses at molecular level, detail biochemical studies and observations under diverse field conditions are required to come up with more conclusive recommendations.

Guerra-Guimaraes L., A. Vieira, I. Chaves, C. Pinheiro, V. Queiroz, J. Renaut, and C. P. Ricardo. 2014. Effect of Greenhouse Conditions on the Leaf Apoplastic Proteome of Coffee Arabica Plants. Journal of Proteomics, 104:128-139.
Reference ID: 21476
Notes: #21476e
Abstract: This work describes the coffee leaf apoplastic proteome and its modulation by the greenhouse conditions. The apoplastic fluid (APP) was obtained by leaf vacuum infiltration, and the recovered proteins were separated by 2-DE and subsequently identified by matrix assisted laser desorption/ionization time of flight-mass spectrometry, followed by homology search in EST coffee databases. Prediction tools revealed that the majority of the 195 identified proteins are involved in cell wall metabolism and in stress/defense responses. Although most of the proteins follow the classical secretory mechanism, a low percentage of them seem to result from unconventional secretion (leaderless secreted proteins). Principal components analysis revealed that the APF samples formed two distinct groups, with the temperature amplitude mostly contributing for this separation (higher or lower than 10 degrees C, respectively). Sixty one polypeptide spots allowed defining these two groups and 28 proteins were identified, belonging to carbohydrate metabolism, cell wall modification and proteolysis. Interestingly stress/defense proteins appeared as more abundant in Group I which is associated with a higher temperature amplitude. It seems that the proteins in the coffee leaf APP might be implicated in structural modifications in the extracellular space that are crucial for plant development/adaptation to the conditions of the prevailing environment. This is the first detailed proteomic study of the coffee leaf apoplastic fluid (APF) and of its modulation by the greenhouse conditions. The comprehensive overview of the most abundant proteins present in the extra-cellular compartment is particularly important for the understanding of coffee responses to abiotic/biotic stress.

Notaro K. D., E. V. de Medeiros, G. P. Duda, A. O. Silva, and P. M. de Moura. 2014. Agroforestry Systems, Nutrients in Litter and Microbial Activity in Soils Cultivated with Coffee at High Attitude. Scientia Agricola, 71:87-95.
Reference ID: 21477
Notes: #21477e
Abstract: Agroforestry systems are an alternative option for sustainable production management. These systems contain trees that absorb nutrients from deeper layers of the soil and leaf litter that help improve the soil quality of the rough terrain in high altitude areas, which are areas extremely susceptible to environmental degradation. The aim of this study was to characterize the stock and nutrients in litter, soil activity and the population of microorganisms in coffee (Coffea arabica L.) plantations under high altitude agroforestry systems in the semi-arid region of the state of Pernambuco, Brazil. Samples were collected from the surface litter together with soil samples taken at two depths (0-10 and 10-20 cm) from areas each subject to one of the following four treatments: agroforestry system (AS), native forest (NF), biodynamic system (BS) and coffee control (CT). The coffee plantation had been abandoned for nearly 15 years and, although there had been no management or harvesting, still contained productive coffee plants. The accumulation of litter and mean nutrient content of the litter, the soil nutrient content, microbial biomass

carbon, total carbon, total nitrogen, C/N ratio, basal respiration, microbial quotient, metabolic quotient and microbial populations (total bacteria, fluorescent bacteria group, total fungi and Trichoderma spp.) were all analyzed. The systems that were exposed to human intervention (AS and BS) differed in their chemical attributes and contained higher levels of nutrients when compared to NF and CT. BS for coffee production at high altitude can be used as a sustainable alternative in the high altitude zones of the semi-arid region in Brazil, which is an area that is highly susceptible to environmental degradation.

de Sa M., J. P. Ferreira, V. T. Queiroz, L. Vilas-Boas, M. C. Silva, M. H. Almeida, L. Guerra-Guimaraes, and M. R. Bronze. 2014. A liquid chromatography/electrospray ionisation tandem mass spectrometry method for the simultaneous quantification of salicylic, jasmonic and abscisic acids in Coffea arabica leaves . Journal of the Science of Food and Agriculture, 94:529-536.
Reference ID: 21478
Notes: #21478e
Abstract: BACKGROUND Plants have developed an efficient system of recognition that induces a complex network of signalling molecules such as salicylic acid (SA), jasmonic acid (JA) and abscisic acid (ABA) in case of a pathogenic infection. The use of specific and sensitive methods is mandatory for the analysis of compounds in these complex samples.
RESULTS In this study a liquid chromatography/electrospray ionisation tandem mass spectrometry method was developed and validated for the simultaneous quantification of SA, JA and ABA in Coffea arabica (L.) leaves in order to understand the role of these phytohormones in the signalling network involved in the coffee defence response against Hemileia vastatrix. The results showed that the method was specific, linear (r 0.99) in the range 0.125-1.00 mu g mL(-1) for JA and ABA and 0.125-5.00 mu g mL(-1) for SA, and precise (relative standard deviation 11%), and the limit of detection (0.010 mu g g(-1) fresh weight) was adequate for quantifying these phytohormones in this type of matrix.
CONCLUSION In comparison with healthy leaves, those infected with H. vastatrix (resistance reaction) displayed an increase in SA level 24 h after inoculation, suggesting the involvement of an SA-dependent pathway in coffee resistance.

Ramalho J. C., A. S. Fortunato, L. F. Goulao, and F. C. Lidon. 2013. Cold-induced changes in mineral content in leaves of Coffea spp. Identification of descriptors for tolerance assessment . Biologia Plantarum, 57:495-506.
Reference ID: 21479
Notes: #21479e
Abstract: Temperature and mineral nutrition are major environmental factors regulating plant growth and development. Yet, cold impact on mineral contents and the ability of the plants to perform changes in specific elements as a part of the acclimation process received little attention. Using five Coffea genotypes previously characterized concerning their cold sensitivity, a mineral analysis was performed considering macro (N, P, K, Ca, Mg, and S) and micro (Na, Fe, Mn, Zn, Cu, and B) nutrients in order to predict their importance in cold tolerance. The results showed a cold-induced dynamics of mineral nutrients in recently mature leaves. The less cold sensitive Icatu, and partially Catuai, accumulated N, Ca, Mn, Cu, and Zn with potential implications in the maintenance of photosynthetic performance, the reinforcement of the antioxidative defense system, lipid metabolism, and the expression of cold regulated genes, thus constituting interesting traits to evaluate the

cold acclimation ability. After a principal component analysis (PCA), N, Fe, Mn, and Cu were further confirmed as strong candidates for an early cold tolerance evaluation due to their dynamics and to specific roles in the activities of Cu/Zn-SOD (Cu), APX (Fe), and PSII (Mn).

Montero-Vargas J. M., L. H. Gonzalez-Gonzalez, E. Galvez-Ponce, E. Ramirez-Chavez, J. Molina-Torres, A. Chagolla, C. Montagnon, and R. Winkler. 2013. Metabolic phenotyping for the classification of coffee trees and the exploration of selection markers . Molecular Biosystems, 9:693-699.
Reference ID: 21480
Notes: #21480e
Abstract: High-throughput metabolic phenotyping is a challenge, but it provides an alternative and comprehensive access to the rapid and accurate characterization of plants. In addition to the technical issues of obtaining quantitative data of plenty of metabolic traits from numerous samples, a suitable data processing and statistical evaluation strategy must be developed. We present a simple, robust and highly scalable strategy for the comparison of multiple chemical profiles from coffee and tea leaf extracts, based on direct-injection electrospray mass spectrometry (DIESI-MS) and hierarchical cluster analysis (HCA). More than 3500 individual Coffea canephora and Coffea arabica trees from experimental fields in Mexico were sampled and processed using this method. Our strategy permits the classification of trees according to their metabolic fingerprints and the screening for families with desired characteristics, such as extraordinarily high or low caffeine content in their leaves.

MPOB. 2015. Proceedings Of International Palm Oil Congress (PIPOC): Agriculture, Biotechnology & Sustainability Vol 1. Page 1 Malaysian Palm Oil Board, Kuala Lumpur.
Reference ID: 21481
Notes: S 8.1.1 #21481

MPOB. 2015. Proceedings Of International Palm Oil Congress (PIPOC): Agriculture, Biotechnology & Sustainability Vol 2 (Book 1). Pages 1-391 Malaysian Palm Oil Board, Kuala Lumpur.
Reference ID: 21482
Notes: S 8.1.1 #21482

MPOB. 2015. Proceedings of International Palm Oil Congress (PIPOC): Agriculture, Biotechnology & Sustainability Vol 2 (Book 2). Pages 392-772 Malaysian Palm Oil Board, Kuala Lumpur.
Reference ID: 21483
Notes: S 8.1.1 #21483

Lima R. B., T. B. dos Santos, L. G. E. Vieira, M. D. L. Ferrarese, L. Donatti, M. R. T. Boeger, and C. L. D. Petkowicz. 2013. Heat Stress Causes Alterations In The Cell-Wall Polymers And Anatomy Of Coffee Leaves (Coffea Arabica L.). Carbohydrate Polymers, 93:135-143.
Reference ID: 21484
Notes: #21484e
Abstract: Coffee plants were subjected to heat stress (37 degrees C) and compared with control plants (24 degrees C). Cell wall polysaccharides were extracted using water (W), EDTA (E) and 4 M NaOH (H30 and H70). In addition, monolignols were

analyzed, and the leaves were observed by microscopy. Plants under heat stress accumulated higher contents of arabinose and galactose in fraction W. Xylose contents were observed to decrease in H30 fractions after the heat stress, whereas galactose and uronic acid increased. H70 fractions from plants exposed to heat stress showed increased xylose contents, whereas the contents of arabinose and glucose decreased. Differences in the molar-mass profiles of polysaccharides were also observed. The primary monolignol contents increased after the heat stress. Structural alterations in palisade cells and ultrastructural damage in chloroplasts were also observed. Our results demonstrate that the chemical profile of coffee cell-wall polymers and structural cell anatomy change under heat stress.

IICA. TURRIALBA: Revista Interamericana de Ciencias Agricolas. Turrialba 19[1], 1-147. 1969. San Jose.
Reference ID: 21485
Notes: S 8 #21485e
Abstract: Included in this issue:
Nutrient Uptake By The Coffee Tree During A Yearly Cycle(#21517)
Studies On A Leaf Analysis in the N P K Nutrition Of Arabica Coffee (#21516)
Environmental Scaling Of Microhabitats For Some Costa Rican Grasser

Bernardes T., M. A. Moreira, M. Adami, A. Giarolla, and B. F. T. Rudorff. 2012. Monitoring Biennial Bearing Effect on Coffee Yield Using MODIS Remote Sensing Imagery. Remote Sensing, 4:2492-2509.
Reference ID: 21486
Notes: #21486e
Abstract: Coffee is the second most valuable traded commodity worldwide. Brazil is the world's largest coffee producer, responsible for one third of the world production. A coffee plot exhibits high and low production in alternated years, a characteristic so called biennial yield. High yield is generally a result of suitable conditions of foliar biomass. Moreover, in high production years one plot tends to lose more leaves than it does in low production years. In both cases some correlation between coffee yield and leaf biomass can be deduced which can be monitored through time series of vegetation indices derived from satellite imagery. In Brazil, a comprehensive, spatially distributed study assessing this relationship has not yet been done. The objective of this study was to assess possible correlations between coffee yield and MODIS derived vegetation indices in the Brazilian largest coffee-exporting province. We assessed EVI and NDVI MODIS products over the period between 2002 and 2009 in the south of Minas Gerais State whose production accounts for about one third of the Brazilian coffee production. Landsat images were used to obtain a reference map of coffee areas and to identify MODIS 250 m pure pixels overlapping homogeneous coffee crops. Only MODIS pixels with 100% coffee were included in the analysis. A wavelet-based filter was used to smooth EVI and NDVI time profiles. Correlations were observed between variations on yield of coffee plots and variations on vegetation indices for pixels overlapping the same coffee plots. The vegetation index metrics best correlated to yield were the amplitude and the minimum values over the growing season. The best correlations were obtained between variation on yield and variation on vegetation indices the previous year (R = 0.74 for minEVI metric and R = 0.68 for minNDVI metric). Although correlations were not enough to estimate coffee yield exclusively from vegetation indices, trends properly reflect the biennial bearing effect on coffee yield.

Batista K. D., W. L. Araujo, W. C. Antunes, P. C. Cavatte, G. A. B. K. Moraes, S. C. V. Martins, and F. M. DaMatta. 2012. Photosynthetic limitations in coffee plants are chiefly governed by diffusive factors. Trees, 26:459-468.
Reference ID: 21487
Notes: #21487e
Abstract: It has long been held that the regulation of photosynthesis in source leaves may be controlled by carbohydrates. The mechanisms that govern the diurnal fluctuation of photosynthesis and the potential role of feedback regulation by carbohydrates during photosynthesis in coffee (Coffea arabica) leaves were investigated in three independent and complementary experiments. An integrative approach using gas exchange measurements in addition to carbon isotope labelling and steady-state carbohydrate and amino acid analysis was performed. Canonical correlation analysis was also performed. In field-grown plants under naturally fluctuating environmental conditions (Experiment I), the overall pattern of gas exchange was characterised by both low stomatal conductance (g (s)) and net carbon assimilation rate (A) in the afternoon; no apparent signs of photoinhibition were observed. Under conditions of low air evaporative demand (Experiment II), only slight decreases (similar to 20%) in A were observed at the end of the day, which were associated with a reduction (similar to 35%) in g (s). For both conditions, any increase in carbohydrate and amino acid pools over the course of the day was small. In leaves from girdled branches (Experiment III), a remarkable decrease in A and particularly in g (s) was observed, as were increases in starch but not in hexoses and sucrose pools. Furthermore, the rate of (CO2)-C-14 uptake (assessed under saturating CO2 conditions) and the partitioning of recently fixed C-14 were not affected by girdling. It is proposed that the diurnal oscillations in A and the differences in A in leaves from girdled and non-girdled branches were merely a consequence of diffusive limitations rather than from photochemical constraints or direct metabolite-mediated down-regulation of photosynthesis.

Maia C. E. 2012. Fertilization Response Likelihood For The Interpretation Of Leaf Analyses. Revista Brasileira De Ciencia Do Solo, 36:437-445.
Reference ID: 21488
Notes: #21488e
Abstract: Leaf analysis is the chemical evaluation of the nutritional status where the nutrient concentrations found in the tissue reflect the nutritional status of the plants. Thus, a correct interpretation of the results of leaf analysis is fundamental for an effective use of this tool. The purpose of this study was to propose and compare the method of Fertilization Response Likelihood (FRL) for interpretation of leaf analysis with that of the Diagnosis and Recommendation Integrated System (DRIS). The database consisted of 157 analyses of the N, P, K, Ca, Mg, S, Cu, Fe, Mn, Zn, and B concentrations in coffee leaves, which were divided into two groups: low yield (<30 bags ha(-1)) and high yield (>= 30 bags ha(-1)). The DRIS indices were calculated using the method proposed by Jones (1981). The fertilization response likelihood was computed based on the approximation of normal distribution. It was found that the Fertilization Response Likelihood (FRL) allowed an evaluation of the nutritional status of coffee trees, coinciding with the DRIS-based diagnoses in 84.96 % of the crops.

Silva S. D. and J. S. D. Lima. 2012. Assessment Of The Variability Of The Nutritional Status And Yield Of Coffee By Principal Component Analysis And Geostatics: Avaliação da variabilidade do estado nutricional e produtividade de café por meio da análise de componentes principais e geoestatística . Revista Ceres, 59:271-277.
Reference ID: 21489
Notes: #21489e
Abstract: Evaluation of plant nutritional status brings several contributions to the coffee crop, especially when considering the spatial variation in the production fields. This experiment aimed to analyze the spatial variability in the nutritional status and yield of arabic coffee, using the principal component analysis (PCA) and geostatistics. The experiment was conducted in a grid of 50 sampling points in a field of Coffea arabica L., cv. Catuaí. Leaf samples were taken for macro and micronutrient analyses, and fruit were collected for yield evaluation. Data were subjected to PCA for transformation of nutrient values into new variables and then submitted to geostatistics to quantify the degree of spatial dependence of the main components and yield. The combined use of PCA and geostatistics allowed the efficient study of the nutritional status of the plants. The crop showed nutritional imbalance, with excess N and Cu limiting yield even in areas with adequate leaf concentration of the other nutrients.

Cavatte P. C., A. A. G. Oliveira, L. E. Morais, S. C. V. Martins, L. M. V. P. Sanglard, and F. M. DaMatta. 2012. Could Shading Reduce The Negative Impacts Of Drought On Coffee? A Morphophysiological Analysis. Physiologia Plantarum, 144:111-122.
Reference ID: 21490
Notes: #21490e
Abstract: Based on indirect evidence, it was previously suggested that shading could attenuate the negative impacts of drought on coffee (Coffea arabica), a tropical crop species native to shady environments. A variety (47) of morphological and physiological traits were examined in plants grown in 30-l pots in either full sunlight or 85% shade for 8 months, after which a 4-month water shortage was implemented. Overall, the traits showed weak or negligible responses to the light x water interaction, explaining less than 10% of the total data variation. Only slight variations in biomass allocation were observed in the combined shade and drought treatment. Differences in relative growth rates were mainly associated with physiological and not with morphological adjustments. In high light, drought constrained the photosynthetic rate through stomatal limitations with no sign of apparent photoinhibition; in low light, such constraints were apparently linked to biochemical factors. Sun-grown plants displayed osmotic adjustments, decreased tissue elasticities and improved long-term water use efficiencies, especially under drought. Regardless of the water availability, higher concentrations of lipids, total phenols, total soluble sugars and lignin were found in high light compared to shade conditions, in contrast to the effects on cellulose and hemicellulose concentrations. Proline concentrations increased in water-deprived plants, particularly those grown under full sun. Phenotypic plasticity was much higher in response to the light than to the water supply. Overall, shading did not alleviate the negative impacts of drought on the coffee tree.

Alves J. D., C. M. Paglis, D. E. do Livramento, S. S. D. Linhares, F. B. Becker, and A. C. Mesquita. 2011. Source-sink Manipulations in Coffea Arabica L. and its Effects on Growth of Shoots and Roots System. Ciencia E Agrotecnologia, 35:956-964.
Reference ID: 21491
Notes: #21491e
Abstract: This paper investigated changes in growth and carbohydrate content of shoots and root systems in response to source-sink manipulation in field-grown coffee trees. The source-sink manipulations were carried out using manual de-fruiting. Two plots of trees were established: in one group, the fruit was left on the tree, while in the second group all fruits were removed manually. Similar results were obtained for coffee trees with and without fruit in terms of height, stem and skirt diameter and branch lengths. A biochemical evaluation of the roots showed that no differences were found between the levels of carbohydrates. In the leaves, levels of soluble sugars and reducing sugars were higher in plants with fruit. The starch concentration in leaves and roots did not vary between the plots. Root length density did not vary between plants with and without fruit in the 0 - 0.4 m soil layer. However, plants without fruit had a higher root length density than plants with a full fruit load. These results contrast with results published by others on source-sink relationships of coffee plants. The joint data analysis shows that young trees, with a moderate fruit load, and with good nutritional and health status, produce carbohydrates in sufficient quantities to maintain vegetative and reproductive growth, without harming root system growth.

Rodrigues F. A. Jr., L. B. Vieira, D. M. de Queiroz, and N. T. Santos. 2011. Coffee Crop Management Zone Delimitation Using Chlorophyll Index And Leaf Analysis. Revista Brasileira De Engenharia Agricola e Ambiental, 15:778-787.
Reference ID: 21492
Notes: #21492e
Abstract: The objective of this work was to define management zones for fertilizer application in coffee crop by using the K-means and the Fuzzy C-Means methods. The data used to define management zones were the chlorophyll index measured by SPAD sensor and the nutritional coffee leaf analysis performed in laboratory. The study was conducted in Jatoba Farm, located in Paula Candido, Minas Gerais state, Brazil. The data was collected in November, 2007 when the coffee fruits were starting their development. The coffee variety was Coffea arabica Catuai, and the total analyzed area was 2.1 ha. The management zones were generated using different set of data: the SPAD values; the N, P and K leaf concentrations; the N and Ca leaf concentrations; the N, Zn and B leaf concentrations; the N, P, K, Ca and S leaf concentrations; and the N, Ca and S leaf concentrations. The management zones generated by using K-means and Fuzzy C-Means did not present difference in management zone delimitation. The management zones defined by using the SPAD values were different from the ones generated by using leaf analysis.

Mesquita G. L., F. A. O. Tanaka, H. Cantarella, and D. Jr. Mattos. 2011. Atmospheroc Absorption of Fluoride by Cultivated Species, Leaf Structural Changes and Plant Growth. Water Air Soil Pollution, 219:143-156.
Reference ID: 21493
Notes: #21493e
Abstract: Fluoride (F) is an air pollutant that causes phytotoxicity. Besides the importance of this, losses of agricultural crops in the vicinity of F polluting industries in Brazil have been recently reported. Injuries caused to plant leaf cell structures by

excess F are not well characterized. However, this may contribute to understanding the ways in which plant physiological and biochemical processes are altered. A study evaluated the effects of the atmospheric F on leaf characteristics and growth of young trees of sweet orange and coffee exposed to low (0.04 mol L(-1)) or high (0.16 mol L(-1)) doses of HF nebulized in closed chamber for 28 days plus a control treatment not exposed. Gladiolus and ryegrass were used as bioindicators in the experiment to monitor F exposure levels. Fluoride concentration and dry mass of leaves were evaluated. Leaf anatomy was observed under light and electron microscopy. High F concentrations (similar to 180 mg kg(-1)) were found in leaves of plants exposed at the highest dose of HF. Visual symptoms of F toxicity in leaves of citrus and coffee were observed. Analyses of plant tissue provided evidence that F caused degeneration of cell wall and cytoplasm and disorganization of bundle sheath, which were more evident in Gladiolus and coffee. Minor changes were observed for sweet orange and ryegrass. Increase on individual stomatal area was also marked for the Gladiolus and coffee, and which were characterized by occurrence of opened ostioles. The increased F absorption by leaves and changes at the structural and ultrastructural level of leaf tissues correlated with reduced plant growth.

Silva S. D., J. S. D. Lima, and D. M. de Queiroz. 2011. Spatial Variability in Nutritional Status of Arabic Coffee Based on DRIS Index: Variabilidade espacial do estado nutricional de variedades de café arábica com base no índice DRIS . Revista Ceres, 58:256-261.
Reference ID: 21494
Notes: #21494e
Abstract: The combined use of precision agriculture and the Diagnosis and Recommendation Integrated System (DRIS) allows the spatial monitoring of coffee nutrient balance to provide more balanced and cost-effective fertilizer recommendations. The objective of this work was to evaluate the spatial variability in the nutritional status of two coffee varieties using the Mean Nutritional Balance Index (NBIm) and its relationship with their respective yields. The experiment was conducted in eastern Minas Gerais in two areas, one planted with variety Catucaí and another with variety Catuaí. The NBIm of the two varieties and their yields were analyzed through geostatistics and, based on the models and parameters of the variograms, were interpolated to obtain their spatial distribution in the studied areas. Variety Catucai, with grater spatial variability, was more nutritional unbalanced than variety Catuai, and consequently produced lower yields. Excess of Fe and Mn makes these elements limiting yield factors.

Partelli F. L., H. D. Vieira, E. P. B. Ferreira, A. P. Viana, J. A. A. Espindola, S. Urquiaga, and R. M. Boddey. 2011. Biologic Dinitrogen Fixation and Nutrient Cycling in Cover Crops and Their Effects on Organic Conilon Coffee. Semina-Ciencias Agrarias, 32:995-1005.
Reference ID: 21495
Notes: #21495e
Abstract: Notwithstanding its relevance, studies regarding nutrient cycling and biological dinitrogen fixation in Conilon coffee (Coffee canephora cv. Conilon) associated with cover plants are very scarce. Aiming to evaluate the contribution of cover crops for organic conilon production, a field experiment was carried out consisting of Pennisetum glaucum, and legume species Canavalia ensiformis, Mucuna deeringiana and Cajanus cajan (inoculated and non inoculated) cultivated

between coffee trees, and spontaneous vegetation as cover crops. The experiment was carried out in Espirito Santo State-Brazil, in a 6.5 years old coffee crop production system. Chemical analyses of soil and vegetative parts of spontaneous and cover crops, as well as coffee leaf nutrients concentration were performed. Biological Nitrogen Fixation (BNF) was determined by the natural abundance method. BNF contributed with about 80% of the nitrogen accumulated by the leguminous plants, corresponding to 27 - 35 kg of N ha(-1). Concentration and accumulation of nutrients varied among cover crops. Rhizobium inoculation did not influence nutrient cycling or BNF. Legume plants partially supplied the nitrogen requirements of Conilon coffee. No significant effect of the treatments was observed on the nutrient concentration of Conilon coffee or on plant growth.

Hanisch S., Z. Dara, K. Brinkmann, and A. Buerkert. 2011. Soil Fertility and Nutrient Status of Traditional Gayo Coffee Agroforestry Systems in the Takengon Region, Aceh Province, Indonesia. Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS), 112:87-100.
Reference ID: 21496
Notes: #21496e
Abstract: Little is known about the traditional coffee cultivation systems in Central Aceh, Indonesia, where coffee production is a major source of income for local Gayo people. Based on field observations and farmer interviews, 14 representative agroforestry coffee plantations of different age classes (60-70 years, 30-40 years, and 20 years) as well as seven adjacent grassland and native forest sites were selected for this study, and soil and coffee leaf samples collected for nutrient analysis. Significant differences in soil and coffee leaf parameters were found between former native forest and Sumatran pine (Pinus merkusii) forest as previous land cover indicating the importance of the land use history for today's coffee cultivation. Soil pH as well as exchangeable Na and Ca concentrations were significantly lower on coffee plantations compared to grassland and forest sites. Soil C, N, plant available P, exchangeable K, and Mg concentrations showed no consistent differences between land use groups. Nitrogen (N), phosphorus (P), and potassium (K) concentrations of coffee leaves were in the sufficiency range, whereas zinc (Zn) contents were found to be consistently below the sufficiency threshold and significantly lower in coffee plantations of previous pine forest cover compared to those of previous native forest cover. While the results of this study provided insights into the nutrient status of coffee plantations in Central Aceh, the heterogeneity of site conditions, limited sampling size, and scarcity of reliable data about the land use history and initial soil conditions of sampled sites preclude more definitive conclusions about the sustainability of the studied systems.

Lana R. M. Q., S. A. de Oliveira, A. M. Q. Lana, and M. V. de Faria. 2010. Coffea Arabica L. Nutritional Status Survey Based on DRIS, in the Upper Paranaiba Region-Minas Germs. Revista Brasileira De Ciencia Do Solo, 34:1147-1156.
Reference ID: 21497
Notes: #21497e
Abstract: A striking characteristic of soils under savanna vegetation is the low natural fertility, as in soils in the Upper Paranaiba region - MG. This characteristic is aggravated by the use of low fertilizer quantities, which may cause nutritional imbalance in plants. The objective of this study was to evaluate the nutritional status of coffee plants in the Upper Paranaiba region - MG, using the integrated system for diagnose and recommendation (DRIS) to interpret leaf analyses and apply the

fertilization response potential to the DRIS index and analyze the correlations and interactions between leaf nutrient concentrations and DRIS index. Coffee leaf samples were collected in the initial fruit growth stage, removing two pairs of leaves from each plant in 20 random plants, in 59 commercial plantations of the region. Nutrient levels were determined and interpreted by the DRIS. DRIS indicated that the yield-limiting nutrients were: P, Fe, K = Mn, and Zn = B. The nutrients to which coffee plants tended to respond positively were: P. B, Fe, K, and Mn. The positives correlations between the DRIS index were: N(P, K and S), P(K, Mg and S) and K(Mg and S), and the negatives correlations: N(Ca, B, Fe, and Zn), P(Ca, B, Fe, Mn, and Zn) and K(Ca, B, Fe, Mn, and Zn).

Dias R. C. E., F. G. Campanha, L. G. E. Vieira, L. P. Ferreira, D. Pot, P. Marraccini, and M. D. Benassi. 2010. Evaluation of Kahweol and Cafestol in Coffee Tissues and Roasted Coffee by a New High-Performance Liquid Chromatography Methodology. Journal of Agricultural and Food Chemistry, 58:88-93.
Reference ID: 21498
Notes: #21498e
Abstract: A reverse phase high-performance liquid chromatography (HPLC) method was developed for the simultaneous quantification of kahweol and cafestol in tissues of fresh fruits, leaves, and roasted coffee beans. The best resolution was obtained with isocratic elution of acetonitrile/water (55/45% v/v) and UV detection. A single sample preparation method carried out by direct saponification and extraction with organic solvent was standardized for all matrices. Good recovery (average of 99% for kahweol and 94% for cafestol), repeatability, and linearity were obtained. Detection limits of 2.3 and 3.0 mg/100 g were observed for kahweol and cafestol. The HPLC method was effective in quantifying these diterpenes in the different coffee matrices. The endosperm and perisperm of Coffea arabica cv. IAPAR 59 showed elevated amounts of kahweol as compared to the pericarp and leaves. On the other hand, cafestol was detected in all samples except in leaves from Coffea canephora cv. Apoata.

Brunsell N. A., P. P. B. Pontes, and R. A. C. Lamparelli. 2009. Remotely Sensed Phenology of Coffee and its Relationship to Yield. Giscience & Remote Sensing, 46:289-304.
Reference ID:: 21499
Notes: #21499e
Abstract: Due to complex microclimatic interactions, a biannual phenological cycle, and the generally small scale of coffee plantations, there have been few applications of satellite observations to examine coffee yield. Using 2001-2006 data, surface precipitation and air temperature are related to MODIS surface temperature and fractional vegetation. Using lagged correlation analysis and deviations from the annual cycle, yield is related to accumulated deviations in fractional vegetation. Results imply that the coarse spatial resolution of MODIS data is compensated for by high temporal coverage, which allows for determination of coffee phenology.

Barsalobres-Cavallari C. F., F. E. Severino, M. P. Maluf, and I. G. Maia. 2009. Identification of Suitable Internal Control Genes for Expression Studies in Coffea Arabica Under Different Experimental Conditions. BMC Molecular Biology, 10.
Reference ID: 21500
Notes: #21500e

Abstract: Background: Quantitative data from gene expression experiments are often normalized by transcription levels of reference or housekeeping genes. An inherent assumption for their use is that the expression of these genes is highly uniform in living organisms during various phases of development, in different cell types and under diverse environmental conditions. To date, the validation of reference genes in plants has received very little attention and suitable reference genes have not been defined for a great number of crop species including Coffea arabica. The aim of the research reported herein was to compare the relative expression of a set of potential reference genes across different types of tissue/organ samples of coffee. We also validated the expression profiles of the selected reference genes at various stages of development and under a specific biotic stress.
Results: The expression levels of five frequently used housekeeping genes (reference genes), namely alcohol dehydrogenase (adh), 14-3-3, polyubiquitin (poly), beta-actin (actin) and glyceraldehyde-3-phosphate dehydrogenase (gapdh) was assessed by quantitative real-time RT-PCR over a set of five tissue/organ samples (root, stem, leaf, flower, and fruits) of Coffea arabica plants. In addition to these commonly used internal controls, three other genes encoding a cysteine proteinase (cys), a caffeine synthase (ccs) and the 60S ribosomal protein L7 (rpl7) were also tested. Their stability and suitability as reference genes were validated by geNorm, NormFinder and BestKeeper programs. The obtained results revealed significantly variable expression levels of all reference genes analyzed, with the exception of gapdh, which showed no significant changes in expression among the investigated experimental conditions.
Conclusion: Our data suggests that the expression of housekeeping genes is not completely stable in coffee. Based on our results, gapdh, followed by 14-3-3 and rpl7 were found to be homogeneously expressed and are therefore adequate for normalization purposes, showing equivalent transcript levels in different tissue/ organ samples. Gapdh is therefore the recommended reference gene for measuring gene expression in Coffea arabica. Its use will enable more accurate and reliable normalization of tissue/organ-specific gene expression studies in this important cherry crop plant.

Naeem M. and M. M. A. Khan. 2009. Phosphorus Ameliorates Crop Productivity, Photosynthesis, Nitrate Reductase Activity and Nutrient Accumulation in Coffee Senna (Senna Occidentalis L.) under Phosphorus-Deficient Soil. Journal of Plant Interactions, 4:145-153.
Reference ID: 21501
Notes: #21501e
Abstract: Coffee senna (Senna occidentalis L.) plants were subjected to five phosphorus levels: 0, 25, 50, 75 and 100 mg P per kg soil (P(0), P(1), P(2), P(3) and P(4), respectively). A pot culture experiment was conducted in a net house, AMU, Aligarh, India, under phosphorus-deficient soil. The present data indicates that soil-applied phosphorus significantly ameliorates most of the attributes studied. Out of five phosphorus levels, 75 mg P per kg soil (P(3)) proved best and enhanced fresh and dry weights, total chlorophyll and carotenoid content, nitrate reductase activity and leaf-NPK and Ca content, analyzed at 120, 270 and 300 days after sowing (DAS). The number of pods, seed-yield per plant and seed-protein content (330 DAS) were significantly enhanced by the P(3) level, except the number of seeds per pod, 100-seed weight and total anthraquinone glycosides content, respectively. Transpiration rate, stomatal conductance and net photosynthetic rate were also enhanced by this treatment.

da Silva A. R., M. T. Leite, and M. D. Ferreira. 2008. Coffee Tree Leaves Area Determination and Its Spray Retention Capacity. Bioscience Journal, 24:66-73.
Reference ID: 21502
Notes: #21502e
Abstract: This work aimed to study the influence of the coffee tree leave's sizes, cv. Mundo Novo, on the evaluation of the leaf area and its spray retention capacity. Leaf mirroring on paper, leaf digitalization and imagine analyzes (QUANT) and rectangle circumscribed to the leaf methods were compared with LiCor area meter, model 3000. The spray retention capacity was evaluated with and without adjuvant addition at 0.1 and 0.2%. There weren't influence of the leave's size on the leaf area determination's methods. The leaves spray retention capacity was altered in function of the leaf size and of the adjuvant presence or not. The bigger spray retention capacity was observed at 7.7, 13.8 and 32 cm(2) leaves area. The spray without adjuvant exhibited biggest spray retention, with 77.1 mL m(-2). The spray additions of the 0.1 and 0.2% of adjuvant reduced in 64.8 and 67.3%, respectively, the spray retention capacity.

Laviola B. G., H. E. P. Martinez, and A. L. Mauri. 2007. Influence of the level of fertilization of the matrix plants in the formation of seedlings of coffee plants in hydroponic systems. Ciencia E Agrotecnologia, 31:1043-1047.
Reference ID: 21503
Notes: #21503e
Abstract: The objective of this work was to evaluate the development of seedlings of four varieties of arabic coffee plant in hydroponic system with expanded clay. The seeds of the cultivars Catuaf, Rubi, Icatu e Acaia were colected from plants submitted to three levels of fertilization. The low and high levels of fertilization received 0.4 and 1.4 times the recommendation done for the appropriate level, respectively. After the collection and preparation, the seeds were germinated in paper rolls and after 30 days they were transplanted to 120 ml containers filled out with commercial substratum. The nutritive solution was supplied to the channels with expanded clay by sub-irrigation. The experimental design was in randomized blocks in a 4 x 3 factorial scheme with 4 replications and 7 useful plants per plot. As soon as the plants reached 5 to 6 pairs of leaves the height of plants and dry matter weight of leaves, stems and root system were measured. The obtained results were submitted to the variance analysis and the averages were compared by the Duncan test. It was observed that the level of fertilization of the matrix plants had little influence upon growth and development of the coffee plant seedlings. The proposed hydroponic system promoted adequate development of the coffee plant seedlings.

Silva E. B., M. M. D. Farnezi, N. A. V. D. Pinto, and P. H. Grazziotti. 2013. DRIS Norms and Critical Nutrients Ranges for Coffee Beverage Quality in High Jequitinhonha Valley, Brazil. EJBS, 6.
Reference ID: 21504
Notes: #21504e
Abstract: High Jequitinhonha Valley has been ascending as coffee pole in Minas Gerais state, Brazil. However, little importance has been given to the diagnosis of the nutritional coffee state that provides together high yield the best drink quality. The objective of this work is to establish DRIS norms and adequate critical range that provides the best nutritional state along with coffee drink quality (measured by polyphenyloxidase enzyme activity)from Jequitinhonha Valley region, MG. DRIS norms were established to the best nutritional state and coffee drink quality from

Jequitinhonha Valley region, Minas Gerais. Values suggested were:N (22.0 -24.8 g kg-1), P (2.0 -2.4 g kg-1), K (14.9 -17.9 g kg-1), Ca (13.0 -16.1 g kg-1), Mg (3.2 -3.8 g kg-1), S (1.0 -1.3 g kg-1), B (77.3 -89.1 mg kg-1), Cu (3.1 -3.8 mg kg-1), Fe (174.0 -242.4 mg kg-1), Mn (197.5 -341.8 mg kg-1) and Zn (19.8 -31.0 mg kg-1).

Martinez H. E. P., A. V. Zabini, I. A. D. Franco, and R. F. Novais. 2005. Translocation and Compartmentation of Zn Doses Applied to Roots of Beans and Coffee Seedlings: Translocação e compartimentalização de Zn em função de doses aplicadas em feijoeiro e cafeeiro via radicular . Ciência Rural, 35:491-497.
Reference ID: 21505
Notes: #21505e
Abstract: Two experiments were conducted aiming at evaluating translocation and compartmentation of zinc applied on roots of bean and coffee seedlings in greenhouse grown in nutrient solution. The plants were grown in geminate containers system and nutrient solution containing 0.0; 0.5; 1.0; 2.0; 3.0; 4.0mumol L-1 of zinc by ZnSO4, which constituted the treatments. The dry matter and total zinc concentration were determined in the stems, roots, upper leaves and lower leaves. Total zinc analysis showed translocation of zinc towards the roots in bean, indicating zinc mobility in phloem of these plants. However, in coffee seedlings zinc showed minimum mobility in phloem. The bean plants presented linear increasing in zinc concentration in the different analyzed parts because of treatments. Coffee seedlings showed minimum alteration in the dry matter and zinc concentration in the aerial part. The stem showed to be a concentration location of zinc, so much in coffee and bean seedlings as weel.

Valarini V., O. C. Bataglia, and L. C. Fazuoli. 2005. Macronutrients in leaves and fruits of dwarf arabica coffee cultivars: Macronutrientes em folhas e frutos de cultivares de café arábica de porte baixo . Bragantia, 64:661-672.
Reference ID: 21506
Notes: #21506e
Abstract: Macronutrient mobilization from leaves to fruits in dwarf arabica coffee cultivars was studied, through serial leaf and fruit samplings. The experiment was set in 1994 in a Rhodic Hapludox soil at Campinas, State of São Paulo, Brazil. Third leaf from the apex of reproductive branches with fruits was collected for macronutrient determinations in December 2002, February and May 2003. Ripe fruits were sun drayed being grain and husks milled separately for analysis. Except for calcium it was observed a decrease in the leaf macronutrient concentrations during the growing season fruit. Concentration of all macronutrients in the leaves was slightly higher for high yielding cultivars as compared to the medium yielding cultivars, except for Ca displaying higher concentrations in high yielding cultivars. Except for Ca concentrations in husks there was no difference in the concentration of macronutrients in husks and grains of the cultivars, despite their great difference in grain yield. There was an inverse relation ship between yield and relative mobilization index. Grain dry weight of higher yielding cultivars was produced with relatively less remobilization of N, P and K from the leaves.

Franco E., E. Miglioranza, and T. D. Fonseca. 2004. High metal contents in coffee plant organs developed in tubets with different proportions of biosolid composts and carbonized rice hulls. Brazilian Archives of Biology and Technology, 47:503-510.
Reference ID: 21507
Notes: #21507e

Abstract: The objective of this study was to analyze the effect of biosolid composts (BC) and carbonized rice hull (RH) on the production of Coffea arabica L. cv Catuai Vermelho seedlings (IAC H 2077-2-5-99) gown in tubets. A totally randomized experimental design with five treatments and four replications was conducted in a nursery, to evaluate Co, Ni, Cr, Pb, Cu, Mn and Zn contents in roots, steins and leaves. Higher contents of Cr, Co, Ni, Pb, Cu and Zn were found in roots, while leaves carried the highest content of Mn. Zn in leaves went from average to high in plants developed in BC. In plants developed in RH. Mn content was about four times higher than the adequate concentration. Ni, Co, Cr, Pb and Cu contents found in leaves were considered normal, according to international standards. The best treatment for coffee seedling nutrition was 50% RH+ 50% BC.

Bataglia O. C., J. A. Quaggio, W. R. dos Santos, and M. F. de Abreu. 2004. Nutrient Diagnosis of Coffee-Tree by DRIS Using Different Sensitivity Constants According To The Nutrient Yield Response: Diagnose nutricional do cafeeiro pelo DRIS variando-se a constante de sensibilidade dos nutrientes de acordo com a intensidade e freqüência de resposta na produção . Bragantia, 63:253-263.
Reference ID: 21508
Notes: #21508e
Abstract: The objective of this study was to test the use of standard scores to reduce the dependence among nutrients on DRIS indices. Different scores were attributed to nutrients with common (R), intermediate (M) and rare (I) response to coffee crop. The study was conducted using data of leaf analysis from plantation farms at Matão and Franca, State of São Paulo, Brazil. Leaves were taken from bearing branches during the summer, from 1999 to 2001. DRIS indices were calculated using the original formula defined in 1981 by Jones with a sensitivity constant k = 30 for all nutrient relations. The tested method attributed different values for the constant k, depending on the type of response of coffee-tree to each nutrient. When the methods were evaluated by comparison of the relations between the nutrient balance index (NBI) and yield, the use of scores in the order I<M<R showed to be more efficient then the usual method using the same score for all nutrients. The methods had about the same efficiency when evaluated by comparing the leaf nutrient diagnosis by DRIS with the sufficiency range method.

Theodoro V. C. D., J. G. de Carvalho, J. B. Correa, and R. J. Guimaraes. 2003. Nutritional Diagnosis of Organic Coffee Agroecosystems in the Minas Gerais State. Ciencia E Agrotecnologia, 27:1222-1230.
Reference ID: 21509
Notes: #21509e
Abstract: The production of organic coffee have been shown as a necessary and irreversible tendency of brazilian agrobusiness. This activity has an important role as an income alternative for some coffee producers, due to the increasing global demand for safety food. However the majority of techniques proposed in the organic agriculture have beeing use empiricaly to the coffee plantings, especialy in Minas Gerais state, the producer state coffee in Brazil. Considering the low natural soil fertility of this coffee region and the great nutrient exportation from the coffee crops, the objective of this research is to evaluate possible negative fators for the organic coffee production related with soil fertility and the nutritional status of plants. Soil and leaf samples were collected in 21coffee plantings of Minas Gerais. The soil samples were analyzed for pH, P, K, P, K, Ca, Mg, S, Al and organic matter contents. Foliar samples were analyzed for N, P, K, Ca, Mg, S, B, Cu, Fe, Mn and Zn contents.

Considering the patterns established for conventional coffee plantings found in literature, frequencies were calculated when soil and leaf contents were low, high and adequate. The data were analyzed through descriptive statistics. More data is required on tissue analysis and soil fertility in order to effectively reveal nutritional disorders in organic coffee plantings.

Bellato A. C. S., A. A. Menegario, and M. F. Gine. 2003. Boron Isotope Dilution in Cellular Fractions of Coffee Leaves Evaluated by Inductively Coupled Plasma Mass Spectrometry With Direct Injection Nebulization (DIN-ICP-MS). Journal of the Brazilian Chemical Society, 14:269-273.
Reference ID: 21510
Notes: #21510e
Abstract: Enriched B-10 (94.14 atom %) was supplied to coffee plantlets for three months. Then boron isotope ratios were determined in the leaf cell compartments, cell wall, nuclei and chloroplast, after a sub-cellular fractionation procedure. The isotopic measurements were performed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) provided with a direct injection nebulizer (DIN), introducing a sample volume of 50 muL. Isotopic ratios from 1.002 to 1.326 were determined with precision characterized by RSD lower than 1.5% for the enriched cell fractions with B concentrations ranging from 3.3 to 10.8 mug g(-1). The detection limit (3sigma) was 0.5 ng B mL(-1). The average enrichments in B-10 atom % found in the cell walls, nuclei and chloroplasts were 46.7, 44.5 and 48.8, respectively.

DaMatta F. M., R. A. Loos, E. A. Silva, M. E. Loureiro, and C. Ducatti. 2002. Effects of Soil Water Deficit and Nitrogen Nutrition on Water Relations and Photosynthesis of Pot-Grown Coffea Canephora Pierre. Trees, 16:555-558.
Reference ID: 21511
Notes: #21511e
Abstract: Coffea canephora plants (clone INCAPER-99) were submitted to low N (LN) or high N (HN) applications and two watering regimes (daily irrigation and irrigation every 5 days for a month). Although water potential was not altered significantly by N, HN plants showed higher relative water content than did LN plants under water deficit. Only HN plants exhibited some ability for osmotic adjustment. Plants from both N treatments increased their cell wall rigidity under drought, with a more pronounced augmentation in HN plants. In well-watered plants, carbon assimilation rate increased with increasing N while stomatal conductance did not respond to N supply. Under drought conditions, carbon assimilation decreased by 68-80% compared to well-watered plants, whereas stomatal conductance and transpiration rate declined by 35% irrespective of the N applications. Stable carbon isotope analysis, combined with leaf gas exchange measurements, indicated that regardless of the watering treatments, N increased the long-term water use efficiency through changes in carbon assimilation with little or no effect on stomatal behaviour.

Tavares-Junior J. E., J. L. Favarin, D. Dourado-Neto, A. D. N. Maia, L. C. Fazuoli, and M. S. Bernardes. 2002. Comparative Analysis Among Methods of Estimating Coffee-Tree Leaf Area: Análise comparativa de métodos de estimativa de área foliar em cafeeiro . Bragantia, 61:199-203.
Reference ID: 21512
Notes: #21512e

Abstract: With the purpose of evaluating the accuracy of three methods to estimate area of individual coffee leaves a field experiment was carried out at Agricultural Institute (IAC) at Campinas, São Paulo State, Brazil, where 50 coffee (cultivar Mundo Novo) leaves were randomized collected. At three methods of measurement (SIARCS 3.0, Barros and leaves discs methods) were compared with the standard one (LI-COR) using simple regression analysis (Yi = betaXi + epsiloni). The three methods were evaluated using the following criteria: a) slope of the linear regression model (beta); b) determination coefficient (R^2); c) mean relative error (EMR), and d) dispersion pattern of residuals. The uncertainty associated to R^2 and EMR was assessed using the bootstrap procedure. The SIARCS 3.0 method was the most accurate one, being useful to estimate leaf area (absolute values), or to calibrate expeditious methods, instead the LI-COR method. The Barros and the leaf disc methods showed a tendency of underestimating and overestimating the leaf area values, respectively.

Lopez Y., N. Riano, P. Mosquera, A. Cadavid, and J. Arcila. 2000. Activities of Phosphoenolpyruvate Carboxylase and Ribulose-1,5-bisphosphate Carboxylase/Oxygenase in Leaves and Fruits pericarp Tissue of Different Coffee (Coffea sp.) Genotypes. Photosynthetica, 38:215-220.
Reference ID: 21513
Notes: #21513e
Abstract: In order to study photosynthetic characteristics, phosphoenolpyruvate carboxylase (PEPC) and ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBPCO) activities as well as soluble protein and chlorophyll contents were determined in leaf and fruit pericarp samples from diverse coffee genotypes (Coffea arabica cv. Colombia, Caturra, Caturra Erecta, San Pacho, Tipica, C. stenophylla, C. eugenioides, C. congensis, C. canephora, C. canephora cv. Arabusta, C. arabica cv. CaturraxC. canephora and Hibrido de Timer. We found a slightly higher PEPC activity in fruit pericarp than in leaves, while RuBPCO activity was much lower in pericarp than leaf tissue. Partial purification of PEPC and RuBPCO was carried out from leaves of C. arabica cv. Caturra and Michaelis-Menten kinetics for RuBPCO (K-m CO2 = 5.34 muM), (K-m RuBP = 9.09 muM) and PEPC (K-m PEP = 19.5 muM) were determined. Leaf tissues of Colombia, Hibrido de Timer, and Caturra consistently showed higher content of protein [55.4-64.4 g kg(-1)(f.m.)] than San Pacho, C. stenophylla, Tipica, Caturra Erect, and CaturraxC. canephora [25.6-36.9 gkg(-1)(f.m.)] and C. canephora cv. Arabusta, Borbon, C. congensis, C, eugenioides, and C. canephora [15.1-21.1 gkg(-1)(Em.)].

de Carvalho C. H. S., A. B. Rena, A. A. Pereira, and A. T. Cordeiro. 1993. Relationship between crop load, N, P, K, Ca, Mg and starch content, and the dieback of catimor (Coffea-Arabica L.). Pesquisa Agropecuaria Brasileira, 28:665-673.
Reference ID: 21514
Notes: #21514e
Abstract: Dieback of the progeny of Coffea arabica L. Catimor UFV-1359 was studied by altering the crop level through thinning of flowers and fruits, and determining the leaf contents of N, P, K, Ca and Mg and starch content in the leaves and plagiotropic branches. Dieback was closely related to the amount of crop on the tree and was not observed in trees whose flowers were removed. No relationship was found between the dieback of the progeny Catimor UFV-1359 and the leaf content of N, P, K, Ca and Mg. The starch content of both leaves and branches was

not always related to the dieback incidence and therefore might not be considered as a good criterion to evaluate coffee tree vigor.

dos Reis A. R., E. Jr. Furlani, S. Buzetti, and M. Andreotti. 2006. Diagnosis of N requirements for coffee plant using a portable chlorophyllmeter: Diagnóstico da exigência do cafeeiro em nitrogênio pela utilização do medidor portátil de clorofila. ragantia, 65:163-171.
Reference ID: 21515
Notes: #21515e
Abstract: Nitrogen is the most required nutrient by coffee crop and its management is very important. The losses of the nutrient are very important specially during rainy season. The study was developed in Sud Mennucci county (northwest of São Paulo State - Brazil) in an Alfisol in order to evaluate the effect of different rates and application times of nitrogen on the chlorophyll and nitrogen content in coffee leaves, and to establish correlations with the productivity. The experimental design was a complete randomized, in a factorial outline 5 x 3, constituted by combination of 5 rates (0, 50, 150, 250 and 350 kg ha-1) of nitrogen (urea) in three application times (a single application in December; two applications: splitted in November and January and three applications: splitted in November, December and January). The leaf chlorophyll content and nitrogen leaf content were evaluated during frutification and harvest. The chlorophyll concentration was positively correlated with the leaf nitrogen content and production of grains adjusted to a quadratic function to rates of applied N, in which the rate of 210 kg ha-1 of nitrogen promoted the greater productivity. The estimative of the chlorophyll content seemed to be a prospective means for detection of N deficiencies in coffee crop.

Raju L. and T. R. Subraman. 1969. Studies on leaf analysis in NPK nutrition of Arabica coffee. Turrialba, 19:49-56.
Reference ID: 21516
Notes: S 8.1.5 #21516 > S 8 #21485e Please look for #21485 in shelf if looking for this journal

Carvajal J., A. Acevedo, and C. Lopez. 1969. Nutrient Uptake By Coffee Tree During A Yearly Cycle. Turrialba, 19:13-20.
Reference ID: 21517
Notes: S 8.1.5 #21517 > S 8 #21485e Please look for #21485 in shelf if looking for this journal

Scalco M. S., L. A. Alvarenga, R. J. Guimaraes, A. W. Dominghetti, A. Colombo, G. A. Assis, and G. F. Abreu. 2014. Leaf contents of phosphorus and zinc, productivity, and growth of irrigated coffee. Pesquisa Agropecuaria Brasileira, 49:95-101.
Reference ID: 21518
Notes: #21518e
Abstract: The objective of this work was to evaluate the effects of irrigation on leaf contents of P and Zn, on the yield, and on the growth of coffee plants (Coffea arabica) under traditional and high density planting. A randomized complete block design was used in split-plot arrangement, with four replicates. Plots consisted of planting density (3,333 and 10,000 plants ha(-1)), and subplots consisted of water depths applied according to four irrigation managements: beginning of irrigation whenever water tension at 0.25 m soil depth reached values near 20 or 60 kPa; fixed irrigation turn (three times a week), according to climatic water balance; and a

control without irrigation. In 2009, 2010, and 2011, the following evaluations were done for: leaf concentrations of P and Zn; yield of processed coffee (bags ha(-1)); and lateral canopy area. Larger water irrigation depths favor root absorption of P and the vegetative growth of plants, on both traditional and high density planting systems, as well as productivity increase in the traditional system. Phosphorus increased availability for plants by greater irrigation depths decreases Zn concentration in the leaves.

Goncalves S. M., R. J. Guimaraes, J. G. de Carvalho, and E. P. Botrel. 2009. Critical ranges of macronutrient content in leaves of coffee seedlings (Coffea arabica L.) grown in plastic pots. Ciencia E Agrotecnologia, 33:743-752.
Reference ID: 21519
Notes: #21519e
Abstract: The aim of this study was to determinate the macronutrient content in leaves of coffee seedlings grown in plastic pots. The experiment was carried out at a greenhouse located in the coffee research area at the Agronomy Department of Lavras Federal University from May 2003 to January 2004. We used a block design in a sample factorial 6 x 3 with four blocks, where the substrate was treated with six levels of fertilization (50, 75, 100, 125, 150, and 200% of standard fertilization with Osmocote for m(3) substrate) and the evaluations were performed at three stages of development (sampling times): three, four, and five pairs of leaves. The following characteristics were evaluated: plant height (cm), stem diameter (mm), leaf area (cm(2)), root dry weight (g), stem dry weight (g), leaf dry weight (g), total dry weight (g), and leaf analysis for the following nutrients: N, P, K, Ca, Mg, S. The critical ranges obtained for macronutrients were: nitrogen (2.26 to 2.62 dag/Kg); phosphorus (0.22 to 0.25 dag/Kg); potassium (2.59 to 2.92 dag/Kg); calcium (0.69 to 0.76 dag/Kg); magnesium (0.11 to 0.12 dag/Kg); sulfur (0.15 to 0.24 dag/Kg). It was confirmed that the four true pair of leaves were the ideal for leaf sampling aiming at the identification of the mactonutrient contents.

Wang N., L. Jassogne, P. J. A. van Asten, D. Mukasa, I. Wanyama, G. Kagezi, and K. E. Giller. 2015. Evaluating coffee yield gaps and important biotic, abiotic, and management factors limiting coffee production in Uganda. European Journal of Agronomy, 63:1-11.
Reference ID: 21520
Notes: #21520e
Abstract: Coffee is Uganda's biggest export commodity, produced mainly by an estimated one million smallholder farmers (<2.5 ha). Arabica (Coffea arabica L.) and Robusta (Coffea canephora Pierre ex Froehn.) are the two coffee species grown. Robusta is dominantly cultivated at lower elevations (<1400 m) such as in Central and Northern Uganda and Arabica is dominant at higher elevations (>1400 m) such as Eastern, Southwest, and Northwest Uganda. Actual yields are far below (<30%) potential due to various biotic, abiotic, and management constraints, yet there is no quantitative information on site-specific production constraints and the yield gaps attributed to those constraints. In this study, yields and diverse production factors were monitored in 254 plots of five major coffee growing regions (i.e., Central, North, East, Southwest, and Northwest). Boundary line analysis was applied to evaluate the relative importance of the individual production factors in limiting coffee production and to quantify the associated yield gaps at regional level. The impacts of rainfall variation on coffee yield were evaluated separately by regression analysis. The results of boundary line analysis indicated that biotic constraints (coffee twig borer)

and poor management practices (unproductive coffee trees and low coffee plant density) restricted Robusta production in the Central region; poor soil nutrient status (especially potassium) and lack of mulching were the causes of yield loss of Robusta grown in the Northern region. For Arabica, unfavorable soil properties (high soil pH and phosphorus concentration) and excessive number of shade trees were the most important constraints in the East; high soil magnesium concentration and poor mulching limited coffee yield in the Southwest; poor soil nutrient status (especially phosphorus and potassium) and low coffee plant density were the important yield limitations in the Northwest. Average explained yield gaps of individual coffee plot due to the most important production constraints were 45%, 52%, 57%, 49%, and 50% of attainable yield, respectively, in the Central, Northern, Eastern, Southwest, and Northwest regions. Considerably less annual precipitation was received in 2009/2010 coffee growing season compared with that in the previous three years (2006-2008). Seasonal rainfall shortage occurred in the Southwest was a significant limitation to Arabica production, while excessive rainfall across the whole growing season was associated with yield reduction in the Eastern and Northwest regions. We conclude that there was a large yield gap for both Robusta and Arabica coffee grown in Uganda. Boundary line analysis allows the evaluation of relative importance of individual production constraint directly in the plot. The important production constraints varied strongly depending on the regions, which calls for site-specific management implementations. Soil fertility can be improved by implementing integrated soil fertility management (ISFM) that makes use of nutrients from the soil, recycled crop residues, mulch and chemical fertilizers. Attentions should also be given to other management practices such as coffee plant density, unproductive coffee trees and shade trees etc.

Garcia J. C., H. Posada-Suarez, and P. Laderach. 2014. Recommendations for the Regionalizing of Coffee Cultivation in Colombia: A Methodological Proposal Based on Agro-Climatic Indices. Plos One, 9.

Reference ID: 21521

Notes: #21521e

Abstract: The Colombian National Federation of Coffee Growers (FNC) conducted an agro-ecological zoning study based on climate, soil, and terrain of the Colombian coffee-growing regions (CCGR) located in the tropics, between 1 degrees and 11.5 degrees N, in areas of complex topography. To support this study, a climate baseline was constructed at a spatial resolution of 5 km. Twenty-one bioclimatic indicators were drawn from this baseline data and from yield data for different coffee genotypes evaluated under conditions at eight experimental stations (ESs) belonging to the National Center for Coffee Research (CENICAFE). Three topographic indicators were obtained from a digital elevation model (DEM). Zoning at a national level resulted in the differentiation of 12 agro-climatic zones. Altitude notably influenced zone differentiation, however other factors such as large air currents, low-pressure atmospheric systems, valleys of the great rivers, and physiography also played an important role. The strategy of zoning according to coffee-growing conditions will enable areas with the greatest potential for the development of coffee cultivation to be identified, criteria for future research to be generated, and the level of technology implementation to be assessed.

Merot-L'Anthone V., B. Mangin, F. Lefebvre-Pautigny, S. Jasson, M. Rigoreau, J. Husson, C. Lambot, and D. Crouzillat. 2014. Comparison of three QTL detection models on biochemical, sensory, and yield characters in Coffea canephora. Tree Genetics & Genomes, 10:1541-1553.
Reference ID: 21522
Notes: #21522e
Abstract: Coffea canephora is subject to enormous competitive challenges from other crops, especially for farmer sustainability and consumer requirements. Coffee breeding programs have to focus on specific traits linked to these two key targets, such as quality character, largely depending on the bean's biochemical composition and field yield. Two segregating populations A and B, from crosses between a hybrid (Congolese x Guinean) FRT58 parental clone and a Congolese FRT51 genotype and between two Congolese parents FRT67 and FRT51, respectively, were used to characterize the quantitative trait loci (QTL) involved in agronomic and biochemical traits. A consensus genetic map was established using 249 SSRs covering 1,201 cM. Three QTL detection models per population with MapQTL (model I) and MCQTL (model II) followed by a connected population approach with MCQTL (model III) were compared based on their efficiency, precision for QTL detection, and their genetic effect assessment (additive, dominance, and parental-favorable allele). The analysis detected a total of 143 QTLs, 60 of which were shared between the three models; 28 found with two models; and two, 13, and 40 specific from models I, II, and III, respectively. The last model III based on connected populations is much more efficient in detecting QTLs with low variance explained and led to the genetic characterization of favorable allele. Thanks to this comparison of three QTL detection models on our quantitative genetic study, we will give a new insight for coffee breeding programs dedicated to managing complex agronomic or qualitative traits.

de Assis G. A., M. S. Scalco, R. J. Guimaraes, A. Colombo, A. W. Dominghetti, and N. M. S. de Matos. 2014. Drip irrigation in coffee crop under different planting densities: Growth and yield in southeastern Brazil. Revista Brasileira De Engenharia Agricola e Ambiental, 18:1116-1123.
Reference ID: 21523
Notes: #21523e
Abstract: Irrigation associated to reduction on planting spaces between rows and between coffee plants has been a featured practice in coffee cultivation. The objective of the present study was to assess, over a period of five consecutive years, influence of different irrigation management regimes and planting densities on growth and bean yield of Coffea arabica L.. The treatments consisted of four irrigation regimes: climatologic water balance, irrigation when the soil water tension reached values close to 20 and 60 kPa; and a control that was not irrigated. The treatments were distributed randomly in five planting densities: 2,500, 3,333, 5,000, 10,000 and 20,000 plants ha(-1). A split-plot in randomized block design was used with four replications. Irrigation promoted better growth of coffee plants and increased yield that varied in function of the plant density per area. For densities from 10,000 to 20,000 plants ha(-1), regardless of the used irrigation management, mean yield increases were over 49.6% compared to the non-irrigated crop.

Taugourdeau S., G. le Maire, J. Avelino, J. R. Jones, L. G. Ramirez, M. J. Quesada, F. Charbonnier, F. Gomez-Delgado, J. M. Harmand, B. Rapidel, P. Vaast, and O. Roupsard. 2014. Leaf area index as an indicator of ecosystem services and management practices: An application for coffee agroforestry. Agriculture, cosystems & Environment, 192:19-37.

Reference ID: 21524

Notes: #21524e

Abstract: Scalable indicators are promising to assess ecosystem services. In a large (660 ha) coffee agroforestry farm, we calibrated the relationship between the Normalized Difference Vegetation Index (NDVI), calculated on a High Resolution (HR) satellite image and ground-truth LAI, providing a 2-layer (shade trees and coffee) LAI calibration with LAI 2000 and a new technique based on the cumulative distribution of LAI along transects. The effective and apparent clumping of coffee leaves were computed (0.76 and 0.89, respectively). We also calibrated the relationship between the derived HR-LAI farm map and NDVI from the Moderate Resolution Imaging Spectroradiometer (MODIS) in order to re-construct LAI time-series (2001-2011).

Coffee LAI, as derived from MODIS after substracting the contribution of shade tree LAI varied seasonally between 2.4 and 4.4 m(2) m(-2), with a maximum by the end of wet season (peak of harvest), steep decline during the drier-cooler season, minimum after annual coffee pruning, recovery during the next rainy season and pause during the grain filling period. MODIS also detected significant inter-annual variations in LAI originating from annual pruning, or plot renovation followed by a progressive LAI recovery during up to 4 years.

We related the coffee-LAI time-series with farm registries to examine the impacts of management on LAI and on selected ecosystem services, namely yield and hydrological services. Nitrogen fertilization was adjusted annually by the farmer and appeared as the best yield predictor (R-2 = 0.53). Combining N-fertilization with LAI from 6 significant months of the year, the prediction was improved (R-2 = 0.74), confirming LAI as an important co-predictor of yield. We ended up with a yield prediction model including also the percentage of pruned resprouts (R-2 = 0.79), with potential uses for regional yield mapping or reconstruction of historical yield time-series.

The impacts of varying LAI (from nil to double actual values) on hydrological services were simulated. LAI affected the partitioning between green water (evapotranspiration) and blue water (infiltration, aquifer recharge, streamflow), thus the water provisioning.

We discussed how LAI was influenced by natural factors (phenology, interaction between vegetative and reproductive components, climate) and by management (pruning, renovation).We confirmed LAI as a powerful scalable indicator for several key ecosystem services.

Valadares S. V., J. C. L. Neves, R. F. Novais, G. N. G. P. Rosa, H. E. P. Martinez, and V. V. H. Alvarez. 2014. Yield Gains Of Coffee Plants From Phosphorus Fertilization May Not Be Generalized For High Density Planting. Revista Brasileira De Ciencia Do Solo, 38:905-911.

Reference ID: 21525

Notes: #21525e

Abstract: Inconclusive responses of the adult coffee plant to phosphorus fertilization have been reported in the literature, especially when dealing with application of this nutrient in high density planting systems. Thus, this study was carried out for the

purpose of assessing the response of adult coffee plants at high planting density in full production (in regard to yield and their biennial cycle/stability) to the addition of different sources and application rates of P in the Zona da Mata region of Minas Gerais, Brazil. The experiment with coffee plants of the Catucai Amarelo 6/30 variety was carried out over four growing seasons. Treatments were arranged in a full factorial design [(4 x 3) + 1] consisting of four P sources (monoammonium phosphate, simple superphosphate, natural reactive rock phosphate from Algeria (Djebel-Onk), and FH 550 (R)), three P rates (100, 200, and 400 kg ha(-1) year(-1) of P2O5), and an additional treatment without application of the nutrient (0 kg ha(-1) year(-1)). A randomized block experimental design was used with three replicates. The four seasons were evaluated as subplots in a split plot experiment. The P contents in soil and leaves increased with increased rates of P application. However, there was no effect from P application on the yield and its biennial cycle/stability regardless of the source used over the four seasons assessed.

de Assis G. A., R. J. Guimaraes, M. S. Scalco, A. Colombo, A. R. de Morais, and J. P. S. Carvalho. 2014. Correlation Between Coffee Plant Growth and Yield as Function of Water Supply Regime and Planting Density. Bioscience Journal, 30:666-675.

Reference ID: 21526

Notes: #21526e

Abstract: This study was carried out in an experimental area of the Universidade Federal de Lavras aiming to evaluate coffee plant growth and yield characteristics and study the correlation between coffee plant growth and yield as function of water supply regime and planting density. An experimental design with randomized blocks and split parcels with four replications was used. Three irrigation regimes were applied as treatment: (i) Irrigation whenever soil water tension approaches a value near 20kPa; (ii) Irrigation whenever soil water tension approaches a value near 60kPa; and a non irrigated control treatment. These three treatments were applied to three planting densities; (i) 2,500 plants ha(-1) (4.0 m x 1.0 m), 10,000 plants ha(-1) (2.0 m x 0.5 m) e 20,000 plants ha(-1) (1.0 m x 0.5 m). Correlation among plant growth characteristics (plant height, steam diameter, and number of plagiotropic branches) and coffee bean production (liters per plant) and beneficed coffee bean yield (60kg bags ha(-1)) were estimated. Along the first two harvest period, plant height and yield showed the highest correlation value found. Only for the first harvest period, the number of plagiotropic branches per plant was positively correlated to yield. Coffee plants growing under higher planting density showed a better response to irrigation.

Miranda J. M., R. A. O. Reinato, and A. B. da Silva. 2014. Mathematical model for predicting coffee yield. Revista Brasileira De Engenharia Agricola e Ambiental, 18:353-361.

Reference ID: 21527

Notes: #21527e

Abstract: The objective of this work was to create a practical and effective mathematical model for the early prediction of crops based on some phenological attributes of the plant: height, number of fruits in the 4th and 5th internodes of the plagiotropic branches, length in meters of the planted coffee row and diameter measured at the lower region of the coffee plants. The experiment was carried out in the coffee plantations of IFSULDEMINAS - campus Machado - where the productivity of four cultivars of different sizes were analysed during the 2010- 2011

season: Catucaf, Mundo Novo, Ruby and Topaz. Each of these was an experimental unit, from which 10 plants were randomly chosen. Of these, 6 branches of each plant were sampled (three on the side of the rising sun, and three on the side of the sunset; two in the upper third, and two in the middle region, and two in the lower region of each plant). Data were collected at the end of February 2011. The model which considers the proportion of the coffee plant canopy in order to get closer to the real architecture of the plant was the most significant, with a coefficient of determination of 0.83.

Classen A., M. K. Peters, S. W. Ferger, M. Helbig-Bonitz, J. M. Schmack, G. Maassen, M. Schleuning, E. K. V. Kalko, K. Bohning-Gaese, and I. Steffan-Dewenter. 2014. Complementary ecosystem services provided by pest predators and pollinators increase quantity and quality of coffee yields. Proceedings of the Royal Society B-Biology Sciences, 281.
Reference ID: 21528
Notes: #21528e
Abstract: Wild animals substantially support crop production by providing ecosystem services, such as pollination and natural pest control. However, the strengths of synergies between ecosystem services and their dependencies on land-use management are largely unknown. Here, we took an experimental approach to test the impact of land-use intensification on both individual and combined pollination and pest control services in coffee production systems at Mount Kilimanjaro. We established a full-factorial pollinator and vertebrate exclosure experiment along a land-use gradient from traditional homegardens (agro-forestry systems), shaded coffee plantations to sun coffee plantations (total sample size = 180 coffee bushes). The exclusion of vertebrates led to a reduction in fruit set of ca 9%. Pollinators did not affect fruit set, but significantly increased fruit weight of coffee by an average of 7.4%. We found no significant decline of these ecosystem services along the land-use gradient. Pest control and pollination service were thus complementary, contributing to coffee production by affecting the quantity and quality of a major tropical cash crop across different coffee production systems at Mount Kilimanjaro.

Castro-Tanzi S., M. Flores, N. Wanner, T. V. Dietsch, J. Banks, N. Urena-Retana, and M. Chandler. 2014. Evaluation of a non-destructive sampling method and a statistical model for predicting fruit load on individual coffee (Coffea arabica) trees. Scientia Horticulturae, 167:117-126.
Reference ID: 21529
Notes: #21529e
Abstract: Destructive sampling schemes are the most direct and accurate methods to estimate yields in agroecosystem studies. However, in many situations these resource-intensive schemes are not feasible and/or sustainable. The objective of this research was to develop and compare non-destructive visual censuses and analytical methods for estimating fruit loads on Coffee arabica var. Caturra and Catual trees using different components of yield.
Fruit load data were collected in coffee farms found in the Los Santos Region of Costa Rica. Two components of yield where estimated: number of productive lateral branches per tree and fruit load per lateral branch. OLS regression was used to develop empirical models relating these components of yield with total fruit load per plant.
Productive laterals at medium relative distance from the apical meristem had higher fruit loads than those found at the top or bottom of the orthotropic stem in C arabica

plants. In addition, by sampling eight to nine productive laterals per plant, the maximum observed error of the estimated fruit load per lateral was reduced by half. Regression coefficients of the empirical models relating total fruit load with yield components ranged between 0.73 and 0.92.
Sampling schemes which grant equal probability of selection to productive laterals at different relative distances from the apical meristern should be chosen when estimating fruit load per lateral in commonly cultivated varieties of C. arabica plants. Furthermore, a non-destructive sampling protocol of the key components of yield provides accurate estimates of total fruit load per tree. Additional research is required to relate fruit loads with total biomass of fresh fruit and dry biomass in this perennial crop.

Altamirano G. N., B. C. Rico, M. A. G. Cruz, R. S. Rindermann, S. C. Hernández, J. L. Baeza, E. G. de la Rosa, U. I. L. Reyes, and A. M. Hernández. 2014. Intensification of production in organic agriculture: coffee case: Intensificación de la producción en la agricultura orgánica: caso café. Revista Mexicana de Ciencias Agricolas, 5:163-169.
Reference ID: 21530
Notes: #21530e
Abstract: In the coastal region of Oaxaca, in the middle of the basin, is the coffee agroe-cosystem, where in addition to environmental services, coffee production is the basis of the rural economy, vulnerable to disasters associated with tropical storms and cyclones. For example, before Hurricane Paulina occurred from 12-15 quintals ha, 13 years after the meteor the coffee have a cover with 81% shade, 7000 kilos of litter has on the ground and an average yield of only 2.9 qq/ha. Soil leaching has led to soil degradation where the pH is 5.4, the C/N of 11.57 and available phosphorus of 17.68 mg kg. Therefore, in demonstration plots scheme is promoted: the restoration of soil biology, organic matter for soil remineralization incorporate nonmetallic secondary minerals, such as zeolites, dolomite and rock phosphate, is practiced inoculation microorganisms: Azotobacter and mycorrhizae, and the incorporation of compost and foliar fertilization.

Carias C. M. D. M., M. A. Tomaz, M. A. G. Ferrao, A. F. A. da Fonseca, R. G. Ferrao, and L. S. A. Goncalves. 2014. Grain yield of coffee conilon different maturity groups by REML/BLUP. Semina-Ciencias Agrarias, 35:707-717.
Reference ID: 21531
Notes: #21531e
Abstract: This study aimed to estimate genetic parameters and evaluate the grain yield clones coffee Conilon three maturity groups by REML / BLUP. We studied 20 clones of coffee Conilon early ripening, maturation 20 intermediate and 20 late maturing for the characteristic grain yield. For each group, represented by different times of ripening of fruits installed an experiment was conducted in a randomized block design with four replications, plots with five plants spaced 3.0 m X 1.2 m with 2777 plantas/ ha-1e evaluations were made in the years 2006, 2007, 2008 and 2009, during harvest, conducted and ceded by the Institute Capixaba Research, Technical Assistance and Rural Extension (Incaper). The average heritability (0.28, 0.38) and the value of accuracy (0.68, 0.69) of clone selection were higher for the group of early and intermediate maturity, respectively. In the late group, the experimental accuracy was not satisfactory and therefore, a low accuracy in inference about the mean genotypic, reflecting the difficulty of selection. Clones 14 and 17 of the early group and 20, 14 and 17 of the intermediate group occupied the

first places in the middle of the feature and productivity were also allocated in the same positions for MHVG (Genetic Stability of Values), PRVG (Adaptability of Genetic Values) and MHPRVG (Stability and Adaptability of Genetic Values), indicating a high yield, stability and adaptability to variations in four crops for these genotypes. The interaction clones x crops was significant for the three maturity groups, characterizing a complex type of interaction, which is problematic for the breeder due to inconsistency of the superiority of clones against variations of crops. The combined results showed superiority of the group over the intermediate early and late.

Karp D. S., C. D. Mendenhall, R. F. Sandi, N. Chaumont, P. R. Ehrlich, E. A. Hadly, and G. C. Daily. 2013. Forest bolsters bird abundance, pest control and coffee yield. Ecology Letters, 16:1339-1347.
Reference ID: 21532
Notes: #21532e
Abstract: Efforts to maximise crop yields are fuelling agricultural intensification, exacerbating the biodiversity crisis. Low-intensity agricultural practices, however, may not sacrifice yields if they support biodiversity-driven ecosystem services. We quantified the value native predators provide to farmers by consuming coffee's most damaging insect pest, the coffee berry borer beetle (Hypothenemus hampei). Our experiments in Costa Rica showed birds reduced infestation by 50%, bats played a marginal role, and farmland forest cover increased pest removal. We identified borer-consuming bird species by assaying faeces for borer DNA and found higher borer-predator abundances on more forested plantations. Our coarse estimate is that forest patches doubled pest control over 230km(2) by providing habitat for 55000 borer-consuming birds. These pest-control services prevented US$75-US$310ha-year(-1) in damage, a benefit per plantation on par with the average annual income of a Costa Rican citizen. Retaining forest and accounting for pest control demonstrates a win-win for biodiversity and coffee farmers.

Cunningham S. A., S. J. Attwood, K. S. Bawa, T. G. Benton, L. M. Broadhurst, R. K. Didham, S. McIntyre, I. Perfecto, M. J. Samways, T. Tscharntke, J. Vandermeer, M. Villard, A. G. Young, and D. B. Lindenmayer. 2013. To close the yield-gap while saving biodiversity will require multiple locally relevant strategies. Agriculture, Ecosystems & Environment, 173:20-27.
Reference ID: 21533
Notes: #21533e
Abstract: Increasing yield has emerged as the most prominent element in strategies to deal with growing global demand for food and fibre. It is usually acknowledged that this needs to be done while minimising harm to the environment, but historically land-use intensification has been a major driver of biodiversity loss. The risk is now great that a singular focus on increasing yields will divert attention from the linked problem of biodiversity decline, and the historical pattern will continue. There are options that increase yields while reducing harm to biodiversity, which should be the focus of future strategies. The solutions are not universal, but are locally specific. This is because landscapes vary greatly in inherent biodiversity, the production systems they can support, and the potential for them to be adopted by landholders. While new production techniques might apply at local scale, biodiversity conservation inevitably requires strategies at landscape and larger scales.

Valadares S. V., J. C. L. Neves, G. N. G. P. Rosa, H. E. P. Martinez, V. H. A. Venegas, and P. C. de Lima. 2013. Yield and production bienniality of dense coffee plantations under different levels of N and K. Pesquisa Agropecuaria Brasileira, 48:296-303.

Reference ID: 21534

Notes: #21534e

Abstract: The objective of this work was to evaluate the effect of N and K fertilization on the yield and production bienniality of dense coffee plantations, in a long-term study. Two experiments were evaluated in the Zona da Mata region of Minas Gerais, Brazil, under a randomized complete block design, split-plotted in time. In the first experiment, carried out with 1.5x0.7 m spacing (9,523 plants per hectare), the effects of seven doses of N + K2O in the proportion of 1:1 were evaluated (0, 200, 400, 600, 800, 1,000, and 1,200 kg ha(-1) per year) during eight crop seasons (2001/2002 to 2008/2009). Since the fertilizer had 1: 1 proportion, in order to obtain the dose for each nutrient (N or K2O), the total dose must be divided by two. The second experiment was done with 2.5x0.6 spacing (6,666 plants per hectare), under a factorial arrangement, with five doses of N (0, 150, 300, 450, and 600 kg ha(-1) per year) and five doses of K2O (0, 150, 300, 450, and 600 kg ha(-1) per year), during six crop seasons (2005/2006 to 2010/2011). The doses related to the maximum yield of processed coffee ranged from 424 to 560 kg ha(-1), for N, and from 21 to 338 kg ha(-1), for K2O. Nitrogen fertilization reduces the effect of production bienniality of coffee plants, and K2O fertilization, in years of low productivity, promotes yield recovery of coffee plants in the next year.

Tesfaye S. G., M. R. Ismail, H. Kausar, M. Marziah, and M. F. Ramlan. 2013. Plant Water Relations, Crop Yield and Quality of Arabica Coffee (Coffea arabica) as Affected by Supplemental Deficit Irrigation. International Journal of Agricultural And Biology, 15:665-672.

Reference ID: 21535

Notes: #21535e

Abstract: Low amount and erratic distribution of the seasonal precipitation and recurrent droughts are major threats to coffee production in Ethiopia. This necessitates application of supplemental deficit irrigation for coffee production. This study evaluated the impact of two supplemental irrigations, viz. supplemental full (SFI) and deficit irrigation (SDI) in comparison to rain-fed (RF) control on plant water relations, yield and quality of Coffea arabica L. during the dry season using three cultivars (cv. F-59, 74110 and 75227). Supplemental full irrigation consistently improved soil and plant water status and stomatal conductance (g(s)) during the dry season and resulted in significantly higher yield. However, the difference between SFI and SDI was not significant for crop yield, but had higher yield than RF control. Overall quality in terms of raw appearance and total quality of coffee beans was substantially improved and the amount of irrigation water applied was considerably reduced by SDI compared to SFI practice. Therefore, SDI appears to be more effective than SFI for coffee production in areas of frequent water scarcity and recurrent drought as for eastern and northern parts of Ethiopia.

Rodrigues W. P., H. D. Vieira, D. H. S. G. Barbosa, and C. Vittorazzi. 2012. Growth and yield of Coffea arabica L. in Northwest Fluminense: 2nd harvest: Crescimento e produtividade de Coffea arabica L. na região Noroeste Fluminense: 2º Colheita. Revista Ceres, 59:809-815.
Reference ID: 21536
Notes: #21536e
Abstract: In recent years, several new coffee cultivars recommended for different regions have been released. However, the performance of these varieties in many traditionally producing regions is unknown. Difference of climate and soil may jeopardize the productivity of the new cultivars and cause losses to farmers. The objective of this study is to evaluate the vegetative growth and productive genotypes of C. arabica in the conditions of the Northwestern Rio de Janeiro State, Brazil. The experiment was settled in 2007, in Panorama 1 Farm, located in the municipality of Varre Sai, RJ. Twenty-five genotypes of C. arabica were planted in a spacing of 2.5 × 0.8 m, using a completely randomized design with five replications and eight plants per plot. There were eight measurements of vegetative growth represented by plant height, stem diameter and number of plagiotropic branches. Assessments of productivity were also performed in years 2009 and 2010. There was a positive phenotypic correlation among vegetative characteristics and between vegetative characteristics and yield in the first harvest, while in the second harvest only the number of plagiotropic branches was positively correlated with yield. Up to date, the genotypes Catucaí amarelo 2 SL, Catiguá MG 02, Acauã, Palma II, Sabiá 398, IPR 103/ Iapar, IPR 100/Iapar, H 419-10-6-2-12-1, Catucaí amarelo 24 / 137, Iapar 59, Catucaí amarelo 20/15, H 419-10-6-2-5-10-1 and H 419-10-6-2-5-1 had the highest average yield after two harvests.

Teixeira A. L., F. M. A. Goncalves, J. C. de Rezende, S. P. de Carvalho, A. A. Pereira, B. F. X. de Moraes, and L. G. V. Teixeira. 2012. Early selection for grain yield in Arabica coffee using morphological traits evaluation. Pesquisa Agropecuaria Brasileira, 47:1110-1117.
Reference ID: 21537
Notes: #21537e
Abstract: The objective of this work was to assess the viability of early selection in Arabica coffee using the correlation between morphological traits and grain yield. Two hundred and sixty-nine accessions of Coffea arabica, among cultivars, hybrids, and wild genotypes, from Epamig's coffee germplasm bank, Patrocinio, MG, Brazil, were evaluated. A randomized complete block design was used, with two replicates, at a spacing of 3.5x0.8 m, with ten plants per plot. Morphological traits were evaluated in 2006, 12 months after planting, when plants were still at the juvenile phase. Grain yield data are from the 2008/2009 and 2009/2010 crop seasons. The length of the first plagiotropic stem, at 12 months of age, was highly correlated and showed a high direct effect in a favorable direction toward grain yield, being the main morphological trait responsible for variations in grain yield. The vegetative vigor at 12 months of age was the most important secondary variable in explaining the variations in grain yield. These traits can be used effectively in the early selection for grain yield in Arabica coffee.

Somporn C., A. Kamtuo, P. Theerakulpisut, and S. Siriamornpun. 2012. Effect of shading on yield, sugar content, phenolic acids and antioxidant property of coffee beans (Coffea Arabica L. cv. Catimor) harvested from north-eastern Thailand. Journal of the Science of Food and Agriculture, 92:1956-1963.
Reference ID: 21538
Notes: #21538e
Abstract: BACKGROUND: Environmental conditions, including shading, generally influence the physical and chemical qualities of coffee beans. The present study assessed the changes in some phenolic compounds, antioxidant activity and agronomic characters of coffee beans (Coffea arabica L. cv. Catimor) as affected by different shading conditions including full sun, three artificial shading conditions using a saran covering (50% shade, 60% shade, and 70% shade) and lychee shade. RESULTS: Bean weight and bean size increased significantly ($P < 0.05$) when the shade level was progressively increased. The coffee beans grown under lychee shade exhibited superior bean yield, 1000-bean weight, total phenolic content and antioxidant activity compared to all other beans. Chlorogenic acid was the most predominant phenolic acid in all samples studied, being the highest in the beans grown under lychee shade, followed by 60% shade, 70% shade, 50% shade and full sun, respectively. In contrast, bean grown under full sun had the highest amount of vanillic acid and caffeic acid. CONCLUSIONS: Antioxidant activity was highly positively associated with chlorogenic acid content. The content of total sugar (fructose, glucose and sucrose) was found highest in coffee beans grown in 60% shade, with fructose the predominant sugar. Under climatic conditions similar to this experiment, it is advisable that growers provide shade to the coffee crop to reduce heat from direct sunlight and promote yield as well as obtain good quality coffee beans.

Fernandes A. L. T., F. L. Partelli, R. Bonomo, and A. Golynski. 2012. The modern coffee planting in the Brazilian savannah: A moderna cafeicultura dos cerrados brasileiros. Pesquisa Agropecuaria Tropical, 42:231-240.
Reference ID: 21539
Notes: #21539e
Abstract: The Brazilian coffee planting presents a great importance in the creation of job opportunities, resources, and exchange value, being very diversified, with local particularities. The Brazilian Savannah covers more than 200 million ha, distributed along the States of Minas Gerais, Goiás, Mato Grosso, Mato Grosso do Sul, Tocantins, Bahia, Piauí, Maranhão, and Distrito Federal, and has reached a yield of more than 5 million bags per year, mainly for Coffea arabica L. The coffee growing, in that region, stands out for presenting yield above the national average and for using, in a more efficient way, agricultural inputs, irrigation, improved varieties, and mechanization, among other practices. The irrigated coffee crop, in Brazil, covers 240,000 ha, most of these in the Brazilian Savannah, representing 10% of the total planted area and 25% of the total coffee yield. The most used irrigation systems are the sprinkler ones (conventional, net sprinkler, and center pivot) and the located ones (dripping and modified). Its climate favours coffee quality, as it allows harvesting under low air humidity conditions, since rainfall is concentrated in the summer. It is also observed, in the Brazilian Savannah areas, higher insolation rates, mainly in the autumn and winter months, favorable to yield and quality. The most planted varieties are the Catuaí and Mundo Novo ones, along with other promising drought and diseases resistant materials.

Morais L. E., P. C. Cavatte, E. F. Medina, P. E. M. Silva, S. C. V. Martins, P. S. Volpi, S. Andrade, J. A. Machado, C. P. Ronchi, and F. M. DaMatta. 2012. The Effects of Pruning at Different Times on the Growth, Photosynthesis and Yield of Conilon Coffee (Coffea Canephora) Clones with Varying Patterns of Fruit Maturation in Southeastern Brazil. Experimental Agriculture, 48:210-221.
Reference ID: 21540
Notes: #21540e
Abstract: The economics of coffee plantations is intrinsically linked to pruning, which can improve the canopy architecture and thereby increase productivity. However, recommended pruning times on conilon coffee plantations have been made on an entirely empirical basis. In this study, by evaluating growth, photosynthetic gas exchanges, starch accumulation and crop productivity, the effects of pruning at different times between harvest and flowering were investigated for six conilon coffee clones with distinct stages of fruit maturation (early, intermediate and late). Clones with an early maturation stage were pruned at four different times: 0, 30, 60 and 90 days after harvest (DAH). Intermediate clones were pruned at 0, 30 and 60 DAH, and late clones were pruned at 0 and 30 DAH. Overall, the rates of shoot growth and net photosynthesis, the stomatal conductance and the crop yield were not affected by the pruning treatments in any of the clones. In addition, pruning times did not affect the concentrations of starch or the photochemical efficiency of photosystem II. The carbon isotope composition ratio was marginally affected by the treatments. These results suggest that the pruning time after harvests is relatively unimportant and pruning operations can be scheduled to optimise the use of labour, which directly impacts the production costs of coffee.

Ferraz G. A. E. S., F. M. da Silva, M. D. Alves, R. D. Bueno, and P. A. N. da Costa. 2012. Geostatistical analysis of fruit yield and detachment force in coffee. Precision Agriculture, 13:76-89.
Reference ID: 21541
Notes: #21541e
Abstract: The aim of this study was to use geostatistical analysis to evaluate the spatial variation in the detachment force of coffee fruit and coffee yield by variograms and kriging for precision agriculture. This study was conducted at Brejao farm, Tres Pontas, Minas Gerais, Brazil. The detachment force of green and mature coffee fruit was measured with a prototype dynamometer and georeferenced. The yield data were obtained from manual harvesting and were georeferenced. The data were evaluated by variograms estimated by residual maximum likelihood (REML), which provided a satisfactory approach for modeling all the variables with a small sample size. Spherical and exponential models were fitted, the first provided the better fit to mature fruit detachment force and the latter provided the better fit to coffee yield and green fruit detachment force. They were used to describe the structure and magnitude of spatial variation in the variables studied. Kriged estimates were obtained with the best fitting variogram models and mapped. The statistical and geostatistical analyses enabled us to characterize the spatial variation of the detachment force of green and mature coffee fruit and coffee yield and to visualize the spatial relations among these variables. The precision agriculture techniques used in this paper to collect, map and analyze the variables studied will help coffee farmers to manage their fields. Maps of coffee yield will enable farmers to apply nutrients site-specifically and manage harvesting either manually or mechanically. In addition, maps of detachment force of coffee fruit can enable farmers to harvest

coffee selectively by choosing the appropriate places and the right time to start. This will improve the quality of the final product and also increase profits.

Ferraz G. A. E. S., F. M. da Silva, L. C. C. Carvalho, M. D. Alves, and B. C. Franco. 2012. Spatial and Temporal Variability of Phosphorus, Potassium and of the Yield of a Coffee Field. Engenharia Agricola, 32:140-150.
Reference ID: 21542
Notes: #21542e
Abstract: The Precision Agriculture appears as an important tool to the management of coffee farms where the knowledge of some soil features associated with the coffee production could help specific application of fertilizing with positive environmental and economic results. So the aim of this study was to use precision agriculture and geoestatistics to evaluate the variables phosphorus, potassium and the coffee plant yield, in three different crops, by evaluating the semivariogram and kriging maps and show that these tools are important to the coffee management. This study was conducted on the Brejao farm in Tres Pontas, Minas Gerais, in 2007/2008, 2008/2009 e 2009/2010 crop. As data base were used chemical soil data obtained by sampling in a georreferenced location using a quadricycle with a sampler and a GPS, and the yield data was obtained from manual harvest on the georreferenced location. It was possible to characterize the spatial variability magnitude of the studied attributes, and they presented huge variation on time and space. Adjusts of the best semivariograms enable to produce more accurate maps that contribute to the geostatistics uses on coffee crop.

Tezotto T., J. L. Favarin, R. A. Azevedo, L. R. F. Alleoni, and P. Mazzafera. 2012. Coffee is highly tolerant to cadmium, nickel and zinc: Plant and soil nutritional status, metal distribution and bean yield. Field Crops Research, 125:25-34.
Reference ID: 21543
Notes: #21543e
Abstract: Sewage sludge has been used to fertilize coffee, increasing the risk of metal contamination in this crop. The aim of this work was to study the effects of Cd, Zn and Ni in adult coffee plants growing under field conditions. Seven-year-old coffee plants growing in the field received one of three;loses of Cd, Zn or Ni: 15,45 and 90 g Cd plant(-1); 35, 105 and 210 g Ni plant(-1); and 100, 300 and 600 g Zn plant(-1), with all three metals in the form of sulphate salts. After three months, we noticed good penetration of the three metals into the soil, especially in the first 50 cm, which is the region where most coffee plant roots are concentrated. Leaf concentrations of K, Ca, Mg, S, B, Cu, Fe and Mn were nor affected. N levels did not change with the application of Ni or Zn but were reduced with either 45 or 90 g Cd plant(-1). Foliar P concentrations decreased with the addition of 45 and 90 g Cd plant(-1) and 600 g Zn plant(-1). Zn levels in leaves were not affected by the application of Cd or Ni. The highest concentrations. of Zn were found in branches (30-230 mg kg(-1)), leaves (7-35 mg kg(-1)) and beam (4-6.5 mg kg(-1)); Ni was found in leaves (4-45 mg kg(-1)), branches (3-18 mg kg(-1)) and beans (1-5 mg kg(-1)); and Cd was found in branches (0-6.2 mg kg(-1)) and beans (0-1.5 mg kg(-1)) but was absent in leaves. The mean yield of two harvests was not affected by Ni, but it decreased at the highest dose of Zn (600 g plant(-1)) and the two higher doses of Cd (45 and 90 g plant(-1)). Plants died when treated with the highest dose of Cd and showed symptoms of toxicity with the highest dose of Zn. Nevertheless, based on the amounts of metal used and the results obtained, we conclude that coffee plants

are highly tolerant to the three metals tested. Moreover, even at high doses, there was very little transport to the beans, which is the part consumed by humans.

Serafim M. E., A. S. de Oliveira, J. M. de Lima, P. T. G. Guimarães, and J. C. Costa. 2011. Intensive Coffee Cultivation Management in the Physiographic Region of the Upper San Francisco River, Mg: A Case Study. Bioscience Journal, 27:964-977.
Reference ID: 21544
Notes: #21544e
Abstract: Aided by genetic improvement and evolution of the cultural treatments, among other aspects, coffee growing in Brazil has expanded to the area of the Savannah, overcoming the water deficit and low natural soil fertility limitations of this area. The evolution of the productive systems has been a constant, seeking to increase the yields within the perspective of the new order of natural resource conservation. With this motivation, an intensive cultivation system of coffee plants has appeared, that has been developed and is being practiced in the Physiographic Region of the High San Francisco River Valley, MG, on farmland of the municipal districts of Sao Roque de Minas, Vargem Bonita and Piumhi, besides other areas in the states of Minas Gerais and Sao Paulo. This system is characterized by the application of high doses of gypsum, brachiaria cultivation in between rows, semi-condensed planting, deep furrow planting, early planting, short stature varieties, use of animal traction and rigorous control of the nutritional state of the plants. The intensive cultivation system stands out by being capable of operationalizing good management practices, allowing to execute them in a routine way within the spectrum of activities required by coffee growing. Good results were verified in Cambisol and Latosol areas with five and ten year-old coffee plants, respectively. The crops showed good visual aspect and the average productivity of the farms is 49 coffee sacks ha(-1). The depth root growth, over two meters, has been a constant in the adult plants. The technical approach considers the system positive. An economical approach to the system is needed for producers of different technological levels.

Poltronieri Y., H. E. P. Martinez, and P. R. Cecon. 2011. Effect of zinc and its form of supply on production and quality of coffee beans. Journal of the Science of Food and Agriculture, 91:2431-2436.
Reference ID: 21545
Notes: #21545e
Abstract: BACKGROUND: In Brazil, the usual forms of zinc (Zn) supply to coffee plants have limitations that compromise the element availability to the plant. This study proposes to test an alternative approach to supplying the nutrient to Coffea arabica L. using trunk implanted zinc tablets. Additionally, the effect of Zn on the production and quality of coffee beans was also evaluated. RESULTS: The highest total coffee bean production was recorded in plants implanted with Zn tablets (TA), while the lowest was recorded in the control treatment, without zinc supply (WZn), reaching a bianual production of 188.2 and 130.1 60-kg bags of processed beans per hectare, respectively. In the treatments where Zn were applied as tablet implantation or as foliage spraying (SZn); the bean size was larger, while the grain electrical conductivity and potassium leaching were lower compared with WZn. CONCLUSION: Zn supply via tablet implantation into tree trunks provides yield and quality similar to those obtained by foliage spraying. Independent of the form of supply, Zn positively influences the production and quality of coffee beans.

Haggar J., M. Barrios, M. Bolanos, M. Merlo, P. Moraga, R. Munguia, A. Ponce, S. Romero, G. Soto, C. Staver, and E. D. F. Virginio. 2011. Coffee agroecosystem performance under full sun, shade, conventional and organic management regimes in Central America. Agroforestry Systems, 82:285-301.
Reference ID: 21546
Notes: #21546e
Abstract: Changes in coffee economics are leading producers to reduce agrochemical use and increase the use of shade. Research is needed on how to balance the competition from shade trees with the provision of ecological services to the coffee. In 2000, long-term coffee experiments were established in Costa Rica and Nicaragua to compare coffee agroecosystem performance under full sun, legume and non-legume shade types, and intensive and moderate conventional and organic inputs. Coffee yield from intensive organic production was not significantly different from intensive conventional in Nicaragua, but in Costa Rica it was lower during three of the six harvests. Full sun coffee production over 6 years was greater than shaded coffee in Costa Rica (61.8 vs. 44.7 t ha(-1), P = 0.0002). In Nicaragua, full sun coffee production over 5 years (32.1 t ha(-1)) was equal to coffee with shade that included Tabebuia rosea (Bertol.) DC., (27-30 t ha(-1)) and both were more productive (P = 0.03) than coffee shaded with Inga laurina (Sw.) Willd. (21.6 t ha(-1)). Moderate input organic production was significantly lower than other managements under all shade types, except in the presence of Erythrina poepiggina (Walp.) O.F. Cook. Inga and Erythrina had greater basal area and nutrient recycling from prunings than other shade species. Intensive organic production increased soil pH and P, and had higher K compared to moderate conventional. Although legume shade trees potentially provide ecological services to associated coffee, this depends on management of the competition from those same trees.

Svatonova T., D. Herak, and A. Kabutey. 2015. Financial Profitability and Sensitivity Analysis of Palm Oil Plantation in Indonesia. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 63: 1365-1373.
Reference ID: 21547
Notes: H 8.1.1.5 #21547e
Abstract: Oil palm cultivation in Indonesia is increasing. This study investigates the financial and economic aspects of establishing an oil palm plantation using data collected in 2014. The financial case study is undertaken from the perspective of company in North Sumatra, Indonesia. A spreadsheet model was used to develop and calculate the net present value (NPV), return of investment (ROI), internal rate of return (IRR) and payback period (PP). Sensitivity analysis of the NPV to the default discount rate (10%) was included. A 8,000 ha plantation over 25 years was estimated to result in a positive NPV of USD 10,670 with a ROI 73.50% and an IRR at 14.83% and payback period of 6.75 years. Establishing an oil palm plantation seems to be very profitable investment on the basis of the assumption made. System is tested on sensitivity in different capital and recurrent costs and in selling price of raw material, while change in selling price of FFB is more sensitive to NPV than change in investment and recurrent costs. Discount rate is also one of the factors affecting NPV and system is tested between 5-15% change in discount rate.

Reis T. H. P., P. T. G. Guimarães, A. E. F. Neto, A. F. Guerra, and N. Curi. 2011. Soil Phosphorus Dynamics and Availability and Irrigated Coffee Yield. Revista Brasileira De Ciencia Do Solo, 35:503-512.
Reference ID: 21548
Notes: #21548e
Abstract: Research data have demonstrated that the P demand of coffee (Coffea arabica L.) is similar to that of short-cycle crops. In this context, the objective of this study was to evaluate the influence of annual P fertilization on the soil P status by the quantification of labile, moderately labile, low-labile, and total P fractions, associating them to coffee yield. The experiment was installed in a typical dystrophic Red Latosol (Oxisol) cultivated with irrigated coffee annually fertilized with triple superphosphate at rates of 0, 50, 100, 200, and 400 kg ha(-1) P(2)O(5). Phosphorus fractions were determined in two soil layers: 0-10 and 10-20 cm. The P leaf contents and coffee yield in 2008 were also evaluated. The irrigated coffee responded to phosphate fertilization in the production phase with gains of up to 138 % in coffee yield by the application of 400 kg ha(-1) P(2)O(5). Coffee leaf P contents increased with P applications and stabilized around 1.98 g kg(-1), at rates of 270 kg ha(-1) P(2)O(5) and higher. Soil P application caused, in general, an increase in bioavailable P fractions, which constitute the main soil P reservoir.

Pereira S. P., G. F. Bartholo, D. P. Baliza, F. M. Sobreira, and R. J. Guimaraes. 2011. Growth, productivity and bienniality of coffee plants according to cultivation spacing. Pesquisa Agropecuaria Brasileira, 46:152-160.
Reference ID: 21549
Notes: #21549e
Abstract: The objective of this work was to evaluate the consequences of spacing reduction between rows and between plants in the planting row on growth, productivity and bienniality of coffee plants (Coffea arabica). The experimental design was a randomized complete block, with three replicates, in a 4x3 factorial arrangement. Four distances between rows (2.0, 2.5, 3.0 and 3.5 m) and three distances between plants in the planting rows (0.50, 0.75 and 1.00 m) were used, which totalized 12 treatments. The productivity and the production per plant were assessed annually between 1994 and 2001, and the growth was evaluated in 2002. The reduction of spacing between rows and between plants in the planting row increases the productivity of coffee plants. The spacing between the rows and plants influences the growth and architecture of the coffee plant.

da Cunha A. R. and C. A. Volpe. 2011. Growth curves of coffee fruits Obata IAC 1669-20 in different alignments planting. Semina-Ciencias Agrarias, 32:49-61.
Reference ID: 21550
Notes: #21550e
Abstract: The growth of the coffee fruit is highly dependent on physiological and environmental factors. Environmental factors that most influence the yield of coffee during the critical growth stages are the minimum and maximum temperatures of air, which are affected by solar radiation and depend on the apparent path of the sun. This research work correlated dry mass versus fresh mass, and, fresh and dry mass as function of days after flowering of fruit coffee cv. Obata IAC 1669-20 planted in three different alignments based on the apparent trajectory of the sun, in Jaboticabal, SP. The planting was aligned according to the apparent path of the sun. There were three treatments with four replications, a total of twelve plots, each plot with one hundred plants of coffee, each treatment corresponded to an alignment of planting.

The three alignments used showed no differences with respect the average fresh and dry mass. The growth rate of fruit, in fresh weight, was higher in the exponential phase, and in dry mass was higher in the linear stage. The dry weight (DW) can be estimated from the fresh weight (FW) using the model: DW = A1*exp(FW/t1). The sigmoidal model that represents the fruit growth in of coffee plants in fresh and/or dry mass in terms of days after flowering (DAF) was: FW(DW) = A2+[(A1-A2)/(1+exp(DAF-x0)/dx)].

da Rosa V. G. C., M. A. Moreira, B. F. T. Rudorff, and M. Adami. 2010. Coffee crop yield estimate using an agrometeorological-spectral model. Pesquisa Agropecuaria Brasileira, 45:1478-1488.
Reference ID: 21551
Notes: #21551e
Abstract: The objective of this work was to evaluate an agrometeorological-spectral model to estimate coffee crop yield. Images from the MODIS sensor and meteorological data from the ETA regional weather forecast model were used to provide input variables to the agrometeorological-spectral model, in the South-Southeast region of Minas Gerais State, Brazil, for crop years 2003/2004 to 2007/2008. The input spectral variable of the spectral-agrometeorological model, the leaf area index (LAI), used in the determination of the maximum yield, was estimated with the normalized-difference vegetation index (NDVI) obtained from MODIS images. Other input variables for the model were: meteorological data generated by the ETA model and the soil available water capacity. Comparing the estimated model average crop yield with those from IBGE, it was verified that the relative differences, at regional scale, were: 0.4; 3.0; 5.3; 1.5 and 8.5% for crop years 2003/2004, 2004/2005, 2005/2006, 2006/2007 and 2007/2008, respectively. The agrometeorological-spectral model, based on Doorenbos & Kassan model, was as efficient as the IBGE official model to estimate the coffee crop yield. Furthermore, it was possible to present the spatial variation of coffee crop yield loss and to predict 80% of final yield by the first fortight of February before the harvest.

da Costa A. R., R. Rezende, P. S. L. de Freitas, J. A. Frizzone, and C. Helbel. 2010. Number of primary branches and productivity of two cultivars of coffee using drip irrigation. Revista Ciencia Agronomica, 41:571-581.
Reference ID: 21552
Notes: #21552e
Abstract: This experiment was conducted in an area of the Technical Center of Irrigation (CTI) of the State University of Maringa (UEM) with the objective of evaluating the effect of the application of different percentages of doses of NPK (50%; 100%; 150%; 200%) in the number of plagiotropic branches and in the productivity of the cultivars of coffee Obata and IAPAR - 59. The seedlings were planted in the spacing of 2.0 meters between lines and 1.0 meter within lines, characterizing a dense system. In this experiment was used the system of localized irrigation by dripping. The experiment followed a design completely randomized in split plots with four replications. The plots and subplots were composed by percentages of doses of NPK and crops, respectively. The interaction between those factors influenced significantly the productivity and the number of plagiotropic branches allowing concluding which dose of fertilizer is indicated for each cultivation. The maximum yield to grow Obata was achieved with doses of NPK percentages of 119.5%, 151.25% and 154.17% for non-irrigated crops, irrigated and fertilized, respectively. The maximum yield for IAPAR - 59 in nonirrigated crops, irrigated and

fertilized was achieved with doses of NPK percentages of 137.83%, 162% and 151.75% respectively. Regarding the number of primary branches the best dose for cultivating crops in irrigated and Obata fertirrigated corresponded to a percentage of 200%, while the percentage dose of 150% showed the most suitable for IAPAR - 59 for the irrigated crops. The best productive was obtained for the fertirrigated cultivations.

Jaramillo-Botero C., R. H. S. Santos, H. E. P. Martinez, P. R. Cecon, and M. P. Fardin. 2010. Production and vegetative growth of coffee trees under fertilization and shade levels. Scientia Agricola, 67:639-645.
Reference ID: 21553
Notes: #21553e
Abstract: It is difficult to separate the effects of light reduction versus nutrient and water competition in agroforestry systems. The objective of this experiment was to evaluate the effect of shading and fertilizer supply on the vegetative development and yield of Coffea arabica over six years. The coffee trees were covered with shade screens (photosynthetically active radiation reduction up to 48%) and fertilized from 100 to 40% of the recommended amount from 2001 on. Leaf area, number of leaves, number of nodes, leaf area per branch and, yield were determined. Although no effect of fertilization was found, shading influenced the number of nodes, leaf area and production from the third year on. The number of nodes and yield decreased as shading increased. The effect of the yield bienniallity was more evident in the unshaded trees, which yielded an average of 2,646 kg ha(-1). The trees under 48% shading yielded an average of 2,094 kg ha(-1). After 2004 the leaf area per branch increased as the shade increased, at the end of both the maximum and minimum growth periods. During the first three years, the coffee trees do not change their vegetative or productive characteristics as a response to shading. The shade effects become more intense after the beginning of the higher yield period. The shaded coffee trees have a larger leaf area and a smaller number of nodes than the coffee trees under full sun. The yield decreases as photosynthetically active radiation limitation increases, and yield bienniallity is less intense in shaded trees.

van Oijen M., J. Dauzat, J. M. Harmand, G. Lawson, and P. Vaast. 2010. Coffee agroforestry systems in Central America: II. Development of a simple process-based model and preliminary results. Agroforestry Systems, 80:361-378.
Reference ID: 21554
Notes: #21554e
Abstract: Research on coffee agroforestry systems in Central America has identified various environmental factors, management strategies and plant characteristics that affect growth, yield and the impact of the systems on the environment. Much of this literature is not quantitative, and it remains difficult to optimise growing area selection, shade tree use and management. To assist in this optimisation we developed a simple dynamic model of coffee agroforestry systems. The model includes the physiology of vegetative and reproductive growth of coffee plants, and its response to different growing conditions. This is integrated into a plot-scale model of coffee and shade tree growth which includes competition for light, water and nutrients and allows for management treatments such as spacing, thinning, pruning and fertilising. Because of the limited availability of quantitative information, model parameterisation remains fraught with uncertainty, but model behaviour seems consistent with observations. We show examples of how the model can be used to

examine trade-offs between increasing coffee and tree productivity, and between maximising productivity and limiting the impact of the system on the environment.

de Carvalho A. M., A. N. G. Mendes, G. R. Carvalho, C. E. Botelho, F. M. A. Goncalves, and A. D. Ferreira. 2010. Correlation between growth and yield of coffee cultivars in different regions of the state of Minas Gerais, Brazil. Pesquisa Agropecuaria Brasileira, 45:269-275.
Reference ID: 21555
Notes: #21555e
Abstract: The objective of this work was to evaluate coffee growth traits in the initial stages of development and to determine its correlation with the crop initial yield in different environments. Twenty-two cultivars resistant to rust and three susceptible ones were evaluated in five representative coffee growing localities in the state of Minas Gerais, Brazil. The experiment was carried out from 2005 to 2008 in a randomized complete block design with three replicates. Besides initial yield, five growth traits were evaluated 12 months after planting: stem diameter, number and length of plagiotropic branches, plant height, and number of nodes. The genotypic and phenotypic correlations were evaluated for all traits. Pau Brasil MG1 and Catuai Amarelo IAC 62 cultivars show superiority in at least four out of the five evaluated characters, in all growing localities. There is a positive correlation between initial yield and the evaluated growth traits, except number of nodes.

Pozza A. A. A., P. T. G. Guimarães, E. B. Silva, A. R. R. Bastos, and F. D. Nogueira. 2009. Zinc sulfate leaf fertilizing in the yield and zinc and phosphorus leaf contents of the Arabic coffee plant. Acta Scientiarum-Agronomy, 31:49-55.
Reference ID: 21556
Notes: #21556e
Abstract: Aiming to evaluate the dose and application schedule of foliar Zn-sulfate spraying in growing and yield of Arabic coffee Mundo Novo, a field experiment was set tip oil Distroferric Red Latosol, at the Experimental Station of the EPAMIG in Sao Sebastiao do Paraiso. The statistical design Used was randomized blocks in s 4 x 2 factorial scheme with five replications and a 30-plant plot with six central valid plants. Zinc sulfate (ZnsO(4)) was sprayed tinder 4 concentrations 0; 0.5; 1.0 and 1.5%, two or four applications per agricultural year. Phosphorus and zinc leaf levels were evaluated for eight years and the yields. It was possible to conclude that there is a positive response to the increasing concentrations of ZnSO(4) applied oil the leaves in terms of yield, and to Zn levels in the leaves. Four low concentrations sprayings promoted higher yields than two high concentrations. The highest yields were achieved with 10.8 and 12.6 kg ha(-1) of ZnSO(4), for 2 and 4 yearly applications, respectively. It is suggested as a critical range for the Zn leaves values between 10 and 28 mg kg(-1) and for P/Zn ratio, between 100 and 150.

Silva E. A., O. Brunini, F. B. Arruda, and R. C. M. Pires. 2009. Influence of controlled water deficits on flowering synchronization and yield of coffee under three distinct edapho-climatic conditions of São Paulo State, Brazil: Influência de déficits hídricos controlados na uniformização do florescimento e produção do cafeeiro em três diferentes condições edafoclimáticas do Estado de São Paulo. Bragantia, 68:493-501.
Reference ID: 21557
Notes: #21557e

Abstract: This work aimed to investigate the influence of controlled water deficits on lowering and yield of Arabica coffee (Coffea arabica L. cv. Obatã grafted on C. canephora cv. Apoatã) in three different local conditions of São Paulo State, in the counties of Adamantina, Mococa and Campinas. Plants, with 2.5 years old, were cultivated at full sun, on spacing 2.5 m x 1.0 m, from July of 2001 to May of 2002, under the following water management: non irrigated (NI), irrigated continually (IC) and withholding irrigation by 30 days in the month of July (I30) and 60 days the months of July and August (I60). Irrespective of local cultivation, the irrigation provided larger yield of coffee per plant, with the largest significant differences observed in Mococa. The treatment I60 was able to impose a predawn leaf water potential (Øwa) of -1.1 in Adamantina, -1.6 in Mococa and -1.2 in Campinas, which was more effective for flowering synchronization of coffee plants, allying yield uniformity with good production. A greater number of flowers and a low yield uniformity of continually irrigated plants (IC) to ratify the importance of a controlled drought period for flowering synchronization. The low Ywa values (-2.5 to -2.8 MPa) of the non irrigated plants (NI), reduced the number of flowers per plant when compared to the irrigated plants with reflexes in the final production indicating the need of irrigation in order to assure good floral initiation.

Lima L. A., A. A. D. Custodio, and N. M. Gomes. 2008. Coffee yield and production during the initial five harvests under irrigation with center pivot in Lavras, MG. Ciencia E Agrotecnologia, 32:1832-1842.
Reference ID: 21558
Notes: #21558e
Abstract: Search for sustainability on agricultural exploration and incorporation of new technologies impose the necessity for knowledge and management of main factors related to production, such as irrigation. This experiment evaluated the irrigation effect on yield and production efficiency (amount of beans to produce a bag of 60Kg) of coffee irrigated by center pivot in Lavras-MG, Brazil. The experiment was planted with the cultivar Rubi MG-1192, planted on March, 1999. spaced 3.5 meters between rows and 0.8 meters between plants. The experimental design was the one of randomized blocks, with six treatment levels and three replicates. The irrigation was applied at intervals of 2 or 3 days, on Mondays, Wednesdays and Fridays, based on the amount estimated by the water blance considering the class A pan evaporation (ECA) and rain depths. The irrigation was calculated as 0% of the difference between ECA and rain depth - 0% ECA (T1, non irrigated), 60% ECA (T2), 80% ECA (T3), 100% ECA (T4), 120% ECA (T5) and 140% ECA (T6). After harvesting the coffee grains from the experimental plots, coffee samples were packed in ventilated plastic bags and dried on wood benches exposed to air long enough to decrease its moisture content between 11 and 12%, gravimetric water content. After drying, the beans were unpeeled and weighed to calculate the yield and production efficiency. Irrigation increased the yield of irrigated plots compared to non irrigated. Although non significant difference was statistically observed when comparing annual yields, the differences were statistically significant when the total production was compared among treatment levels. Application of 60% ECA resulted in a total production along five years of 225.6 bags, with annual average of 45.12 bags per hectare, representing an increase of 119% when compared to the non irrigated treatment, where the annual average was 24 bags per hectare. The beans were ripened differently among treatments and this fact influenced the production efficiency, being the dry and ripen fruits, those mostly affected.

Philpott S. M., P. Bichier, R. A. Rice, and R. Greenberg. 2008. Biodiversity conservation, yield, and alternative products in coffee agroecosystems in Sumatra, Indonesia. Biodiversity and Conservation, 17:1805-1820.
Reference ID: 21559
Notes: #21559e
Abstract: Agroecology and conservation must overlap to protect biodiversity and farmer livelihoods. Coffee agroecosystems with complex shade canopies protect biodiversity. Yet, few have examined biodiversity in coffee agroecosystems in Asia relative to the Americas and many question whether coffee agroecosystems can play a similar role for conservation. We examined vegetation, ant and bird diversity, coffee yields and revenues, and harvest of alternative products in coffee farms and forests in SW Sumatra, Indonesia near Bukit Barisan Selatan National Park (BBS). BBS is among the last habitats for large mammals in Sumatra and > 15,000 families illegally cultivate coffee inside of BBS. As a basis for informing management recommendations, we compared the conservation potential and economic outputs from farms inside and outside of BBS. Forests had higher canopy cover, canopy depth, tree height, epiphyte loads, and more emergent trees than coffee farms. Coffee farms inside BBS had more epiphytes and trees and fewer coffee plants than farms outside BBS. Tree, ant, and bird richness was significantly greater in forests than in coffee farms, and richness did not differ in coffee farms inside and outside of BBS. Species similarity of forest and coffee trees, ants, and birds was generally low (< 50%). Surprisingly, farms inside the park were significantly older, but farm size, coffee yields, and revenues from coffee did not depend on farm location. Farmers outside BBS received higher prices for their coffee and also more often produced other crops in their coffee fields such that incentives could be created to draw illegal farmers out of the park. We also discuss these results with reference to similar work in Chiapas, Mexico to compare the relative contribution of coffee fields to conservation in the two continents, and discuss implications for working with farmers in Sumatra towards conservation plans incorporating sustainable coffee production.

Veddeler D., R. Olschewski, T. Tscharntke, and A. M. Klein. 2008. The contribution of non-managed social bees to coffee production: new economic insights based on farm-scale yield data. Agroforestry Systems, 73:109-114.
Reference ID: 21560
Notes: #21560e
Abstract: Fruit set and quality of highland coffee (Coffea arabica) have been experimentally shown to be higher with bee-mediated or manual pollen supplementation than with autonomous self-pollination. Based on extrapolation from these small-scale experiments, very substantial monetary values for the pollination service have recently been suggested. However, previous research has not included direct measurement of coffee yield at a farm level in relation to pollinator activity, testing if pollinators are not only limiting fruit set and quality, but also coffee yield and farm profit. The extrapolations from small-scale experiments may be subject to error, because resource reallocation during fruit development, associated with enhanced pollination, was neglected, and many studies were restricted to a single coffee farm, limiting the validity of extrapolation. Here, we investigate the relationship between coffee yield and the community of coffee flower-visiting bees on 21 farms in Ecuador, where coffee is grown under tree shade. Our data show, for the first time on a farm-scale, that coffee yield was positively related to the density of non-managed, social flower-visiting bees per coffee shrub, but not to the number of inflorescences per shrub. Our data revealed that a fourfold increase in bee density was associated with

an 80% increase in yield and an 800% increase in net revenues. Consequently, in our study higher yield associated with increased pollination generated higher revenues per hectare, so that farm profit was higher when bees were abundant.

Morais H., C. J. Marur, P. H. Caramori, M. S. Koguishi, J. S. Gomes, and A. M. D. Ribeiro. 2008. Floral buds development, flowering, photosynthesis and yield of coffee plants under shading conditions. Pesquisa Agropecuaria Brasileira, 43:465-472.
Reference ID: 21561
Notes: #21561e
Abstract: The objective of this paper was to evaluate the influence of shading, during the period of floral development, on floral bud, flowering, photosynthesis and grain yield of coffee plants. Adult plants IAPAR 59, grown in Londrina, Parana State, Brazil, were shaded in different periods, with shading screens with 50% porosity, and compared to open-grown plants. The shading screens were placed in monthly intervals, from April to August, and were all removed in the beginning of October. Shading density and period did not influence the amount of nodes in each event of development on floral bud, period and intensity of flowering, photosynthesis and grain yield of the coffee plants, which indicates that the interception of until 50% incident radiation, during the period of floral development, does not affect the yield potential of this crop.

da Silva C. A., R. E. F. Teodoro, and B. de Melo. 2008. Productivity and yield of coffee plant under irrigation levels. Pesquisa Agropecuaria Brasileira, 43:387-394.
Reference ID: 21562
Notes: #21562e
Abstract: The objective of this work was to evaluate the productivity and yield of the first four crops of coffee plants (Coffea arabica L.) cultivated under irrigation levels. The experiment was carried out at Fazenda Experimental do Gloria, in the County of Uberlandia, MC Brazil. It was used the randomized blocks design, with eight treatments and four repetitions. The irrigation levels were 0 (without irrigation), 30, 60, 90, 120, 150, 180 and 210% of the evaporation measured in Class A tank (ECA). Planting took place in January 2001, at 3.5x0.7 in spacing. Plots consisted of three rows with eight plants each. A drip irrigation system was used, with self compensating drippers at 3.5 L h(-1) flow. Maximum productivity was 115 sacks ha(-1), obtained under 164.1 % ECA. Replenishment of 143% ECA led to optimum yield 291.8 L of "farm coffee" per processed sack. The effect of irrigation levels on productivity and yield depends on the year. Irrigation does not mitigate the production biannuality of coffee plants, regarding plants cultivated without irrigation.

Pereira S. P., R. J. Guimaraes, G. F. Bartholo, P. T. G. Guimarães, and J. D. Alves. 2007. Vegetative growth and yield of coffee plants (Coffea arabica L.) in two different pruning times, conducted at different spacings. Ciencia E Agrotecnologia, 31:643-649.
Reference ID: 21563
Notes: #21563e
Abstract: The experiment was established in the Empresa de Pesquisa Agropecuaria de Minas Gerais - Epamig Experiment Station, located in the city of Machado, south of the Minas Gerais state, Brazil, in the year of 1992, with the objective of evaluating the consequences of the reduction on planting spaces among rows and among plants, upon beans yield and plant phenology (Coffea arabica L.). The experimental

design used was a 4x 3 factorial with split plot at four distances between planting rows (2,0; 2,5; 3,0 e 3,5 m) and three distances among plants in the row (0,5; 0,75 e 1,0 m), and two different pruning times (one precociously conducted just after the harvest, on july 2002, and the other latter on january 2003), making a total 24 treatments arranged in randomized blocks with three replicates. In july 2002 and january 2003 a drastic pruning was clone and conducing two sprouts per plant. Vegetative growth and beans yield were evaluated in august 2004. Coffee plant spacing did not affected growth of any of the vegetative components of sprouting, during the evaluated period. All the vegetative characteristics were positively affected by the early pruning procedure, as well as the beans yield of the first harvest after pruning, which also showed to be positively influenced by the adoption of a narrower spacing plant. The coffee plants which were submitted to late prunning, had lancer bean yield in july 2004 as those precociously prunned.

Carvalho G. R., A. N. G. Mendes, G. F. Bartholo, A. M. Nogueira, and M. A. Amaral. 2006. Yield evaluation of coffee plant (Coffea arabica L.) progenies in two tillage systems. Ciencia E Agrotecnologia, 30:838-843.
Reference ID: 21564
Notes: #21564e
Abstract: The present work was carried out in order to analyze the planting system (high and low plant stand) influence on coffee trees (Coffea arabica L.) yield, of Catua and Mundo Novo progenies. Twenty nine progenies at fourth generation by selfing of the second backcrossing of Catua to Mundo Novo, developed by Coffee Genetic Breeding Minas Gerais program, coordinated by EPAMIG. Thirteen cultivars were used as control, topazio MG-1189 and 1189 SL, Catua Vermelho IAC-15, IAC-99 and IAC-144, Catua Amarelo MG-17, Rubi MG-1192 and 1192SL. Acaia Cerrado MG-1474 and 1474SL, Mundo Novo IAC379-19, IAC-376-4 and 376-4 SL The experiment established on the Sao Sebastiao do Para so EPAMIG's experimental station, January of 1996 at the spacing of 3.50 x 1.00 m (free growth) and 1.80 x 0.60 m (high stand system). The randomized block design was utilized, the treatments being made up of 42 progenies/cultivars with three replicates and six plants per plot. Bean yield in bags of 60 kg of processed coffee/ha was evaluated. The analysis of variance was accomplished with split plots where each biennium (grouping of harvest) was considered as a subplot. The results obtained allowed to verify that the initial yield in the crowded system was higher than that in the free growth, however, during the development of the plants, that difference tends to decrease. For both the spacing, one can utilize any of the cultivars since they behaved themselves in a similar way. The cultivars utilized as a control which presented the highest yields were: Topazio MG-1189 and 1189SL, RubiMG-1192 and 1192SL, Catua Vermelho IAC 15 and IAC - 144 and Mundo Novo IAC-376-4 and 376-4SL.

Partelli F. L., H. D. Vieira, A. R. Santiago, and D. G. Barroso. 2006. Yield and root development of 'Conilon' coffee plants propagated by cuttings and seeds. Pesquisa Agropecuaria Brasileira, 41:949-954.
Reference ID: 21565
Notes: #21565e
Abstract: The objective of this work was to evaluate the production and root and shoot development of plants of 'Conilon' coffee, grown from seeds and branches, in Vila Valerio, ES, Brazil. The experiment was performed in randomized complete block design, with two treatments (seedlings originated from seeds and branches),

and 12 replicates with five plants per plot. Shoot growth evaluation was performed seven months after planting. Six pruning of the orthotropic branches and five yields were evaluated. The evaluation of the root system was done 52 months after planting in four depths (0-10, 10-20,20-40 and 40-60 cm). Diameter, length and superficial area of roots were quantified. Plants grown from cuttings produced more plagiotropic branches, during the first seven months, and less orthotropic branches throughout the experimental period. There were no differences either in length or superficial area of roots from plants propagated by seeds or cuttings. There was a greater concentration of fine roots in the superficial layers of the soil. The productivity of plants grown from cuttings is higher than that observed in plants grown from seeds.

Cilas C., A. Bar-Hen, C. Montagnon, and C. Godin. 2006. Definition of architectural ideotypes for good yield capacity in Coffea canephora. Annals of Botany, 97:405-411.
Reference ID: 21566
Notes: #21566e
Abstract: Background: Yield capacity is a target trait for selection of agronomically desirable lines; it is preferred to simple yields recorded over different harvests. Yield capacity is derived using certain architectural parameters used to measure the components of yield capacity.
Methods: Observation protocols for describing architecture and yield capacity were applied to six clones of coffee trees (Coffea canephora) in a comparative trial. The observations were used to establish architectural databases, which were explored using AMAPmod, a software dedicated to the analyses of plant architecture data. The traits extracted from the database were used to identify architectural parameters for predicting the yield of the plant material studied.
Conclusions: Architectural traits are highly heritable and some display strong genetic correlations with cumulated yield. In particular, the proportion of fruiting nodes at plagiotropic level 15 counting from the top of the tree proved to be a good predictor of yield over two fruiting cycles.

Santos M. and M. B. P. Camargo. 2006. Calibration of an agrometeorological model for predicting coffee (Coffea arabica L.) productivity in Sao Paulo State, Brazil: Parametrização de modelo agrometeorológico de estimativa de produtividade do cafeeiro nas condições do Estado de São Paulo. Bragantia, 65:173-183.
Reference ID: 21567
Notes: #21567e
Abstract: Agrometeorological models make possible to assess the quantitative influence of climatic variables, such as air temperature and soil water balance on the coffee development and grain production. An agrometeorological model (CAMARGO et al., 2003) that monitor and assess agrometeorological impact on coffee yields just before the beginning of the maturation growth stage was modified and calibrated. Grain yield were collected from adult coffee plantations at four different regions of the State of Sao Paulo, Brazil. The modified agrometeorological model is based in two parts: first, the model estimates the beginning of the floral induction based on accumulated growing degree days, and a critical rainfall depth. The second part is based on penalization of the potential crop grain yield according to the previous yield and the water stress ratio (ETr/ETp), derived by a 10-day soil water balance during different growth stages. These ratios were weighted by derivation of crop phase yield-response sensitivity coefficients (Ky values), in a multiplicative type model.

Also, the model considers penalization for minimum and maximum air temperature. An analysis of the sensitivity coefficients values shows that this model gives higher weight to the water relations during flowering and coffee bean formation phases. This period generally occurs between October and January and it will determine the production of the coffee crop. The statistical analysis for actual and estimated coffee grain yield presented a good linear relationship, "R" between 0.76 and 0.93, "d" index of agreement between 0.73 and 0.90, "C" index of performance between 0.60 and 0.84, and "Ea" unsystematic error between 144 and 558 kg ha-1. The values of "Es" systematic error were relatively low, between 324 and 762 kg ha-1, showing a little tendency of the model to overestimate the predicting coffee grain productivity. The results support the overall conclusion that the proposed model shows a good capacity to estimate coffee grain productivity and it is a promising tool for monitoring climatic impacts on coffee grain yields.

Paulo E. M., R. S. Berton, J. C. Cavichioli, E. A. Bulisani, and F. S. Kasai. 2006. Productivity of grafted coffee during intercropping with five leguminous species in the western region of São Paulo State, Brazil: Produtividade do cafeeiro Mundo Novo enxertado e submetido à adubação verde antes e após recepa da lavoura. Bragantia, 65:115-120.
Reference ID: 21568
Notes: #21568e
Abstract: Yield of arabica coffee (Coffea arabica) of grafted onto robusta coffee (Coffea canephora Pierre ex Froehner) Apoatã IAC 2258 was evaluated during six years of intercropping with five leguminous species: sunn hemp (Crotalaria juncea L.), Crotalaria spectabilis Roth., dwarf velvet bean (Stizolobium deeringeanum Bort.), soybean Glycine max (L.) Merryl] and pigeon pea [Cajanus cajan (L.) Millsp.] in the Western region of São Paulo State, Brazil, from 1989 to 1995. Leguminous species were sown 50 cm away from coffee plants and incorporated into the soil flowering stage. The treatments were arranged in randomized complete block design with five replicates. Coffee yield was not affected by Crotalaria spectabili Roth, sunn hemp, dwarf velvet bean and soybean IAC 9 as interrow crop. After stamping back the trees only the Crotalaria spectabilis Roth did not affect yield. Stem diameter and yield were significantly decreased by pigeon pea intercrop. The highest amount of legume dry biomass was produced by pigeon pea and sunn hemp. Linear correlation analysis showed that coffee yield was inversely correlated with leguminous dry biomass and positively correlated with coffee stem diameter at the harvest year.

Nogueira A. M., S. P. de Carvalho, G. F. Bartholo, and A. N. G. Mendes. 2005. Vegetative vigor and yield evaluations of coffee cultivars, "Catuai Vermelho" and "Amarelo" (Coffea arabica L.) planted isolated and different combinations. Ciencia E Agrotecnologia, 29:27-33.
Reference ID: 21569
Notes: #21569e
Abstract: One experiment was conducted at EPAMIG's experimental station at Sao Sebastiao do Paraiso, MG, to evaluate yield characteristics and vegetative vigor, of "Catuai Vermelho" (IAC 44, IAC 81, and IAC 99), "Catuai Amarelo" (IAC 47, IAC 62, and IAC 86), coffee lineage cultivars from 1994 to 1999, planted isolated and in different combinations. An experimental randomized blocks design was used, with 3 replications 14 lineages combination as treatment, each plot with six plants, spaced 3.5 by 1.0 m, respectively among interrows and lines. Lineages cultivars were grouped and planted isolated and in multi-lines at proposition of 33% and 50%.

Characteristics were evaluated individually, and averages compared by Duncan test. Coffee cultivars combinations planted in multi-lines showed greater yield and greater vigor plants as compared to isolated planting. "Catua Vermelho" IAC 44 cultivar in combination with the IAC 81 and the lineage combinations of the IAC 81 and IAC 99 at 50% proportion of each, showed positive interaction by the fact of to present greater yield than when planted isolated. Take in account lineages of "Catua Amarelo", better combination was found with IAC 47 by IAC 62 at 50% proportion. There were no differences in vegetative vigor among lineages; some differences occurred is due to environment interactions with lineage.

Bertrand B., H. Etienne, C. Cilas, A. Charrier, and P. Baradat. 2005. Coffea arabica hybrid performance for yield, fertility and bean weight. Euphytica, 1441:255-262.
Reference ID: 21570
Notes: #21570e
Abstract: The performance of F1 hybrid plants derived from crosses between raditional varieties of Coffea arabica of Latin America with a "wild" collection of Sudan - Ethiopian origin were studied for yield, fertility and bean weight. Sudan Ethiopian material possesses resistance to certain diseases, and possibly, better beverage quality. The objective of this breeding programme is to widen the very narrow genetic base of Central American coffee, even while increasing quality and productivity. The hybrid plants were obtained from two factorial crosses made and evaluated in two locations. They were compared in the two field trials using the six maternal lines as controls. Observations were taken on vegetative characters, annual and cumulated yield, dry weight of 100 beans, extent of early abortion as measured by the fraction of 'peaberries' and post-zygotic ovule fertility as measured by the fraction of mature no-floating berries in water (FF). The F1 hybrid population were compared to the populations of maternal lines for the aforementioned variables. An index-based selection was done in the hybrid populations employing three traits, yield, 100-bean weight and the post-zygotic fertility (FF). The performance of the selected hybrids was then compared to those of the best parental 'control' lines in each trial. The hybrid populations yielded 22 - 47% more than the maternal lines, but hybrids showed significantly more sterility than the parental control lines. Selection in the hybrid populations using the three selected traits led to significant genetic gain for yield and dry weight of 100 beans, and insignificant gain for fertility (FF). When selected on the basis of fertility alone, increase in yield and 100-bean weight were not obtained within the hybrid populations. By applying selection on yield and 100-bean weight, the selected hybrids produced 11 - 47% higher yields than the best line along with significantly higher or identical 100-bean weight and performed identically for fertility. The yield performance of hybrids between the Latin American material and the "wild" Sudan - Ethiopian material calls for further selection effort for improving beverage quality.

dela Cruz Q. D., J. T. Lee, and N. L. Manigbas 2014. Operations Handbook: Direct Seeded and Transplanted Rice Production, Central Luzon State University, Science City of Munoz, Philippines.
Reference ID: 21571
Notes: S 8.2.1 #21571

de Carvalho L. G., G. C. Sediyama, P. R. Cecon, and H. M. R. Alves. 2004. A regression model to predict coffee productivity in Southern Minas Gerais, Brazil: Modelo de regressão para a previsão de produdividade de cafeeiros no Estado de Minas Gerais. Revista Brasileira De Engenharia Agricola e Ambiental, 8:204-211.
Reference ID: 21572
Notes: #21572e
Abstract: The objective of this work was to set up and test a multiple linear regression model applied to principal components for representative coffee crop yield series for three places in Southern Minas Gerais, based on the model proposed by Stewart et al. (1976), with new variables, represented by agrometeorological elements, besides the soil water depletion for the four quarterly periods in agricultural cycle (July to June). Since the number of observations was lower than the amount number of variables, we resorted to principal component analysis to reduce the dimension of this set of variables. The multiple linear regression analysis was applied to the first three principal components. In agreement with the tests, the model presented relative errors of estimates with high discrepancies and a tendency to overestimate productivity for the three places. However, it was verified that the estimates for the model tended to present behavior similar to observed data.

Silva C. A., L. C. A. Melo, O. J. P. Rangel, and P. T. G. Guimarães. 2004. Coffee yield and fertility attributes of a latosol under influence of population density and liming management. Ciencia E Agrotecnologia, 28:1066-1076.
Reference ID: 21573
Notes: #21573e
Abstract: The objective of this work was to evaluate the effects of coffee population density and liming management practices on the fertility attributes of a Latosol, and in the nutritional status and yield of coffee (Coffea arabica L.). The experiment was carried out from February 2000 to June 2003 in the Experimental Farm of Epamig (Sao Sebastiao do Para so, MG). The treatments tested consisted of the combination of two coffee population densities (2,857 and 10,000 plants ha(-1)) with three methods of liming management (without lime; lime incorporation at 0 to 20 cm soil layer, and surface liming). As an additional treatment, liming (0 to 20 cm) plus phosphogypsum were applied in an area with 10.000 pl ha(-1). Soil samples were collected at soil depths of 0 to 10, 10 to 20 and 20 to 40 cm, in four sampling times. The samples were analyzed for: pH, Ca and Mg exchangeable, P (Mehlich-1solution), sulfate, nitrate e ammonium, and the saturation for bases. The liming management practices reduced the acidity until the soil depth of 0 to 10 cm. Transport of lime applied at soil surface was verified only at the forth sampling. The soil fertility attributes analyzed were not influenced by coffee population density. In average, the coffee yield in the higher plant density was 14 and 33 bags ha(-1) higher than in the lower plant density, respectively in the first and second harvest seasons.

Malta M. R., F. D. Nogueira, and P. T. G. Guimarães. 2003. Chemical Composition, Yield and Quality of the Fertilized Coffee with Different Sources and Doses of Nitrogen. Ciencia E Agrotecnologia, 27:1246-1252.
Reference ID: 21574
Notes: #21574e
Abstract: This experiment was conducted to analyze the effect of nitrogen fertilization on coffee yield and quality (Coffea arabica L). The experimental design was a randomized complete-block with the split-plot scheme, in which six sources of

nitrogen (N) were used: calcionamida, potassium nitrate, calcium nitrate, ammonium sulphate, urea and ammonium nitrate in the plots combined with four doses of N (0, 80, 160 and 320 kg ha(-1)) applied in the subplots, with three replications. Yield and qualitative variables such as polyphenoloxidase activity, total titrable acidity, total sugars, total phenolic compounds, chlorogenic acids, caffeine and sensorial analysis were evaluated. There was no response of yield to N sources and doses. Coffee quality reduction was observed when calcium nitrate and ammonium nitrate were used. Regarding the doses used, the N sources presented differentiated effects on the coffee quality; however, it was observed by the analyses of the polyphenoloxidase activity, total titrable acidity, total chlorogenic acids and total phenolic compounds, that higher doses of ammonium sulphate had a negative effect on both chemical composition and quality of the grain.

Lima D. M., R. L. da Cunha, E. V. R. Von Pinho, and R. J. Guimaraes. 2003. Effect of Foliar Fertilizations at Pre And Post Blossom on the Yield and Quality of Coffee Seeds. Ciencia E Agrotecnologia, 27:1499-1505.
Reference ID: 21575
Notes: #21575e
Abstract: Use of high quality seeds is one of the primordial factors for the success of yield and among others, the nutrition of the parent plant is one of the factors which affect this characteristic. This work was intended to evaluate the influence of nutrients applied at pre and post blossom on the yield and quality of coffee seeds. The experiment was established in a crop of the cultivar Acaia at the Department of Agriculture of the UFLA. The experimental design was in randomized blocks with the following treatments: 1-2g borax/plant; 2- boric acid(0,25%) * *; 3 - boric acid(0,25%) + KCl(0,1%) * *; 4-KCl(0,1%) * *; 5-boric acid (0,25%) + Ca Cl-2 (0,05%) * *; 6- boric acid(0,25%) + Ca Cl-2(0,05%) + KCl(0,1%) * *; 7- Ca Cl-2(0,05%) * *; 8- boric acid(0,25%) + KCl(0,1%) + sugar(0,1%) + urea(0,1%) + Zn sulphate(0,3%) *; 9- treatment 8 + MAP(0,1%) *; 10- treatment 9 + Cu sulphate(0,1%) + Mn sulphate(0,1%) + Mo(0,01%) *; 11- treatment 10 + CaCl2(0,05%) *; 12- sugar(0,1%) + urea(0,1%) + Zn sulphate(0,3%) + Mg sulphate(0,1%) + MAP(0,1%) *; 13- boric acid(0,25%) + sugar(0,1%) + urea(0,1%) + Zn sulphate(0,3%) + Mg sulphate(0,1%) + MAP(0,1%) * *; 14-treatment 13 + Ca Cl-2(0,05%) * *; 15- check with no spraying. (*) A spraying after main blossom was done, (* *) two spraying, one before and the other after the main blossom; in four replicates were done. In addition to yield, seed quality was evaluated by the germination tests, germination velocity index, T-50, electric conductivity and total protein analysis by SDS-PAGE system and isoenzyme activity by the PAGE system for esterase and catalase. Treatments 5, 13, 1, 2, 6, 7, 11 and 14 provided the highest yields. No effects of the treatments on the percentage of seeds germination, germination velocity index, T50 and electric conductivity. Were found the selected biochemical markers did not detect any differences among the treatments.

Cilas C., P. Bouharmont, and A. Bar-Hen. 2003. Yield stability in Coffea canephora from diallel mating designs monitored for 14 years. Heredity, 91:528-532.
Reference ID: 21576
Notes: #21576e
Abstract: The genetic parameters of several agronomic traits were estimated in Coffea canephora in a triangular diallel with six parents and in a partial diallel with 18 parents. The yield data came from harvests obtained over 14 years divided into an initial 6-year cycle, a second cycle of 5 years after cutting back and a third cycle of 3

years after topping. Risk incidence was also observed over several years. The general combining abilities (GCA) were the principal sources of variation for the various traits considered. Parents derived from the Yangambi selections (Democratic Republic of Congo) proved to be best for yields in the three cropping cycles. The rank correlations between the GCA of the various traits indicated that first-cycle production was still not enough to predict the GCA for yield over 14 years. Susceptibility to leaf anthracnose and to drought could lead to modifications in successive classifications, with a more significant impact on production during the first cycle. The differences in susceptibility to Coffee Berry Borers had an impact on yield, which increased in line with coffee tree age. There was a rather good relation between inherent values and values in parent combinations and it was thus possible to choose parents on their own performance.

Bartholo G. F., P. T. G. Guimarães, and A. N. G. Mendes. 2003. Yield of Coffee Cultivars (Coffea Arabica L.) under Different Split-Fertilization Times. Ciencia E Agrotecnologia, 27:816-821.
Reference ID: 21577
Notes: #21577e
Abstract: The work was conducted at EPAMIG's Experimental Station in Sao Sebastiao do Paraiso, MG, to study the performance of Mundo Novo-IAC 379/19; Icatu Precoce-IAC 3282; Icatu Amarelo-IAC 2944 and Rubi-MG 1192 coffee cultivars, in relation to time and parceling out of fertilization. Cultivar responses were evaluated by yield measurements, with the results showing that this parameter was affected by time in which fertilization was made. Mundo Novo-IAC 379/19 cultivar tolerated broader intervals between the fertilizations from October to March. Icatu Amarelo-IAC 2944 response was significant to four consecutive parceling, with intervals from 30 to 40 days between applications. Icatu Precoce-IAC 3282 cultivar presented other more appropriate time options depending on the start of rainy season. Rubi-MG 1192 cultivar was not responsive to split-fertilization.

Peeters L. Y. K., L. Soto-Pinto, H. Perales, G. Montoya, and M. Ishiki. 2003. Coffee production, timber, and firewood in traditional and Inga-shaded plantations in Southern Mexico. Agriculture, Ecosystems & Environment, 95:481-493.
Reference ID:: 21578
Notes: #21578e
Abstract: Traditional Mexican coffee plantations, with a diverse shade vegetation of native tree species, are being replaced by coffee monocultures shaded by trees of the genus Inga, resulting in loss of biodiversity and ecological services. Coffee production is said to benefit from Inga shade, but few on-field experiments have been done to support this hypothesis. Secondary production (timber, firewood, fruits, medicines, etc.) is probably lower in Inga-shaded coffee plantations, and that loss could outweigh benefits from increased coffee production. Coffee yields, present stock of timber, and aboveground tree biomass as an indicator of firewood production were measured and compared for plots in traditional and in Inga-shaded plantations in Plan Paredon, Chiapas, Mexico. Coffee production was similar in both plantation types. Timber production was significantly higher in traditional plantations, and amounted to ten times the timber production in Inga-shaded plantations. Total tree biomass was significantly higher in traditional coffee plantations, but not biomass of tree species apt for firewood. However, firewood production could be higher in traditional plantations. There seems to be no reason to replace traditional

plantations by Inga-shaded ones in order to increase production in the plantations studied.

Arruda F. B. and M. A. Grande. 2003. Coffee yield response factor as related to the water deficit: Fator de resposta da produção do cafeeiro ao deficit hídrico em Campinas. Bragantia, 62:139-145.
Reference ID: 21579
Notes: #21579e
Abstract: Coffee yield response to available water is a major factor on yield prediction and irrigation feasibility. In this way, results of irrigated (Yi) and non irrigated (Yni) yields of a 16-year field experiment with coffee plants carried out in Campinas, State of São Paulo, Brazil, were analyzed as relative differences of (Yi-Yni)/Yi and correlated to the relative difference of actual evapotranspiration, (ETRi-ETRni)/ETRi. By suppressing each month of the year in that correlation, it was observed that water deficit occurred in April, May, June and July were important to yield analysis. It was possible to adjust the sensitivity coefficient (Ky) or the yield response factor to water deficit, as recommended by FAO. The annual yield response factor (Ky) showed a linear relation to plant age indicating an increase of plant sensitivity to water stress along the years.

Montagnon C., T. Leroy, C. Cilas, and A. Charrier. 2003. Heritability of Coffea canephora yield estimated from several mating designs. Euphytica, 133:209-218.
Reference ID: 21580
Notes: #21580e
Abstract: Eleven mating designs, 6 top-crosses and 5 North Carolina II, were used to estimate narrow sense, broad sense and within-cross heritability of Coffea canephora yield in Cote d'Ivoire. The objective was to predict achievable genetic gains according to different breeding strategies. Narrow sense, broad sense, family and within-cross heritabilities were 0.32, 0.43, 0.83 and 0.22, on average respectively. The percentage of additivity was high (81% on average). A degree of variation was nevertheless observed for estimates over trials. This was found to be mainly due to parent sampling in each trial. By theoretical computation, the minimum number of parents required to obtain optimum precision was found to be around 30. Predicted genetic gains for yield through clonal selection at a selection level of 1% ranged from 7 to 28% over the best hybrid in each trial, suggesting thus clones still interesting for breeders. The consequences for coffee breeding are discussed.

Wamatu J. N., E. Thomas, and H. P. Piepho. 2003. Responses of different arabica coffee (Coffea arabica L.) clones to varied environmental conditions. Euphytica, 129:175-182.
Reference ID: 21581
Notes: #21581e
Abstract: Different improved coffee arabica crosses having resistance to coffee berry disease and leaf rust, plus a standard cultivar, were grown under a range of environmental conditions in a series of field trials in Kenya. The effects of location and year of production and their interactions with the clones were determined for berry yield. These data were used to estimate and compare methods of analysis of GEI. An AMMI model, joint regression model and ANOVA with repeated measurements were used to investigate these interactions. The results indicated the relative effects of the clones and the environmental conditions, with Meru being the location where there was greatest discrimination between the clones, probably

because it was better suited for coffee. Clones, environments and joint regressions combined accounted for 31.20% of the interaction, leaving a residual of 68.80%. Significant residual mean squares showed the relationship between clones and environments not to be strictly linear, thus indicating that regression analysis did not always provide good estimates of individual clonal performance across environments. High correlations were obtained between mean yield and regression coefficients and between ecovalence and mean square deviations as well as the coefficient of determination. Results showed that the improved clones surpassed the standard cultivar both in terms of yield and stability. Different analyses of the various aspects of genotype response enabled the 21 clones to be classified into different similarity groups based on their performance and phenotypic stability as measured by various stability parameters and the use of biplots from the AMMI analysis.

Roubik, D. W. Tropical agriculture - The value of bees to the coffee harvest. Nature 417[6890], 708. 2002.
Reference ID: 21582
Notes: #21582e

Romero-Alvarado Y., L. Soto-Pinto, L. Garcia-Barrios, and J. F. Barrera-Gaytan. 2002. Coffee yields and soil nutrients under the shades of Inga sp vs. multiple species in Chiapas, Mexico. Agroforestry Systems, 54:215-224.
Reference ID: 21583
Notes: #21583e
Abstract: For many decades, simplification of traditionally shaded coffee- production systems has been an idealised model for increasing yields. In Mexico, coffee producers have been interested in replacing diverse natural shade with Inga species monocultures due to this practice having the supposed advantages of producing higher coffee yields than diverse shade. However, the effect of different shade systems on yields is little known. The purpose of this study was to evaluate the effect of two types of shaded-coffee systems on coffee yields and soil nutrient content; the first shade system is mainly dominated by Inga latibracteata Harms and the other composed of species-rich natural vegetation. The investigation took place in producer plots in the Francisco I. Madero Community, Municipality of Jitotol, Chiapas, Mexico. Collected data included species richness, shade-tree density, number of strata, tree diameter, tree height, shade-cover percentage, direct and diffused light, coffee yields, soil-nutrient concentrations (N, P, K, Ca and Mg), soil-organic matter and pH. Evaluated shade type did not have an effect on grain yield or soil nutrients. The perceived advantage of the Inga shade system is reduced weed emergence, saving farmers one annual weed-clearing. There was no significant correlation between total N and organic matter. The presence of fewer products and services in comparison to the multiple shade system was thought to be an additional disadvantage to the Inga dominated system. Organic matter in the multiple shade system correlated positively with total N. Due to its complex structure and diversity, the multiple shade system could be certified as shade or bird-friendly coffee.

Silva E. B., F. D. Nogueira, P. T. G. Guimarães, and A. E. F. Neto. 2001. Coffee tree response to potassium fertilization in low and high yields. Pesquisa Agropecuaria Brasileira, 36:1331-1337.
Reference ID: 21584
Notes: #21584e

Abstract: In order to evaluate the response of coffee trees to potassium fertilization for low and high yield, two experiments were carried out in two Oxisols of Epamig Experimental Farms, in the Minas Gerais state, Brazil. The experiments were implanted in a field crop of the cultivar Catuai Vermelho, line MG-99, which was planted six years ago at the spacing 3.5 x 0.7 m. The experiment was carried out in a randomized block design, with four repetitions in the split plot scheme. In the plots, K sources were applied: potassium chloride, potassium sulphate and potassium nitrate; and in the subplots, K doses (0, 100, 200 and 400 kg ha(-1)) were applied. Yield of processed coffee grains, available soil K (Mehlich-1) and leaf contents were determined in four crops (1995 to 1998): two crops for low yields (1995 and 1997) and two crops for high yields (1996 and 1998) in both soils. Coffee tree response to K doses was different between high and low yield. The yield alternation of coffee trees shows that critic levels of K in the soil and in the leaf contents should be obtained in high crops.

Lyngbaek A. E., R. G. Muschler, and F. L. Sinclair. 2001. Productivity and profitability of multistrata organic versus conventional coffee farms in Costa Rica. Agroforestry Systems, 53:205-213.
Reference ID: 21585
Notes: #21585e
Abstract: In areas where traditional multistrata coffee systems have been transformed to systems with patchy or no shade at all, often dependent on high chemical inputs, ecological and socioeconomic degradation has become an increasing issue. During the 1990s, rising environmental and health concerns have promoted the interest in organic production systems and their environmental services for natural resource conservation. This study compared productivity, profitability, producer-defined constraints, and goals and research priorities between ten individually paired organic and conventional coffee farms in Costa Rica. Although five of the organic farms matched or exceeded the production of their conventional counterparts, the three-year mean yield of the organic farms as a group was 22% lower than that of the conventional farms. However, excluding organic certification costs, mean variable costs and net income (NI) were similar for both groups, mainly because organic price premiums received by the farmers compensated for lower yields. If current organic certification costs are included, the price premiums paid to organic producers would have to increase to 38% in order to equal the NI from conventional coffee. Conventional farmers indentified low and unstable prices as the main constraints to sustained production and stated further intensification of production as their main goal. In contrast, the key issues for future development of the organic group centered on farm diversification, agroecological self-sufficiency, and agronomic practices that permit organic farm management.

de Toledo S. V. and I. de Barros. 1999. Influence of plant density and pruning system on the yield of coffee. Pesquisa Agropecuaria Brasileira, 34:1379-1384.
Reference ID: 21586
Notes: #21586e
Abstract: An experiment with the objective of evaluating the influence of the number of plants per hole, plant density and pruning system on the yield of the Caturra and Mundo Novo varieties of Coffea arabica L. was carried out in Campinas, SP, Brazil, during 19 years. Five planting densities were evaluated: 1, 2, 3, 5 and 6 m(2)/hole, combined with one and two plants per hole carried out without pruning; pruning at 2 m from the soil; and, plants lapped close to the soil in a regime pre-determinated by

Beaumont & Fukunaga. High planting density showed high yields in the first harvests with pronounced decrease after seven harvests. The Mundo Novo variety kept its yield potential while the Caturra variety highly decreased its yield throughout the years; the adoption of a pruning system did not influence the yield and was even prejudicial in some periods.

Silva E. B., F. D. Nogueira, P. T. G. Guimarães, S. J. D. Chagas, and L. Costa. 1999. Sources and doses of potassium on the yield and quality of green coffee. Pesquisa Agropecuaria Brasileira, 34:335-345.
Reference ID: 21587
Notes: #21587e
Abstract: A field experiment was established on a dystrophic Dusky Red Latosol of the EPAMIG experimental farm at Sao Sebastiao do Paraiso, MG, Brazil, in February 1993, with coffee (Coffea arabica L.) cultivar Catuai Vermelho, line LCH 2077-2-5-44, to study the effect of sources and doses of K on the yield and quality of green coffee. A randomized block experimental design with four replications was utilized, under a split-plot scheme, using three sources of K in the plots (KCI, I,SO, and K2SO4.2MgSO(4)) and four doses in the subplots (0, 100, 200 e 400 g hole(-1) of K). The experiment was conducted till October 1994. In 1993 and 1994 the yield, the qualitative variables of the processed grains and the contents of K, Mg, S and Cl in the leaves and grains were evaluated. There was no response of yield along two years to the sources and doses of K. For the processed grains, K,SO, increased polyphenoloxidase activity and decreased total titrable acidity in the year 1993. In 1994, the same trend to polyphenoloxidase activity and total titrable acidity was observed, showing an even higher color index and favorable response in the total sugar contents. The K,SO, promoted a best quality of green coffee.

Siqueira J. O., O. J. Saggin-Junior, W. W. Flores-Aylar, and P. T. G. Guimarães. 1998. Arbuscular mycorrhizal inoculation and superphosphate application influence plant development and yield of coffee in Brazil. Mycorrhiza, 7:293-300.
Reference ID: 21588
Notes: #21588e
Abstract: This paper reports a 6-year field study of the effects of mycorrhizal pre-colonization of coffee seedlings on initial crop development and coffee bean yield in a low-fertility Oxisol amended with superphosphate (P) at planting. The experiment included five P rates (0, 20, 40, 80 and 160 g plant(-1) P(2)O(5)) combined with seven fungal treatments [non-mycorrhizal control, pre-colonization with a mix of Glomus clarum and Gigaspora margarita (CM) and with five isolates of Glomus etunicatum]. Inoculated and non-inoculated outplants were raised under glasshouse conditions, transplanted into the field in January 1989 and monitored until July 1995. Plant height and stem diameter were greatly enhanced by P application and were higher in mycorrhizal seedlings than in controls up to 19 months after transplanting (MAT) but were not different at 26 MAT. Inoculation effects on tree canopy diameter were significant up to 26 MAT, at which time mycorrhizal colonization was high (43-55%), but did not differ amongst plants, regardless of whether or not the plants had been pre-colonized at the nursery stage. Root colonization and spore number in the soil were reduced by high P rates at 26 MAT. The first bean yield (1991) was highly enhanced by P and all pre-colonization treatments (38% increment over control) and these factors showed a significant interaction. Three isolates of G. etunicatum showed yield enhancements above 50%. The P rate for maximal yield was 207 g plant(-1) P(2)O(5) for non-pre-colonized and approximately 100 g plant(-1) for pre-

colonized plants. For this harvest, the mycorrhizal biofertilizer effect was equal to 254 kg ha(-1) P(2)O(5). In subsequent years, pre-colonization effects were reduced and inconsistent. In 1992, 1993 and 1995, yield was affected by P but not by mycorrhizal inoculation. In 1994 there was a P versus mycorrhiza interaction and CM and G. etunicatum-Var gave higher yields than non-precolonized plants. Considering accumulated yield for this 5-year period, P application resulted in high yield increment in all treatments, whereas pre-colonization effects were extremely diminished. However, despite inconsistency amongst mycorrhizal treatments, pre-colonization effects were detected at the fifth harvest in some fungal treatments. Based on the total yield of five harvests, maximal productivity was achieved with CM at 20 g plant(-1) P(2)O(5) and with CM and G. etunicatum-Var at the highest P rate. Diminishing mycorrhizal effects over time are related to colonization of non-precolonized seedlings by the indigenous fungi and to the reduced external P requirement of the mature crop. If adequate phosphorus is applied at planting, pre-colonization of outplants with selected arbuscular mycorrhizal fungi enhances early crop development and productivity of coffee in low-fertility soils of Brazil.

Baggio A. J., P. H. Caramori, A. Androcioli, and L. Montoya. 1997. Productivity of southern Brazilian coffee plantations shaded by different stockings of Grevillea robusta. Agroforestry Systems, 37:111-120.
Reference ID: 21589
Notes: #21589e
Abstract: A field experiment was conducted from 1984 to 1994 in the North of Parana State, Brazil (23 degrees 45' S, 52 degrees 30' W), to evaluate the effect of Grevillea robusta (grevillea) on interplanted coffee. Grevillea was planted in five densities (26, 34, 48, 71, and 119 trees per ha). Compared with open grown coffee, there was no decline in the yield of coffee under grevillea at densities of 26, 34, and 48 trees per ha; however, total economic productivity (including the value of both coffee and grevillea) was higher for combinations of coffee and grevillea at 34, 48, and 71 trees per ha. The severe radiative frost of June 1994 that damaged most coffee plants did not damage coffee plants interplanted under grevillea trees at densities of 71 and 119 trees per hectare.

Meinzer F., J. Ingamelis, and C. Crisosto. 1991. Carbon Isotope Discrimination Correlates With Bean Yield Of Diverse Coffee Seedling Populations. HortScience, 26:1413-1414.
Reference ID: 21590
Notes: #21590e
Abstract: Foliar C isotope discrimination (DELTA) and yield of green coffee (Coffea arabica L.) beans were evaluated for seedling populations from 14 diverse coffee cultivars growing in Hawaii. DELTA was negatively correlated with yield of green coffee beans. The 2% variation in DELTA observed in leaves sampled about 2 months after completion of the first harvest corresponded to a 3-fold variation in yield. Substantial variation in DELTA exists among coffee cultivars, and foliar DELTA-analyses show promise as a means of selecting superior genotypes of long-lived woody crops.

Aerts, R., Berecha, G., and Honnay, O. Protecting Coffee from Intensification. Science 347[6218], 139. 2015.
Reference ID: 21591
Notes: #21591e

Hajian-Forooshani Z., D. J. Gonthier, L. Marin, A. L. Iverson, and I. Perfecto. 2014. Changes in species diversity of arboreal spiders in Mexican coffee agroecosystems: untangling the web of local and landscape influences driving diversity. PeerJ, 2.
Reference ID: 21592
Notes: #21592e
Abstract: Agricultural intensification is implicated as a major driver of global biodiversity loss. Local management and landscape scale factors both influence biodiversity in agricultural systems, but there are relatively few studies to date looking at how local and landscape scales influence biodiversity in tropical agroecosystems. Understanding what drives the diversity of groups of organisms such as spiders is important from a pragmatic point of view because of the important biocontrol services they offer to agriculture. Spiders in coffee are somewhat enigmatic because of their positive or lack of response to agricultural intensification. In this study, we provide the first analysis, to our knowledge, of the arboreal spiders in the shade trees of coffee plantations. In the Soconusco region of Chiapas, Mexico we sampled across 38 sites on 9 coffee plantations. Tree and canopy connectedness were found to positively influence overall arboreal spider richness and abundance. We found that different functional groups of spiders are responding to different local and landscape factors, but overall elevation was most important variable influencing arboreal spider diversity. Our study has practical management applications that suggest having shade grown coffee offers more suitable habitat for arboreal spiders due to a variety of the characteristics of the shade trees. Our results which show consistently more diverse arboreal spider communities in lower elevations are important in light of looming global climate change. As the range of suitable elevations for coffee cultivation shrinks promoting arboreal spider diversity will be important in sustaining the viability of coffee.

Marie-Vivien D., C. A. Garcia, C. G. Kushalappa, and P. Vaast. 2014. Trademarks, Geographical Indications and Environmental Labelling to Promote Biodiversity: The Case of Agroforestry Coffee in India. Development Policy Review, 32:379-398.
Reference ID: 21593
Notes: #21593e
Abstract: The district of Kodagu, also called Coorg, in the Western Ghats of India produces 2% of the world's coffee, the expansion and intensification of which have reduced the forest cover by more than 30% in 20 years. Innovative actions are therefore urgently required to link economic development and biodiversity conservation, and stakeholders are exploring three strategies to add value to coffee from Coorg and prevent further biodiversity erosion: registration of trademarks; geographical indications; and environmental certification, via eco-labels. This article analyses their respective strengths and weaknesses and discusses the synergies between them.

Tadesse G., E. Zavaleta, C. Shennan, and M. FitzSimmons. 2014. Prospects for forest-based ecosystem services in forest-coffee mosaics as forest loss continues in southwestern Ethiopia. Applied Geography, 50: 144-151.
Reference ID: 21594
Notes: #21594e
Abstract: When natural ecosystems are degraded owing to land-use changes, humans will increasingly rely on managed landscapes for biodiversity and ecosystem services. In landscapes with ongoing forest agriculture transitions and agricultural intensification, we need to understand the impact of land-use changes on ecosystem

service provisioning and the relative roles of remnant forests and managed landscapes in ecosystem service delivery. Using socio-ecological surveys in southwest Ethiopian agro-ecosystems, we assessed the impact of land-use changes on forest-based ecosystem services and livelihoods, and the prospects for coffee agroforests to provide complementary forest-based ecosystem services. We found that over 67% of provisioning and <50% of cultural and regulating forest-based services can be provided by semi-forest and garden coffee systems. Most forest-based cultural, regulating and supporting services cannot be substituted in coffee agroforests since these services are largely concentrated in the forest remnants. The extent to which people substitute or complement those losses in coffee agroforests depends on the livelihood strategies and socio-cultural practices of local people, management intensity, and policy and demographic factors that affect agroecosystem intensification.

Berecha G., R. Aerts, K. Vandepitte, S. Van Glabeke, B. Muys, I. Roldan-Ruiz, and O. Honnay. 2014. Effects of forest management on mating patterns, pollen flow and intergenerational transfer of genetic diversity in wild Arabica coffee (Coffea arabica L.) from Afromontane rainforests. Biological Journal of the Linnean Society, 112:76-88.
Reference ID: 21595
Notes: #21595e
Abstract: Coffea arabica, the wild ancestor of all commercial Arabica coffee cultivars worldwide, is endemic to the montane rainforests of Ethiopia. These forests, which harbour the most important C. arabica gene pool, are threatened by increasing anthropogenic disturbance, potentially altering the mating patterns, pollen dispersal and maintenance of genetic diversity in C. arabica understorey populations. We genotyped 376 adult coffee shrubs and 418 progenies from three natural unmanaged, and three highly managed coffee populations, using 24 microsatellite markers. Mating system analysis of C. arabica yielded an overall multilocus outcrossing rate of 76%, which contrasts with the common knowledge that C. arabica is a predominantly selfing species. In highly managed coffee populations, paternity could be assigned to 78% of the progenies, whereas in the unmanaged natural coffee populations, only 57% of the progenies could be assigned to a father, indicating reduced long-distance pollen dispersal in managed forests. Furthermore, the fraction of selfed progenies was significantly higher in managed (23%) than unmanaged (10%) coffee forests. Finally, the lack of spatial genetic structure in all studied populations suggests high seed dispersal in unmanaged populations, and intense berry harvesting and coffee planting in the managed populations. Our results imply that in situ conservation of the wild gene pool of C. arabica must focus on limiting intensification of coffee forest management, as decreased pollen dispersal and increased selfing in C. arabica in intensively managed populations may increase the risk of genetic erosion.

Briggs H. M., I. Perfecto, and B. J. Brosi. 2013. The Role of the Agricultural Matrix: Coffee Management and Euglossine Bee (Hymenoptera: Apidae: Euglossini) Communities in Southern Mexico. Environmental Entomology, 42:1210-1217.
Reference ID: 21596
Notes: #21596e
Abstract: With growing concern surrounding global pollinator declines, it is important to understand how habitat destruction and agricultural intensification impact pollinator communities. Euglossine bees are tropical forest-dependent pollinators

responsible for pollination of both economically important crops and wild plant species. A growing body of work has focused on the effect of habitat fragmentation on euglossine bees, yet little is known about how these bees are impacted by agricultural intensification. Coffee cultivation is widespread in the tropics, and its management is conducted along a gradient of intensity, which ranges from monoculture (i.e., no shade, high inputs) to polyculture (shade overstory retained, fewer inputs). We used a landscape in Soconusco, Chiapas, Mexico, that allowed for comparison between monoculture and polyculture coffee farms, while holding distance to native habitat, as well as native habitat quality, constant. We found that habitat management influenced abundance, estimated richness, and community composition of euglossine bees. The polyculture coffee farm boasts a more similar community composition to the forest than to the monoculture coffee farm. In addition, the polyculture farm had almost double the euglossine abundance compared with the monoculture farm. Our results suggest that coffee management regimes may strongly impact euglossine communities and that less intensive polyculture approaches may mitigate species losses of this important group of pollinators.

Hylander K., S. Nemomissa, J. Delrue, and W. Enkosa. 2013. Effects of Coffee Management on Deforestation Rates and Forest Integrity. Conservation Biology, 27:1031-1040.
Reference ID: 21597
Notes: #21597e
Abstract: Knowledge about how forest margins are utilized can be crucial for a general understanding of changes in forest cover, forest structure, and biodiversity across landscapes. We studied forest-agriculture transitions in southwestern Ethiopia and hypothesized that the presence of coffee (Coffea arabica)decreases deforestation rates because of coffee's importance to local economies and its widespread occurrence in forests and forest margins. Using satellite images and elevation data, we compared changes in forest cover over 37 years (1973-2010) across elevations in 2 forest-agriculture mosaic landscapes (1100 km(2) around Bonga and 3000 km(2) in Goma-Gera). In the field in the Bonga area, we determined coffee cover and forest structure in 40 forest margins that differed in time since deforestation. Both the absolute and relative deforestation rates were lower at coffee-growing elevations compared with at higher elevations (-10/20% vs. -40/50% comparing relative rates at 1800 m asl and 2300-2500 m asl, respectively). Within the coffee-growing elevation, the proportion of sites with high coffee cover (>20%) was significantly higher in stable margins (42% of sites that had been in the same location for the entire period) than in recently changed margins (0% of sites where expansion of annual crops had changed the margin). Disturbance level and forest structure did not differ between sites with 30% or 3% coffee. However, a growing body of literature on gradients of coffee management in Ethiopia reports coffee's negative effects on abundances of forest-specialist species. Even if the presence of coffee slows down the conversion of forest to annual-crop agriculture, there is a risk that an intensification of coffee management will still threaten forest biodiversity, including the genetic diversity of wild coffee. Conservation policy for Ethiopian forests thus needs to develop strategies that acknowledge that forests without coffee production may have higher deforestation risks than forests with coffee production and that forests with coffee production often have lower biodiversity value.

Tully K. L., S. A. Wood, and D. Lawrence. 2013. Fertilizer type and species composition affect leachate nutrient concentrations in coffee agroecosystems. Agroforestry Systems, 87:1083-1100.
Reference ID: 21598
Notes: #21598e
Abstract: Intensification of coffee (Coffea arabica) production is associated with increases in inorganic fertilizer application and decreases in species diversity. Both the use of organic fertilizers and the incorporation of trees on farms can, in theory, reduce nutrient loss in comparison with intensified practices. To test this, we measured nutrient concentrations in leachate at 15 and 100 cm depths on working farms. We examined (1) organically managed coffee agroforests (38 kg N ha(-1) year(-1); n = 4), (2) conventionally managed coffee agroforests (96 kg N ha(-1) year(-1); n = 4), and (3) one conventionally managed monoculture coffee farm in Costa Rica (300 kg N ha(-1) year(-1)). Concentrations of nitrate (NO3 (-)-N) and phosphate (PO4 (3-)-P) were higher in the monoculture compared to agroforests at both depths. Nitrate concentrations were higher in conventional than organic agroforests at 15 cm only. Soil solutions collected under nitrogen (N)-fixing Erythrina poeppigiana had elevated NO3 (-)-N concentrations at 15 cm compared to Musa acuminata (banana) or Coffea. Total soil N and carbon (C) were also higher under Erythrina. This research shows that both fertilizer type and species affect concentrations of N and P in leachate in coffee agroecosystems.

Bucagu C., B. Vanlauwe, and K. E. Giller. 2013. Managing Tephrosia mulch and fertilizer to enhance coffee productivity on smallholder farms in the Eastern African Highlands. European Journal of Agronomy, 48: 29.
Reference ID: 21599
Notes: #21599e
Abstract: In Maraba, Southwest Rwanda, coffee productivity is constrained by poor soil fertility and lack of organic mulch. We investigated the potential to produce mulch by growing Tephrosia vogelii either intercropped with smallholder coffee or in arable fields outside the coffee, and the effect of the mulch on coffee yields over two years. Two accessions of T. vogelii (ex. Gisagara, Rwanda and ex. Kisumu, Kenya) were grown for six months both within and outside smallholder coffee fields in the first year. Experimental blocks were replicated across eight smallholder farms, only a single replicate per farm due to the small farm sizes. The accession from Rwanda (T. vogelii ex. Gisagara) grew more vigorously in all experiments. Soils within the coffee fields were more fertile those outside the coffee fields, presumably due to farmers' long-term management with mulch. Tephrosia grew less well in the fields outside coffee, producing only 0.6-0.7 Mg ha(-1) of biomass and adding (in kg ha(-1)) 19 N, 1 P and 6 K in the mulch. By contrast, Tephrosia intercropped with coffee, produced 1.4-1.9 Mg ha(-1) of biomass and added (in kg ha(-1)) 42-57 N, 3 P and 13-16 K in the mulch. Coffee yields were increased significantly by 400-500 kg ha(-1) only in the treatments where Tephrosia was intercropped with coffee. Soil analysis and a missing-nutrient pot experiment showed that the poor growth of Tephrosia in the fields outside coffee was due to soil acidity (aluminium toxicity) combined with deficiencies of P. K and Ca.
In the second year, the treatments in fields outside coffee were discontinued, and in the coffee intercrops, two Tephrosia accessions were grown in treatments with and without NPK fertilizer. Tephrosia grew well and produced between 2.5 and 3.8 Mg ha(-1) biomass for the two accessions when interplanted within coffee fields, adding 103-150 kg N ha(-1), 5-9 kg P ha(-1) and 24-38 kg K ha(-1). Tephrosia mulch

increased yields of coffee by 400 kg ha(-1). Combined use of NPK + Tephrosia mulch increased Tephrosia biomass production and in turn yielded an additional 300-700 kg ha(-1) of coffee. Over the two years, this was equivalent to a 23-36% increase in coffee yield using Tephrosia intercropping alone and a further 25-42% increase in coffee yield when NPK fertilizer was also added. Agronomic efficiency (AE) of nutrients added were 30% greater when the Tephrosia mulch was grown in situ and the two cultivars of Tephrosia did not differ in AE. The AE of Tephrosia mulch was 87% that of NPK fertilizer, reflecting the rapid mineralization of Tephrosia mulch. There was a synergistic effect of Tephrosia mulch on the efficiency with which NPK fertilizer was used by coffee. The increase in coffee yields was positively related to the amount of nutrients added in the Tephrosia biomass. Tephrosia intercropping required 30 man-days ha(-1) less than current farmer management due to reduced labour required for weeding, and benefit-cost ratios ranged between 3.4 and 5.5. The Tephrosia-coffee intercropping system offers great potential for agroecological intensification for smallholder farmers in the East African highlands.

Boreux V., S. Krishnan, K. G. Cheppudira, and J. Ghazoul. 2013. Impact of forest fragments on bee visits and fruit set in rain-fed and irrigated coffee agro-forests. Agriculture, Ecosystems & Environment, 172:48.
Reference ID: 21600
Notes: #21600e
Abstract: Forest fragments in agricultural landscapes are recognised to provide a variety of ecosystem services, several of which benefit neighbouring agricultural land uses. Pollination of crops is one such service that has attracted much research and public attention, yet the dependency of crops on pollinators, and the role of forest fragments in providing this service, remains contentious. Indeed, the trend towards increasing crop production through intensification is at odds with the expected concurrent decline in pollination. We investigated the combined effect of distance from forest and forest size on pollinator abundance at coffee agro-forests in Kodagu District, India, under two contrasting flowering scenarios: irrigation triggered flowering in a single agro-forest, and rain triggered flowering at all the remaining agro-forests that received rain but were not previously irrigated. Three social bee species, Apis dorsata, Apis cerana and Tetragonula iridipennis were the main flower visitors. In rain-fed agro-forests, the total visitor abundance at coffee flowers decreased with increasing distance to the nearest forest. When the three main pollinators were analysed separately, the abundances of A. dorsata and T. iridipennis decreased with increasing distance from a neighbouring forest patch but this distance effect was reduced with an increase in size of the nearby forest. An increase in pollinator abundance at coffee flowers increased coffee fruit set in rain-fed agro-forests. Irrigated agro-forests had far higher pollinator abundance and fruit set than rain-fed agro-forests. We attribute this to the small-scale staggered flowering of irrigated agro-forests resulting in the concentration of pollinators at these sites regardless of its proximity to forests or the size of nearby forest. Agro-forest shade tree species richness also negatively affected pollinator abundance in rain-fed agro-forests. Although our results show that distance to forest and size of neighbouring forest fragments do affect the abundance of pollinators at coffee, at least in rain-fed agro-forests, justifying the conservation of large forest remnants is problematic on this account as there was no direct effect of forest on coffee fruit set. This is likely to be because there remains a high density of forest remnants within Kodagu, and a threshold of forest cover at which crop fruit set begins to be affected by pollinator scarcity has yet to be reached. By controlling the timing of flowering

through irrigation or managing domesticated bee hives, farmers effectively reduce the dependency on nearby forest cover for pollinator services irrespective of the distance between forests and agro-forests, but these management practices incur costs that not every farmer can cover.

Marin L. and I. Perfecto. 2013. Spider Diversity in Coffee Agroecosystems: The Influence of Agricultural Intensification and Aggressive Ants. Environmental Entomology, 42:204-213.
Reference ID: 21601
Notes: #21601e
Abstract: Spiders are a very diverse group of invertebrate predators found in agroecosystems and natural systems. However, spider distribution, abundance, and eventually their ecological function in ecosystems can be influenced by abiotic and biotic factors such as agricultural intensification and dominant ants. Here we explore the influence of both agricultural intensification and the dominant arboreal ant Azteca instabilis on the spider community in coffee agroecosystems in southern Mexico. To measure the influence of the arboreal ant Azteca instabilis (F. Smith) on the spider community inhabiting the coffee layer of coffee agroecosystems, spiders were collected from coffee plants that were and were not patrolled by the ant in sites differing in agricultural intensification. For 2008, generalized linear mixed models showed that spider diversity was affected positively by agricultural intensification but not by the ant. However, results suggested that some spider species were associated with A. instabilis. Therefore, in 2009 we concentrated our research on the effect of A. instabilis on spider diversity and composition. For 2009, generalized linear mixed models show that spider richness and abundance per plant were significantly higher in the presence of A. instabilis. In addition, analyses of visual counts of insects and sticky traps data show that more resources were present in plants patrolled by the ant. The positive effect of A. instabilis on spiders seems to be caused by at least two mechanisms: high abundance of insects and protection against predators.

Hundera K., R. Aerts, A. Fontaine, M. Van Mechelen, P. Gijbels, O. Honnay, and B. Muys. 2013. Effects of Coffee Management Intensity on Composition, Structure, and Regeneration Status of Ethiopian Moist Evergreen Afromontane Forests. Environmental Management, 51:801-809.
Reference ID: 21602
Notes: #21602e
Abstract: The effect of arabica coffee management intensity on composition, structure, and regeneration of moist evergreen Afromontane forests was studied in three traditional coffee-management systems of southwest Ethiopia: semiplantation coffee, semiforest coffee, and forest coffee. Vegetation and environmental data were collected in 84 plots from forests varying in intensity of coffee management. After controlling for environmental variation (altitude, aspect, slope, soil nutrient availability, and soil depth), differences in woody species composition, forest structure, and regeneration potential among management systems were compared using one way analysis of variance. The study showed that intensification of forest coffee cultivation to maximize coffee production negatively affects diversity and structure of Ethiopian moist evergreen Afromontane forests. Intensification of coffee productivity starts with the conversion of forest coffee to semiforest coffee, which has significant negative effects on tree seedling abundance. Further intensification leads to the conversion of semiforest to semiplantation coffee, causing significant diversity

losses and the collapse of forest structure (decrease of stem density, basal area, crown closure, crown cover, and dominant tree height). Our study underlines the need for shade certification schemes to include variables other than canopy cover and that the loss of species diversity in intensively managed coffee systems may jeopardize the sustainability of coffee production itself through the decrease of ecosystem resilience and disruption of ecosystem services related to coffee yield, such as pollination and pest control.

Williams-Guillen K. and I. Perfecto. 2011. Ensemble Composition and Activity Levels of Insectivorous Bats in Response to Management Intensification in Coffee Agroforestry Systems. Plos One, 6.
Reference ID: 21603
Notes: #21603e
Abstract: Shade coffee plantations have received attention for their role in biodiversity conservation. Bats are among the most diverse mammalian taxa in these systems; however, previous studies of bats in coffee plantations have focused on the largely herbivorous leaf-nosed bats (Phyllostomidae). In contrast, we have virtually no information on how ensembles of aerial insectivorous bats - nearly half the Neotropical bat species - change in response to habitat modification. To evaluate the effects of agroecosystem management on insectivorous bats, we studied their diversity and activity in southern Chiapas, Mexico, a landscape dominated by coffee agroforestry. We used acoustic monitoring and live captures to characterize the insectivorous bat ensemble in forest fragments and coffee plantations differing in the structural and taxonomic complexity of shade trees. We captured bats of 12 non-phyllostomid species; acoustic monitoring revealed the presence of at least 12 more species of aerial insectivores. Richness of forest bats was the same across all land-use types; in contrast, species richness of open-space bats increased in low shade, intensively managed coffee plantations. Conversely, only forest bats demonstrated significant differences in ensemble structure (as measured by similarity indices) across land-use types. Both overall activity and feeding activity of forest bats declined significantly with increasing management intensity, while the overall activity, but not feeding activity, of open-space bats increased. We conclude that diverse shade coffee plantations in our study area serve as valuable foraging and commuting habitat for aerial insectivorous bats, and several species also commute through or forage in low shade coffee monocultures.

Hernandez-Martinez G., R. H. Manson, and A. C. Hernandez. 2009. Quantitative classification of coffee agroecosystems spanning a range of production intensities in central Veracruz, Mexico. Agriculture, Ecosystems & Environment, 134:89-98.
Reference ID: 21604
Notes: #21604e
Abstract: Coffee production has attracted considerable attention globally, due to its economic, social, and ecological importance. The capacity of coffee farms to conserve the biodiversity and environmental benefits offered by adjacent forest ecosystems varies greatly in relation to varying cultivation strategies. However descriptions of these strategies are scarce and largely qualitative in nature, thus hindering comparisons between studies. A rigorous quantitative classification of this agroecosystem was undertaken, in order to address these concerns. For this purpose, a multivariate analysis was applied, in order to analyze the changes in the biophysical structure and management of 18 coffee plantations and three fragments of montane cloud forest, spanning a wide variety of cultivation intensities in central

Veracruz, Mexico. This analysis identified five main classes of vegetation structure, ranging from sun exposed to rustic coffee plantations, with the mean height of shade trees, vertical vegetation diversity, tree richness and abundance and coffee plant density, representing the most important structural descriptors, referring to the farms studied. Analysis of the frequency and type of management practices employed (fertilization, weed and pest control) yielded three groups of farms ordered along a gradient, ranging from conventional to alternative practices. Together, these analyses yield a robust quantitative classification system for coffee farms in central Veracruz, which differs in several important ways from accepted qualitative classification schemes. As vegetation structure and management practices did not co-vary in this analysis, future studies should include standardized measurements of both dimensions used to describe coffee farms, in order to improve understanding of how intensification affects conservation potential and help to identify more sustainable production strategies.

Steffan-Dewenter I., M. Kessler, J. Barkmann, M. M. Bos, D. Buchori, S. Erasmi, H. Faust, G. Gerold, K. Glenk, S. R. Gradstein, E. Guhardja, M. Harteveld, D. Hertel, P. Hohn, M. Kappas, S. Kohler, C. Leuschner, M. Maertens, R. Marggraf, S. Migge-Kleian, J. Mogea, R. Pitopang, M. Schaefer, S. Schwarze, S. G. Sporn, A. Steingrebe, S. S. Tjitrosoedirdjo, S. Tjitrosoemito, A. Twele, R. Weber, L. Woltmann, M. Zeller, and T. Tscharntke. 2007. Tradeoffs between income, biodiversity, and ecosystem functioning during tropical rainforest conversion and agroforestry intensification. Proceedings of the National Academy of Sciences of the United States of America, 104:4973-4978.
Reference ID: 21605
Notes: #21605e
Abstract: Losses of biodiversity and ecosystem functioning due to rainforest destruction and agricultural intensification are prime concerns for science and society alike. Potentially, ecosystems show nonlinear responses to land-use intensification that would open management options with limited ecological losses but satisfying economic gains. However, multidisciplinary studies to quantify ecological losses and socioeconomic tradeoffs under different management options are rare. Here, we evaluate opposing land use strategies in cacao agroforestry in Sulawesi, Indonesia, by using data on species richness of nine plant and animal taxa, six related ecosystem functions, and on socioeconomic drivers of agroforestry expansion. Expansion of cacao cultivation by 230% in the last two decades was triggered not only by economic market mechanisms, but also by rarely considered cultural factors. Transformation from near-primary forest to agroforestry had little effect on overall species richness, but reduced plant biomass and carbon storage by approximate to 75% and species richness of forest-using species by approximate to 60%. In contrast, increased land use intensity in cacao agroforestry, coupled with a reduction in shade tree cover from 80% to 40%, caused only minor quantitative changes in biodiversity and maintained high levels of ecosystem functioning while doubling farmers' net income. However, unshaded systems further increased income by approximate to 40%, implying that current economic incentives and cultural preferences for new intensification practices put shaded systems at risk. We conclude that low-shade agroforestry provides the best available compromise between economic forces and ecological needs. Certification schemes for shade-grown crops may provide a market-based mechanism to slow down current intensification trends.

Priess J. A., M. Mimler, A. M. Klein, S. Schwarze, T. Tscharntke, and I. Steffan-Dewenter. 2007. Linking deforestation scenarios to pollination services and economic returns in coffee agroforestry systems. Ecological Applications, 17:407-417.

Reference ID: 21606

Notes: #21606e

Abstract: The ecological and economic consequences of rain forest conversion and fragmentation for biodiversity, ecosystem functioning, and ecosystem services like protection of soils, water retention, pollination, or biocontrol are poorly understood. In human-dominated tropical landscapes, forest remnants may provide ecosystem services and act as a source for beneficial organisms immigrating into adjacent annual and perennial agro-ecosystems. In this study, we use empirical data on the negative effects of increasing forest distance on both pollinator diversity and fruit set of coffee to estimate future changes in pollination services for different land use scenarios in Sulawesi, Indonesia. Spatially explicit land use simulations demonstrate that depending on the magnitude and location of ongoing forest conversion, pollination services are expected to decline continuously and thus directly reduce coffee yields by up to 18%, and net revenues per hectare up to 14% within the next two decades (compared to average yields of the year 2001). Currently, forests in the study area annually provide pollination services worth 46 Euros per hectare. However, our simulations also revealed a potential win-win constellation, in which ecological and economic values can be preserved, if patches of forests (or other natural vegetation) are maintained in the agricultural landscape, which could be a viable near future option for local farmers and regional land use planners.

Gordon C., R. Manson, J. Sundberg, and A. Cruz-Angon. 2007. Biodiversity, profitability, and vegetation structure in a Mexican coffee agroecosystern. Agriculture, Ecosystems & Environment, 118:256-266.

Reference ID: 21607

Notes: #21607e

Abstract: We studied the relationships of bird and small mammal species richness, composition, and abundance to vegetation structure and economic profitability across a coffee intensification gradient in central Veracruz, Mexico. We conducted 2 years of point count censuses for summer resident birds, 2 years of Sherman live trapping for small mammals, and gathered vegetation structure data at 147 sampling points distributed over 16 sites spanning a cultivation intensification gradient. We calculated net annual revenue per hectare as an index of profitability from economic and management data collected during interviews with plantation owners/managers. Both the species richness and abundance of forest-affiliated birds were significantly greater in floristically and structurally diverse 'bajo monte' coffee and forest compared with commercial polyculture coffee, which was, in turn, significantly richer than statistically indistinguishable specialized shade and sun coffee. Mammal capture rates were extremely low at all but two sites. Forest bird species richness and abundance were explained by multiple linear regression models that included statistically significant effects of shade cover, percent of trees with epiphytes, and canopy height. We found no clear relationship between profitability and biodiversity, with biodiverse bajo monte coffee plantations ranking among the most profitable under all price scenarios. The high profitability of biodiverse bajo monte coffee systems was not dependent on the inclusion of long-term environmental costs or premium pricing systems. Our results demonstrate that high-biodiversity coffee cultivation can be compatible with high profitability, and has significant potential for

conserving biodiversity in coffee-growing regions, but only as a substitute for low-biodiversity coffee cultivation, not forest.

Verchot L. V., L. Hutabarat, K. Hairiah, and M. van Noordwijk. 2006. Nitrogen availability and soil N(2)O emissions following conversion of forests to coffee in southern Sumatra. Global Biogeochemical Cycles, 20.
Reference ID: 21608
Notes: #21608e
Abstract: Changes in land use impact on the N cycle with both local and global consequences. We examined how conversion of forest to agriculture in one catchment in southern Sumatra altered N availability and soil N(2)O emission. Measurements were made along a chronosequence of forest land converted to coffee gardens. A number of different management practices were also examined. Inorganic N stocks and N cycling rates were highest in the forest and lower in the coffee gardens. The forest and young conversion sites appeared to be N limited, whereas the older agricultural sites and the more intensively managed sites were not as strongly N limited. N(2)O emissions were low in the forest (< 2 kgN ha(-1) yr(-1)) and increased sharply following deforestation. Emissions on recently cleared land were 4.6 kgN ha(-1) yr(-1) and 8.4 kgN ha(-1) yr(-1) in a 1-year-old coffee garden. Emissions in the older coffee gardens were lower with the lowest flux observed in a 10 year old site (1.8 kgN ha(-1) yr(-1)). We explored the effects of different types of management approaches that farmers are using in this landscape. Emissions in an 18-year-old multistrata coffee garden with a significant overstory of N fixing trees were 5 times greater (15.5 kg ha(-1) yr(-1)) than emissions from forests. We also found that intensive organic matter management produced high emissions. To understand the spatial and temporal variability of the N(2)O emissions we used the hole-in-the-pipe conceptual model. N(2)O fluxes were lowest on N limited sites. Soil water content also played an important role and emissions were highest when water filled pore space (WFPS) was between 85 and 95%. A number of formulations of this model have been applied in different ways over the years to explain spatial and temporal variation in the soil N-oxide flux, and in this study we found the mechanistic explanation useful. Our study suggests that land use change and intensification of agriculture in N limited highland landscapes may significantly increase the biosphere to atmosphere flux of N gases.

Philpott S. M., I. Perfecto, and J. Vandermeer. 2006. Effects of management intensity and season on arboreal ant diversity and abundance in coffee agroecosystems. Biodiversity and Conservation, 15:139-155.
Reference ID: 21609
Notes: #21609e
Abstract: Agricultural intensification decreases arthropod predator diversity, abundance and population stability, and may affect interactions between top predators and their arthropod prey - ultimately affecting ecosystem services. Coffee management intensification (reduction or removal of shade trees) reduces diversity of arthropod predators (ground-foraging ants). Because ants provide ecosystem services by controlling pests, influences of intensification on arboreal, coffee-foraging ant diversity and abundance are important. We here address how coffee intensification affects: (1) coffee-foraging ant diversity and abundance and (2) seasonal fluctuations in ant abundance. In each of four coffee sites of varying management intensity in Chiapas, Mexico, we sampled vegetation and using two methods, sampled ant diversity and abundance over two years. Sites significantly

differed in vegetation and management intensity. Coffee-foraging ant diversity generally decreased with increasing management intensity (16-26% fewer species observed in the most intensively-managed site). Ant abundance was higher in the wet season. Management intensity, however, did not influence ant abundance or seasonal fluctuations in abundance. Our results highlight the importance of diverse agricultural systems in maintaining arthropod predator diversity, and point to one model system in which we may effectively test how diversity per se affects ecosystem services.

Philpott S. M., S. Uno, and J. Maldonado. 2006. The importance of ants and high-shade management to coffee pollination and fruit weight in Chiapas, Mexico. Biodiversity and Conservation, 15:487-501.
Reference ID: 21610
Notes: #21610e
Abstract: Recent reports show importance of pollinators to coffee and importance of ants as pollinators or floral protectors in many systems. Arthropod and pollinator diversity, however, declines with management intensification of coffee (Coffea arabica) agroecosystems. We investigated influences of both flying pollinators and ants on coffee fruit set and fruit weight in one high-shade (high-biodiversity) and one low-shade (low-biodiversity) coffee farm in Chiapas, Mexico through exclusion experiments. Contradictory to previous reports, flying pollinators alone did not affect coffee fruit set or fruit weight. Individual fruit weights, however, were higher on branches with both ants and flying pollinators (1.78 g +/- 0.312 (SE)) compared to branches without ants (1.03 +/- 0.029) or branches without ants or flying pollinators (1.05 +/- 0.049), but only in the high-shade site. Although the mechanisms producing higher fruit weights are unknown, we discuss how ants or ant-flying pollinator interactions under high-shade coffee management may contribute to increased fruit weight and the implications of high-shade management for both sustainable coffee production and biodiversity conservation.

Gillison A. N., N. Liswanti, S. Budidarsono, M. van Noordwijk, and T. P. Tomich. 2004. Impact of cropping methods on biodiversity in coffee agroecosystems in Sumatra, Indonesia. Ecology and Society, 9.
Reference ID: 21611
Notes: #21611e
Abstract: The sustainable management of biodiversity and productivity in forested lands requires an understanding of key interactions between socioeconomic and biophysical factors and their response to environmental change. Appropriate baseline data are rarely available. As part of a broader study on biodiversity and profitability, we examined the impact of different cropping methods on biodiversity (plant species richness) along a subjectively determined land-use intensity gradient in southern Sumatra, ranging from primary and secondary forest to coffee-farming systems (simple, complex, with and without shade crops) and smallholder coffee plantings, at increasing levels of intensity. We used 24 (40 x 5 m) plots to record site physical data, including soil nutrients and soil texture together with vegetation structure, all vascular plant species, and plant functional types (PFTs-readily observable, adaptive, morphological features). Biodiversity was lowest under simple, intensive, non-shaded farming systems and increased progressively through shaded and more complex agroforests to late secondary and closed-canopy forests. The most efficient single indicators of biodiversity and soil nutrient status were PFT richness and a derived measure of plant functional complexity. Vegetation structure,

tree dry weight, and duration of the land-use type, to a lesser degree, were also highly correlated with biodiversity. Together with a vegetation, or V index, the close correspondence between these variables and soil nutrients suggests they are potentially useful indicators of coffee production and profitability across different farming systems. These findings provide a unique quantitative basis for a subsequent study of the nexus between biodiversity and profitability.

Perfecto I., A. Mas, T. Dietsch, and J. Vandermeer. 2003. Conservation of biodiversity in coffee agroecosystems: a tri-taxa comparison in southern Mexico. Biodiversity and Conservation, 12:1239-1252.
Reference ID: 21612
Notes: #21612e
Abstract: We compare species richness of birds, fruit-feeding butterflies and ground-foraging ants along a coffee intensification gradient represented by a reduction in the number of species of shade trees and percentage of shade cover in coffee plantations. We sampled the three taxa in the same plots within the same period of time. Two sites were selected in the Soconusco region of the state of Chiapas, Mexico. Within each site four habitat types were selected and within each habitat type four points were randomly selected. The habitat types were forest, rustic coffee, diverse shade coffee, and intensive coffee (low density of shade). We found different responses of the three taxa along the intensification gradient. While ants and butterflies generally decrease in species richness with the decrease of shade cover, birds declined in one site but increased in the other. Ant species richness appears to be more resistant to habitat modification, while butterfly species richness appears to be more sensitive. Bird species richness was correlated with distance from forest fragments but not with habitat type, suggesting that scale and landscape structure may be important for more mobile taxa. For each of these taxa, the rustic plantation was the one that maintained species richness most similar to the forest. We found no correlation between the three taxa, suggesting that none of these taxa are good candidates as surrogates for each other. We discuss the implications of these results for the conservation of biodiversity in coffee plantations, in particular, the importance of distinguishing between different levels of shade, and the possibility that different taxa might be responding to habitat changes at different spatial scales.

Zaal F. and R. H. Oostendorp. 2002. Explaining a miracle: Intensification and the transition towards sustainable small-scale agriculture in dryland Machakos and Kitui Districts, Kenya. World Development, 30: 1271-1287.
Reference ID: 21613
Notes: #21613e
Abstract: The transition to sustainable agriculture in tropical small-scale farming has been discussed intensively since Boserup published her theory on the role of population pressure as a leading factor. Bosernp's work challenged the Malthusian approach to rural transformation. Recent evidence supports the Boserup theory as applied to Machakos District, Kenya. This paper aims to establish how much of terracing is directly explained by population density increases as opposed to other district and village-level variables by using a retrospective multivariate analysis in Machakos and Kitui Districts. Kenya. The findings suggest that variables such as the distance to major urban markets and the windfall profits from the coffee boom in the late 1970s are at least as important in explaining the investment in the quanlity of land in Machakos and Kitui Districts.

Dorsey B. 1999. Agricultural intensification, diversification, and commercial production among smallholder coffee growers in central Kenya. Economic Geography, 75:178-195.
Reference ID: 21614
Notes: #21614e
Abstract: The research summarized in this article establishes direct links between the scale, process, and output of agricultural production by examining the dynamics of intensification, crop diversification, and commercialization. Small farm survey results from Kirinyaga District, Kenya show that diversified production provides smallholders with the opportunity to select a particular crop or crops for commercial production (such as coffee, French beans, or tomatoes) in order to increase farm-generated income while meeting increasing demands for local farm produce and export crops. The study shows that income per hectare (acre) does not consistently increase with increasing farm size, regardless of the level of commercialization. Smallholders operating at the 1.2 to 1.6 hectare (3-4 acre) scale appear to engage in higher-risk, more diversified, commercial production strategies than those with less area under production. These findings expand upon induced intensification theory and support the thesis that increased agricultural productivity results from both subsistence- and commodity-based production, though the research focuses on the latter.

Lopez-Rodriguez G., D. Sotomayor-Ramirez, J. A. Amador, and E. C. Schroder. 2015. Contribution of nitrogen from litter and soil mineralization to shade and sun coffee (Coffea arabica L.) agroecosystems. Tropical Ecology, 56:155-167.
Reference ID: 21615
Notes: #21615e
Abstract: Coffee (Coffea arabica L.) production is important for its economic, ecological and social values in tropical areas. Whether coffee is grown under shade (SHD) or full sunlight (SUN), may have a direct impact on soil nitrogen (N) cycling, which can affect yield and agroecosystem sustainability. We studied N cycling in coffee farms in three municipalities in Puerto Rico and evaluated three ecosystem types in each: SUN coffee, SHD coffee and Secondary forest (FOR). Aboveground litter dry matter and litter N inputs were quantified. Litter dry matter inputs (t ha(-1) year(-1)) were higher in SHD (2.15) and FOR (1.83), and were significantly greater than SUN (1.40). Litter N inputs (kg N ha(-1) year(-1)) were significantly lower in SUN (31) than in SHD (52) and FOR (43). Cycling of N was evaluated in detail in the municipality of Las Marias in SHD and SUN coffee. Litter N inputs (kg N ha-1 year-1) to soil were significantly different between FOR (41) and SHD (56). The standing stock of N in aboveground biomass SHD was similar to 3 times that in SUN, and total N input was twice that in SUN. However, soil N standing stocks were similar in SHD and SUN, indicating faster litter N turnover in SUN than in SHD ecosystems. By contrast, net soil N mineralization rates (kg N ha(-1) year(-1)) were similar to 2 times higher in SHD (96) than in SUN (49), indicating that soil N turnover is greater in SHD than SUN. Our results suggest that litter N is mineralized at a slower rate in SHD than in SUN, whereas soil N is mineralized at a slower rate in SUN than in SHD. Higher inputs of N to soil, and soil N turnover in SHD may result in improved coffee production and associated forest biomass N uptake. Higher soil N mineralization rates in SHD coffee. suggest improved ecosystem sustainability than in SUN coffee, presumably due to higher microbial activity, greater microbial diversity and substrate availability.

Garcia-Perez J. A., E. Alarcon-Gutierrez, Y. Perroni, and I. Barois. 2014. Earthworm communities and soil properties in shaded coffee plantations with and without application of glyphosate. Applied Soil Ecology, 83:230-237.
Reference ID: 21616
Notes: #21616e
Abstract: In central Veracruz, Mexico, many coffee plantations are managed using agrochemicals for weed control, with glyphosate-based herbicides (GBH) the most commonly used. To date, however, no studies in this region have characterized the soil biological and physicochemical properties in coffee plantations under such glyphosate application. In this study, earthworms were used as bioindicator organisms by measuring differences in the earthworm community in plots within shaded coffee plantations, with and without repeated applications of glyphosate. Differences in earthworm-induced soil processes, such as water infiltration rates, potential net carbon mineralization rates and soil physicochemical properties were also evaluated. Eight plots were selected in shaded coffee plantations; four had received regular applications of GBH over the preceding 22 years, while the other four had received no herbicides over the preceding 7 years. The earthworm species found in plots with no GBH treatment were Pontoscolex corethrurus (99%) and Amynthas corticis (1%), while A. corticis was absent in plots that had been treated with GBH. Significant differences ($P < 0.01$) in earthworm density (168 +/- 16 and 353 +/- 37 ind m(-2)) and biomass (22.7 +/- 1.1 and 45.4 +/- 6.9 gm(-2)) were observed in soils with and without GBH, respectively. No significant difference ($P=0.08$) was observed in the water infiltration rate (2 x 10(-4) +/- 4 x 10(-5) and 4 x 10(-4) +/- 1 x 10(-4) cm s(-1) with and without GBH, respectively). Soil carbon flow was greater in plots with GBH (76 +/- 7 mu g dry soil(-1) d(-1)) than in those without GBH (62 +/- 1 mu g dry soil(-1) d(-1), $P < 0.005$). Significant differences ($P < 0.05$) were found in pH and in the clay, silt and Ca content of the soil. Our findings indicated reduced species number, density and biomass of earthworms, and increased net carbon mineralization rate in plots with GBH. The plots managed with glyphosate presented a negative effect on the earthworm parameters measured, and we conclude that the earthworms therefore acted as indicators of perturbation. It is also possible that this effect could be due to factors unrelated to the glyphosate that were not considered in this study, such as chemical fertilization or legume litter spatial variability, among others.

Filho A. F. D., J. J. F. Palacin, R. J. D. Rigueira, A. Ribeiro, and E. D. Melo. 2014. Energy balance in the production of mountain coffee. Renewable and Sustainable Energy Reviews, 39:1208-1213.
Reference ID: 21617
Notes: #21617e
Abstract: Coffee culture is highly relevant in Brazilian agriculture in socioeconomic terms. The energy balance of production systems results from the subtraction of the consumed energy (MJ ha(-1)) from the produced energy (MJ ha(-1)), in any culture or system. Produced energy is understood as the transformation resulting from the production of grains or fruits, or dry matter, into energy. Consumed energy or cultural energy (MJ ha(-1)) is understood as the sum of the energy coefficients related to the fertilizers, seeds, fungicides, herbicides, insecticides, incident solar energy during the cycle and operations related to sowing, fertilization, application of products and manual harvesting. Post-harvest is considered to be the sum of the energy coefficients spent in the pre-processing and processing operations used in each treatment. The present work aimed at evaluating the energy balance in a mountain

coffee production system with emphasis on production, harvest and post-harvest. It was concluded that plants and their individual components take little advantage from the amount of energy aggregated in the energy balance (less than 0.3%).

Silva S. D. and J. S. D. Lima. 2014. Spatial Estimation of Foliar Phosphorus in Different Species of the Genus Coffea Based on Soil Properties. Revista Brasileira De Ciencia Do Solo, 38:1439-1447.
Reference ID: 21618
Notes: #21618e
Abstract: Information underlying analyses of coffee fertilization systems should consider both the soil and the nutritional status of plants. This study investigated the spatial relationship between phosphorus (P) levels in coffee plant tissues and soil chemical and physical properties. The study was performed using two arabica and one canephora coffee variety. Sampling grids were established in the areas, and the points georeferenced. The assessed properties of the soil were levels of available phosphorus (P-Mehlich), remaining phosphorus (P-rem) and particle size, and of the plant tissue, phosphorus levels (foliar P). The data were subjected to descriptive statistical analysis, correlation analysis, cluster analysis, and probability tests. Geostatistical and trend analyses were only performed for pairs of variables with significant linear correlation. The spatial variability for foliar P content was high for the variety Catuai and medium for the other evaluated plants. Unlike P-Mehlich, the variability in P-rem of the soil indicated the nutritional status of this nutrient in the plant.

Araujo L. G., C. C. de Figueiredo, I. B. Borges, M. L. G. Ramos, O. C. Rocha, and A. F. Guerra. 2014. Organic matter fractions in soil under coffee with split applications of phosphorus and water regimes. Revista Brasileira De Engenharia Agricola e Ambiental, 18:1017-1022.
Reference ID: 21619
Notes: #21619e
Abstract: Phosphorus fertilization and irrigation management are essential practices to increase coffee yields, though information is scarce about the effect of these practices on organic matter fractions of soils of the 'Cerrado' (savanna-like vegetation). The purpose of this study was to evaluate organic matter fractions of a clayey Oxisol under coffee with split applications of phosphorus (P) and water regimes. The experimental design was a randomized block with 3 x 2 factorial arrangement with three split applications of P (P1: 300 kg ha(-1) P2O5 applied annually of which 2/3 applied in September and 1/3 in December; P2: 600 kg ha(-1) P2O5 applied at planting and every two years, and P3: 1800 kg ha(-1) of P2O5 applied only at planting, corresponding to a 6-year requirement), two water regimes (with and without irrigation) and three replications. Soil from the 0-5 and 5-10 cm layers was sampled. The total organic carbon (TOC), labile carbon (LC), microbial carbon (Cmic), and carbon fractions of fulvic acid (FA), humic acid (HA) and humin (HU) were determined. The irrigation regime of coffee increased the TOC, LC and Cmic levels and the humified fractions of soil organic matter. In general, the form of P splitting had little influence on the fractions of soil organic matter.

Sousa F. A., E. B. Silva, A. T. Campos, A. M. M. Gandini, J. M. Correa, and P. H. Grazziotti. 2014. Microbial Activity and Production of Coffee Crops after Fertilization with Pig Slurry. Bioscience Journal, 30:1041-1049.
Reference ID: 21620
Notes: #21620e
Abstract: A viable alternative for the disposal of pig slurry (DLS) is the distribution as biofertilizers in soils after a suitable treatment. This study aimed to evaluate the changes in microbial attributes of a soil cultivated with coffee after application of different doses of pig slurry treated in system stabilization ponds in series. The study was conducted at Fazenda Yamaguchi in a Alfissol in Diamantina, Minas Gerais. The treatments consisted of application of 0, 125, 250, 500 kg N ha-1 in the form of effluent and 250 kg ha-1 of ammonium sulfate (conventional) on soil cultivated with coffee. Soil samples were collected at 0-10 cm depth in the following periods: before, 30, 60 and 90 days after fertilization. The production of coffee, basal respiration and microbial biomass carbon and metabolic quotient determined. Samples 60 and 90 days after fertilization showed difference from the control sample, favoring increases in biomass and microbial activity. It is observed that the application of 125 kg N ha yr-1 yr-1 DLS is the best dose for presenting production significantly to grain yield equivalent dosage of 250 kg N ha-1 year of SA. Thus, in the long term, consecutive applications of pig slurry on soil cultivated with coffee, tend to improve soil microbial attributes. The DLS can be used along with conventional fertilization for growing coffee.

USDA. Oilseeds: World Markets and Trades: Indian Soybean Meal Exports Unlikely to Recover in 2015/16. 1-36. 2015. U.S.A.
Reference ID: 21621
Notes: H 8.5.1.1 #21621e

MPOC. Global Oils & Fats Business Magazine Vol 12 Issue 2 (Apr-June) 2015. Global Oils and Fats Business Magazine 12[2], 1-43. 2015. Selangor, Malaysia, MPOC.
Reference ID: 21622
Notes: S 19 #21622

Partelli F. L., M. C. Espindula, W. B. Marre, and H. D. Vieira. 2014. Dry Matter and Macronutrient Accumulation in Fruits of Conilon Coffee with Different Ripening Cycles. Revista Brasileira De Ciencia Do Solo, 38:214-222.
Reference ID: 21623
Notes: #21623e
Abstract: The period between anthesis and fruit ripening varies according to the Conilon coffee (Coffea canephora) genotype. Therefore, the time of the nutritional requirements for fruit formation may differ, depending on the formation phase and the genotype, and may directly affect split application of fertilizer. The aim of this study was to quantify the accumulation of dry matter and N, P, K, Ca, Mg and S at several stages in the fruit of the Conilon coffee genotype with different ripening cycles, which may suggest the need for split application of fertilizer in coffee. The experiment was carried out in the municipality of Nova Venecia, Espirito Santo, Brazil, throughout the reproductive cycle. The treatments were composed of four coffee genotypes with different ripening cycles. A completely randomised experimental design was used. with five replicates. Plagiotropic branches were harvested from flowering to fruit ripening at 28-day intervals to determine the dry

matter of the fruits and the concentration and accumulation of the nutrients they contained. The behavior of dry matter and macronutrient accumulation during the study period was similar and increasing, but it differed among genotypes sampled in the same season. Early genotypes exhibited a higher speed of dry matter and nutrient accumulation. Split application of fertilizer should differ among coffee genotypes with different ripening cycles (early, intermediate, late and very late).

Reis T. H. P., A. E. F. Neto, P. T. G. Guimarães, A. F. Guerra, and C. H. C. de Oliveira. 2013. Nutritional status and foliar fractions of P in coffee plants according to phosphate fertilization: Estado nutricional e frações foliares de P no cafeeiro em função da adubação fosfatada. Pesquisa Agropecuaria Brasileira, 48:765-773.
Reference ID: 21624
Notes: #21624e
Abstract: The objective of this work was to evaluate, in the rainy and dry seasons, the nutritional status and foliar fractions of P in coffee plants, according to phosphate fertilization, and to determine their relation with coffee yield. The cultivar Rubi MG1192 of Arabic coffee was used under centralpivot, with high density (7,143 plants per ha) on Rhodic Hapludox, in the Cerrados' region. From 2002 to 2010, the following annual doses of P were used: 0, 50, 100, 200, and 400 kg ha1 P2O5. Foliar samples were taken after harvest, in July (dry season), and before grain filling stage, in December (rainy season). Foliar P contents were evaluated in 2009 and 2010, and the coffee yield, from 2008 to 2011. Coffee yield responded linearly to doses up to 400 kg ha1 of P2O5. In high yielding conditions, with high P supply, foliar ranges of P are probably different from the ones reported in literature. The reserve of inorganic phosphorus in coffee leaves increases in plants with improved P supply, which ensures greater metabolic activity of plants during periods of drought stress and enables higher productivity.

Martins L. D., M. A. Tomaz, J. F. T. Amaral, S. M. Braganca, and H. E. P. Martinez. 2013. Efficiency and response of conilon coffee clones to phosphorus fertilization. Revista Ceres, 60:406-411.
Reference ID: 21625
Notes: #21625e
Abstract: Studies on nutritional efficiency of phosphorus in conilon coffee plants are important tools to unravel the high limitation that natural low levels of this nutrient in soil impose to these species cultivars. Therefore, this study aimed at evaluating the nutritional efficiency and the response to phosphorus of conilon coffee clones. Plants were managed during 150 days in pots containing 10 dm^3 of soil, in greenhouse. A factorial scheme 13 x 2 was used, with three replications, being the factors: 13 clones constituting the clonal cultivar "Vitória Incaper 8142" and two levels of phosphate fertilization (0% and 150% of the P2O5 usualy recommended), in a completely randomized design (CRD). The results indicate a differentiated response of dry matter production and of phosphorus content on each level of phosphate fertilization for the conilon coffee clones and that CV-04, CV-05 and CV-08 clones are nutritionally efficient and responsive to the phosphate fertilization.

Jaramillo D. F. J., S. K. Sadeghian, and L. A. S. Lince. 2013. Spatial Variability of Bases in an Andisol of the Colombian Central Coffee Zone: Variabilidad Espacial De Las Bases En Un Andisol De La Zona Cafetera Central Colombiana. Boletin de Ciencias de la Tierra, 111-124.
Reference ID: 21626
Notes: #21626e
Abstract: In a coffee farm in the department of Quindío, Colombia a study of the spatial variability of bases in andisols was made, doing a sampling grid of 20 x 20 m. The base contents should have transformed to logarithm. The Ca and Mg logarithms had quadratic spatial trend, and they and the K log presented experimental semivariogram that suggest a patchy distribution. All the variables presented covariables that when included, together with the spatial trend, in the semivariogram calculation, accentuated even more the patch effect in them. Maps were drawn with different data sets and interpolation systems to assess the distribution of base contents in the lot. The three maps of Ca log and the three of Mg log were very similar among themselves and practically zoned the lot in similar way. Both maps of log K, elaborated with and without covariables, were very different and produced two different zoning. According to the obtained maps, Mg and K fertilization can be made with techniques of handling by specific site. On the other hand, with Ca there must be done an application generalized to the whole lot, based on its content average, since it has been done traditionally.

Cannavo P., J.-M. Harmand, B. Zeller, P. Vaast, J. E. Ramirez, and E. Dambrine. 2013. Low nitrogen use efficiency and high nitrate leaching in a highly fertilized Coffea arabica-Inga densiflora agroforestry system: a N-15 labeled fertilizer study. Nutrient Cycling in Agroecosystems, 95: 377-394.
Reference ID: 21627
Notes: #21627e
Abstract: In intensive cultivation of coffee (Coffea arabica L.), large N fertilizer inputs are thought to increase nitrate (NO3 (-)) water contamination and greenhouse gas emissions. This study was carried out (1) to evaluate the nitrogen use efficiency of a highly fertilized C. arabica-Inga densiflora agroforestry system on an Andosol and (2) to determine the control mechanisms of N fluxes and losses. Nitrogen pools and fluxes were monitored for one cropping season in a coffee plantation (density 4,722 plants ha(-1), height 2.1 m), shaded by regularly pruned leguminous trees (density 278 trees ha(-1); height 8 m), in the Central Valley of Costa Rica. The fate of N fertilizer (250 kg N ha(-1) year(-1)) was traced by adding N-15-urea at 1.61 kg N-15 ha(-1). The labeled urea was rapidly nitrified or immobilized in soil organic matter with 20.8 % recovered in organic form at the end of the cropping season in the top 2 m of the soil. There was high net N mineralization and nitrification in the top soil (a parts per thousand 200 kg N ha(-1) year(-1) in 0-10 cm) and up to 257 kg NO3 (-)-N ha(-1) were found in the top 2 m of the soil. Only 25.2 % (63 kg N ha(-1)) of the applied fertilizer (N-15 recovery) was taken up by the two plant species (13.5 % in the coffee plants, 9.6 % in the shade trees and 2.1 % in the litter). Total N export in the coffee fruit harvest accounted for 110 kg N ha(-1) but only 17.6 kg N ha(-1) came from the applied fertilizer (7 % of N-15 recovery). During this year of high coffee production, the coffee plant acquired most of its N from mineralized soil N rather than from N fertilizer. High fertilization resulted in a low rate of N-2 fixation by I. densiflora, estimated at 22.7 kg N ha(-1) year(-1) (Ndfa of 16.1 %). As a result of high water drainage (1,745 mm for a total rainfall of 2,678 mm), the main fate of N fertilizer was NO3 (-) leaching (33-55 % of N-15 recovery). The annual NO3 (-)-N leaching at a

depth of 120 cm was 157.2 kg N ha(-1) year(-1)(including 82.8 from applied N) and the N2O-N emission was 5.8 kg N ha(-1) year(-1). These results clearly showed that the system was N saturated, leading to low use efficiency of the N fertilizer and significant losses of N, principally through NO3 (-) leaching. This study provided an insight on how to reduce the negative environmental impact of N fertilization in intensive coffee cultivation and increase N use efficiency.

da Costa A. R., J. H. Sato, M. L. G. Ramos, C. C. de Figueiredo, G. P. de Souza, O. C. Rocha, and A. F. Guerra. 2013. Microbiological Properties and Oxidizable Organic Carbon Fractions of an Oxisol Under Coffee with Split Phosphorus Applications and Irrigation Regimes. Revista Brasileira De Ciencia Do Solo, 37:55-65.
Reference ID: 21628
Notes: #21628e
Abstract: Phosphorus fertilization and irrigation increase coffee production, but little is known about the effect of these practices on soil organic matter and soil microbiota in the Cerrado. The objective of this study was to evaluate the microbiological and oxidizable organic carbon fractions of a dystrophic Red Latossol under coffee and split phosphorus (P) applications and different irrigation regimes. The experiment was arranged in a randomized block design in a 3 x 2 factorial design with three split P applications (P1: 300 kg ha(-1) P2O5, recommended for the crop year, of which two thirds were applied in September and the third part in December; P2: 600 kg ha(-1) P2O5, applied at planting and then every two years, and P3: 1,800 kg ha(-1) P2O5, the requirement for six years, applied at once at planting), two irrigation regimes (rainfed and year-round irrigation), with three replications. The layers 0-5 and 5-10 cm were sampled to determine microbial biomass carbon (MBC), basal respiration (BR), enzyme activity of acid phosphatase, the oxidizable organic carbon fractions (F1, F2, F3, and F4), and total organic carbon (TOC). The irrigation regimes increased the levels of MBC, microbial activity and acid phosphatase, TOC and oxidizable fractions of soil organic matter under coffee. In general, the form of dividing P had little influence on the soil microbial properties and OC. Only P3 under irrigation increased the levels of MBC and acid phosphatase activity.

de Souza R. S., C. Helbel, R. Rezende, A. R. da Costa, P. S. L. de Freitas, R. V. Tavore, and A. Maller. 2013. Initial growth characteristics of two coffee cultivars under different water regimes and levels of NPK fertilization. Semina-Ciencias Agrarias, 34:3141-3152.
Reference ID: 21629
Notes: #21629e
Abstract: The experiment objectified to evaluate the effects of water regimes (irrigation and no irrigation) and fertigation, combined with fertilizer doses for N, P and K, during the initial growth phase of two coffee cultivars, Obata and IAPAR-59, in the north-western region of the state of Parana, Brazil. The experimental design was the completely randomized in a split-plot arrangement. The main plots were represented by fertilizer doses, corresponding to 15, 30, 45 and 60 g m(-1), for N and K, and to 3, 6, 9 and 12 g m(-1), for P, which are equivalent, respectively, to percentages of 50%, 100%, 150% and 200% of the dose recommended for each nutrient. The sub-plots were constituted by lines of plants that received the water regimes. Were evaluated stalk diameter, length of the first plagiotropic branch and its number of inter-knots. The treatments were analyzed separately for each cultivar of

coffee. Fertigation and irrigation favored the initial growth of both coffee cultivars. For the IAPAR-59 cultivar, the number of inter-knots was upper only with fertigation. The number of inter-knots increased with irrigation and decreased in no irrigation regime, linearly, for IAPAR-59 and Obata, respectively, in function of the NPK doses increasing. In fertigation, it was observed reduction of stalk diameter at doses higher than the lowest dose tested, for IAPAR-59, while the largest number of inter-knots was obtained with the highest dose used, for Obata.

Marchi G., V. A. Silva, L. R. G. Guilherme, J. M. Lima, F. D. Nogueira, and P. T. G. Guimarães. 2012. Potassium Extractability from Soils of Brazilian Coffee Regions. Bioscience Journal, 28:913-919.
Reference ID: 21630
Notes: #21630e
Abstract: Coffee, which is an important commodity for Brazil, is a highly K-demanding crop. Methods for recommending K fertilization to coffee crops in Brazil are based on the amount of exchangeable K. Mineralogical studies estimating K supply capacity from different soil fractions, from medium to long term, were performed in Brazilian soils, but very few studies have been carried out focusing on the use of successive chemical extractions. This study evaluated K release from whole soil, as well as clay, silt, and sand fractions of B-horizon samples of a basalt-derived Oxisol and a sienite-derived Ultisol, both representative soils from coffee regions of Minas Gerais State. Successive extractions (0 to 665 h) of K were performed with 10(-3) mol L-1 of either citrate or oxalate at 1:10 solid:solution ratio. The cumulative results were compared with forms of K (exchangeable, non-exchangeable, and total) as measured by different extraction procedures. The results showed that exchangeable K was higher, and non-exchangeable as well as total K were lower in the whole soil fraction of the Oxisol, than the K forms extracted from the Ultisol. The clay fraction was the main source of K in the Oxisol whereas the silt fraction contributed most for K supply in the Ultisol. Citrate and oxalate extracted similar amounts of K from the Oxisol, which is probably related to the fact that most of its K supply came from the exchangeable form. Citrate caused a greater release of K (part of which being from the non-exchangeable form) from the Ultisol than did oxalate. This work showed that soil texture alone is not a good indicator of K supply capacity, since for the same particle size, the studied soils revealed different K extractability.

Effgen T. A. M., R. R. Passos, F. V. Andrade, J. S. D. Lima, E. F. Reis, and E. N. Borges. 2012. Physical soil properties as a function of management in crops of conilon coffee: Propriedades físicas do solo em função de manejos em lavouras de cafeeiro conilon. Revista Ceres, 59:414-421.
Reference ID: 21631
Notes: #21631e
Abstract: Agricultural soils are subject to change in their properties, according to the type of use and management systems adopted. The objective of this study was to evaluate, in different sampling sites, the physical properties of soils cultivated with conilon coffee under different managements in the South of Espirito Santo State, Brazil. Samples were collected from the layers 0,00-0,20 m and 0,20-0,40 m in the upper part of the coffee plant canopy, in relation to the direction of the slope. Coffee crops, representative of the South of the Espirito Santo State, with the same soil class (dystrophic Red Yellow Latosol (Oxisol) hilly relief), were used for the study ,including the following managements: M1 - drip irrigation, liming every two years,

fertilization, cleared and use of the straw of conilon; M2 - manuring, cleared and weedings; M3 - weedings and mowing. For each management, the following sampling sites were evaluated: UT - upper third, MT - medium third; LT - lower third, along the slope. The physical soil properties evaluated were: bulk density, total porosity, macroporosity, microporosity and soil resistance penetration. For the experimental conditions, the soil resistance penetration, the macroporosity and microporosity important physical indicators of the quality of the soil were shown, influenced by the management, sampling site and evaluation depth.

Oberthur T., C. R. Donough, S. Cook, J. Cock, C. K. Chua, C. H. Lim, S. N. Mohanaraj, R. Lim, and S. P. Kam. 2015. Oil Palm Plantation Intelligence: Production Data Analysis for Effective Agronomic Decision Making and Fertilizer Management. Pages 1-9 18th International Oil Palm Conference, Cartagena de Indias, Colombia, 22-25th Sept 2015, Colombia.
Reference ID: 21632
Notes: H 8.1.1.6 #21632
18th International Oil Palm Conference, Cartagena de Indias, Colombia, 22-25th Sept 2015
Abstract: The oil palm industry is at a turning point. The last 2 decades of spectacular growth through land acquisition cannot go on forever. Plantation owners now face not only a lack of suitable land but also a decline inthe value of palm oil, yield ambiguity, labour shortage, and a lacklustre public image. The industry needs to find a new footing, devise better processes and do more with less. It must develop a new future for oil palm as a credible contributor to local and global food, energy, and environmental security. The promise of Plantation Intelligence is about implementing and accelerating this change through 'Big Data' generation and analysis. Oil palm production is a data-rich but information-poor activity. The industry collects vast amounts of data, but relatively little is anlysed to improve management. It is the data, however, that hold the key to better agronomic practices, better resource allocation, and better management decisions. Plantation Intelligence (PI) is an adaptive learning process based on the analysis of a large database of crop performance to achieve better yield. Some of these factors cannot be controlled, such as climate and soil, while others can be manipulated, such as fertilization and harvesting protocols. The International Plants Nutrition Institute's (IPNI) experience suggests that it is fairly straightforward for commercial plantations to adopt PI. Among the benefits are accurate assessments of performance, return-on-investment, and identification of obstacles to efficient production. In this paper we introduce the concept of PI and demonstrate how it is used to better understand oil palm response to fertilizer and the factors interacting with it, in order to identify and implement strategies for nutrient management that enhance a plantation's overall performance.

Arias R. M., G. Heredia-Abarca, V. J. Sosa, and L. E. Fuentes-Ramirez. 2012. Diversity and abundance of arbuscular mycorrhizal fungi spores under different coffee production systems and in a tropical montane cloud forest patch in Veracruz, Mexico. Agroforestry Systems, 85:179-193.
Reference ID: 21633
Notes: #21633e
Abstract: We evaluate the arbuscular mycorrhizal fungi (AMF) community as measured by spores in different coffee production systems (at the depth of 0-15 cm). In addition, we analyze the similarities between the AMF communities in coffee

production systems and those that occur in a tropical montane cloud forest patch in order to evaluate the capacity of coffee production systems to preserve the native AMF community. We carried out four samplings in five coffee production systems representative of a vegetation structure gradient, and in a forest. From 120 soil samples, 33 morphospecies were detected. In all the sites, the dominant morphospecies were and sp. 3. We found no significant difference in AMF spore richness between sites. Diversity was similar in most of the coffee production systems. Significant differences were only detected in spore abundance; during the dry season the forest, shaded traditional rustic system and shaded simple system presented the highest spore abundance. With the exception of one species exclusive to the forest, the coffee production systems all share the same AMF species as the forest. The coffee production systems with the greatest similarity to cloud forest were the shaded traditional rustic system and the shaded simple system. It is suggested that control of weeds and fertilization could be important factors influencing the composition and abundance of AMF spores in coffee production systems.

Bruno I. P., M. J. Unkovich, R. P. Bortolotto, O. O. S. Bacchi, D. Dourado-Neto, and K. Reichardt. 2011. Fertilizer nitrogen in fertigated coffee crop: Absorption changes in plant compartments over time. Field Crops Research, 124:369-377.
Reference ID: 21634
Notes: #21634e
Abstract: Nitrogen (N) dynamics in plants during their development in agricultural crops has to be well understood in order to design management practices that lead to maximum productivity with minimum N loss from the system. In a labeled fertilizer field study (15)N accumulation in different plant parts of mature coffee was observed over time. The objective was to ascertain the time of greatest crop N demand as a scientific basis for designing fertigation schedules. Coffee plantations of central Brazil are routinely fertigated only with extremely high applications of N. Good coffee bean production should be sustainable by applying lower N quantities at those frequencies designated by additional scientific criteria. The experiment was carried out over a complete coffee cropping cycle (2008/2009) in a field of low soil fertility in the Brazilian savanna "cerrado". Rates of 0, 200, 400,600 and 800 kg N ha(-1) year(-1) as (15)N-labeled urea were applied via fertigation, divided equally over the year into 26 portions, distributed every 14 days. Changes of N absorption in various plant compartments indicated that fertilizer use could be improved if a lower rate is applied only up to the beginning of fruit maturation, focusing on the stage before fruit filling. This specific stage was found to be the period of greatest N consumption by leaf and fruit. (15)N absorption data showed that it is possible to decrease the routine fertilization rate of 600 to a much lower value, of order of 200 kg N ha(-1) without decreasing the production of coffee beans.

Ferraz G. A. E. S., F. M. da Silva, F. D. Carvalho, P. A. N. da Costa, and L. C. C. Carvalho. 2011. Economic Viability of the Variable Rate Technology Compared to the Traditional System of Fertilization in a Coffee Field: A Case Study. Engenharia Agricola, 31:906-915.
Reference ID: 21635
Notes: #21635e
Abstract: The precision agriculture appears as an important tool to improve coffee field management, mainly to this culture that has high production costs. The present work intended to accomplish a comparative study of the economic feasibility of two fertilizer systems: one using the precision agriculture and other using conventional

fertilization. The data base used were extracted from the production costs of the Brejao farm, in south of Minas Gerais, in three areas (22 ha, 10.52 ha and 6.23 ha), where were applied fertilizer in variable rates in the 2007/2008 and 2008/2009 harvests. The precision agriculture was characterized by the georeferenced soil sampling and the application of phosphorus and potassium in variable rates. The conventional fertilization costs were obtained by simulations considering the traditional soil sampling performed at these areas. In order to compare the two fertilization systems, it was considered the operations and the amount of fertilizer necessary in each of the fertilization system. It was realized differences in the elements and in the amount that should be applied between the two systems. The variable rate fertilization was more profitable to the area of 22 ha and 10.52 ha in the two harvests studied and to the area of 6.23 ha was profitable (less prejudice) only to the last crop.

Gonthier D. J., J. D. Witter, A. L. Spongberg, and S. M. Philpott. 2011. Effect of nitrogen fertilization on caffeine production in coffee (Coffea arabica). Chemoecology, 21:123-130.
Reference ID: 21636
Notes: #21636e
Abstract: Nitrogen (N) based secondary metabolite production is thought to be costly to plants because N is required for growth, as well as, the synthesis of these compounds. Therefore, variation in N availability may result in variation in N-based secondary metabolite production. Here, we determine the effect of N fertilization on caffeine (N-based alkaloid) production in coffee (Coffea arabica) seedlings. A growth chamber experiment was performed with three N treatments applied to seedlings. N fertilization increased plant growth, leaf biomass, and plant N. Caffeine concentration in phloem exudates was greater in high-N fertilized plants relative to intermediate- and low-N plants. However, leaf, stem, root, and total overall caffeine concentration and content did not differ across N treatments. These results suggest caffeine in coffee is strongly regulated by genetic factors, and environment is likely less important to caffeine phenotype. This is among the first studies to investigate the effect of N fertilization on caffeine within the phloem, which has important implications for herbivores that are sensitive to caffeine and plant N and feed from the phloem of coffee.

Diaz A. P., C. A. B. Gonzalez, G. M. M. Alonso, R. A. R. Espinosa, R. V. Nuñez, and M. I. R. Castro. 2011. Nitrogen fertilization after robusta coffee pruning in Cambisols. Pesquisa Agropecuaria Brasileira, 46:935-943.
Reference ID: 21637
Notes: #21637e
Abstract: The objective of this work was to evaluate the influence of nitrogen mineral fertilization, after robusta coffee pruning, on crop yield and some chemical (pH, organic matter) and microbiological (biological gas exchange and nitrification) soil indicators in two Cambisols in Tercer Frente, Santiago de Cuba, and La Alcarraza, Holguin, during the years 2003-2007. The response to increasing doses of N (0 up to 400 kg ha(-1)), in the presence of fixed amounts of P (50 kg ha(-1)) and K (160 kg ha(-1)), was studied in a randomized block design with four replicates. To obtain coffee yields between 0.50 and 0.84 Mg ha(-1), 75 kg ha(-1) N are sufficient. In both soils, applications of 100 kg ha(-1) N allowed for coffee yields between 1.22 and 1.25 Mg ha(-1). With a dose of 153 kg ha(-1) N, 1.80 Mg ha(-1) coffee yields are obtained, whereas for yields higher than 2 Mg ha(-1), it is necessary to apply 200 kg ha(-1) N.

There was a significant coffee yield increment per each kilogram of N applied, which ranged from 2.13 to 7.80. The proposed doses per site did not affect the microbial activity or soil organic matter. There was a soil pH reduction compared to its initial stage.

Mera A. C., C. A. D. Oliveira, A. F. Guerra, and G. C. Rodrigues. 2011. Water regimes and phosphorus levels on coffee plants. Bragantia, 70:302-311.
Reference ID: 21638
Notes: #21638e
Abstract: This work aimed to study the vegetative and reproductive growth and yield of coffee plants under three water regimes and four phosphorus fertilization doses, on second year after pruning on cerrado soil. The cultivar used was Catuai Rubi, MG 1192, Coffea arabica L. with 7,143 plants ha(-1). Water regimes were: all year round irrigation (I); after June 24(th), 2007, irrigation was stopped for 70 days (SI(70)) and for 109 days (SI(109)). Treatments SI(70) e SI(109) were interrupted with a rainfall of 12 mm (October 1(st), 2007), which visually caused flowering initiation. The four phosphorus doses were: 0 (P(0)), 100 (P(100)), 200 (P(200)) e 400 (P(400)) kg of P(2)O(5) ha(-1). The experiment was arranged in randomized complete block design for water regime with phosphorus doses as split plot and three replications. The highest doses of phosphorus (P(200)) and (P(400)) provided increases in branch length, leaf area, number of fruits and grain yield. Water regimes SI(70) and SI(109) provided higher cherry fruit percentage and the highest and lowest grain yield, respectively.

do Amaral J. F. T., H. E. P. Martinez, B. G. Laviola, E. Fernandes, and C. D. Cruz. 2011. Nutrients use efficiency by coffee cultivars. Ciência Rural, 41:621-629.
Reference ID: 21639
Notes: #21639e
Abstract: To elucidate the differences in the nutritional requirements among the cultivated varieties of plant species is a form of obtaining higher productivity and to optimize the fertilizer use. This work had as objective to evaluate the root and shoot production efficiency of four arabic coffee cultivars ('Acaia IAC 474-19', 'Icatu Amarelo IAC-3282', 'Rubi MG-1192' and 'Catuai Vermelho IAC 99') per unit of N, P, K, Ca, Mg, S, B, Cu and Zn absorbed. For this purpose an experiment was carried out in field conditions at the Universidade Federal de Vicosa. The treatments were settled in a 4x3 factorial arrangement (four cultivars and three fertilization levels; low, normal and high) in randomized blocks with four replications. The plants of the normal fertilization level received fertilization based on previously determined coffee plant recruitment. The plants of the levels low and high received, respectively, 0.4 and 1.4 times the normal fertilization doses. The efficiency of production of roots was differentiated among them cultivate when there was restriction in the amount of supplied fertilizers (low level), did not have differences among them when normal and high dose of fertilizers was used. When cultivate in the low fertilization level 'Acaia IAC 474-19' presented highest efficiency to the production of roots per unit of N, P, K, Ca Mg and S absorbed, while in the some condition 'Rubi MG-1192' presented the smallest. It was concluded that efficiency of utilization of nutrients for root and shoot productions were differentiated among cultivars.

dos Reis A. R., J. L. Favarin, L. A. Gallo, M. F. Moraes, T. Tezotto, and J. Lavres. 2011. Influence of Nitrogen Fertilization on Nickel Accumulation and Chemical Composition of Coffee Plants During Fruit Development. Journal of Plant Nutrition, 34:1853-1866.
Reference ID: 21640
Notes: #21640e
Abstract: Nutritional and physiological significance of micronutrients in coffee plants, especially with regard to nickel (Ni) is still unknown. The dynamics of nitrogen (N), phosphorus (P), potassium (K) and Ni accumulation in coffee fruits, as well as their relationships with total soluble protein, amino acids, reducing sugars, and starch content during coffee fruit development (green, ripe, and dry fruits), were investigated. Coffee trees received three N fertilizer rates (0, 150, and 300 kg of N ha(-1)) as ammonium sulfate split into three applications per year. Nitrogen fertilization increased reducing sugars and starch concentrations in ripe fruits. In contrast, green fruits showed the highest amino acid and Ni concentrations. Fruit Ni concentration decreased in both green and ripe fruits as N rates increased; thus, indicating the possibility of either a N-associated dilution effect on Ni concentration or that Ni uptake by roots and/or transport to developing fruit was limiting. Plant nutritional status and fruit development stage influenced the coffee grain chemical composition. Furthermore, the variation in reducing sugars and starch content was more closely linked to the stage of fruit development than to N supply. A supposed relationship among the decreased of caffeine, starch, amino acids, and proteins with Ni content during green fruit development suggests a fundamental role for Ni in coffee fruit ripening. The interaction between N and Ni metabolism during fruit ripening might influence the chemical parameters involved in the coffee grain quality. This is the first report documenting changes in Ni concentrations of coffee fruit as a function of N fertilization rates and the development stage, but further research is needed to better understand the significance of N-Ni interaction in developing coffee fruit.

Guarconi M. A. 2011. Soil fertility characteristics as affected by close spacing of conilon coffee plants. Semina-Ciencias Agrarias, 32:949-957.
Reference ID: 21641
Notes: #21641e
Abstract: In arabica coffee crops grown at high altitudes with lower temperatures, soil fertility can be improved by condensed spacing. However, at low lands with warmer temperatures in which conilon coffee is grown, the effect of close spacing on the soil characteristics may change. Aiming to determine the effect of coffee-trees close planting grown with or without NPK fertilization on the soil fertility characteristics, soil samples were collected (0-20 and 20-40 cm depth) within four different conilon crop spacings (2,222; 3,333; 4,000; and 5,000 plants/ha). It was determined pH, H+Al, effective CEC (t), pH 7.0 CEC (T), base saturation (v), aluminum saturation (m) values and organic matter (OM), P, K, Ca(2+), Mg(2+) and Al(3+) contents. The analytical results were compared by Student t test and regression analysis. Conilon coffee-trees with close planting only changed soil fertility characteristics when coffee plants received annual NPK fertilization. Close planting substantially increased P and K contents and the T value in the upper soil layer and P and K contents and T, t and H+Al values in the lower soil layer.

Pompelli M. F., S. C. V. Martins, W. C. Antunes, A. R. M. Chaves, and F. M. DaMatta. 2010. Photosynthesis and photoprotection in coffee leaves is affected by nitrogen and light availabilities in winter conditions. Journal of Plant Physiology, 167:1052-1060.
Reference ID: 21642
Notes: #21642e
Abstract: Coffee is native to shady environments but often grows better and produces higher yields without shade, though at the expense of high fertilization inputs, particularly nitrogen (N). Potted plants were grown under full sunlight and shade (50%) conditions and were fertilized with nutrient solutions containing either 0 or 23 mM N. Measurements were made in southeastern Brazil during winter conditions, when relatively low night temperatures and high diurnal insolation are common. Overall, the net carbon assimilation rate was quite low, which was associated with diffusive, rather than biochemical, constraints. N deficiency led to decreases in the concentrations of chlorophylls (Chl) and total carotenoids as well as in the Chl/N ratio. These conditions also led to qualitative changes in the carotenoid composition, e.g., increased antheraxanthin (A) and zeaxanthin (Z) pools on a Chl basis, particularly at high light, which was linked to increased thermal dissipation of absorbed light. The variable-to-maximum fluorescence ratio at predawn decreased with increasing A + Z pools and decreased linearly with decreasing N. We showed that this ratio was inadequate for assessing photoinhibition under N limitation. Expressed per unit mass, the activities of superoxide dismutase and glutathione reductase were not altered with the treatments. In contrast, ascorbate peroxidase activity was lower in low N plants, particularly under shade, whereas catalase activity was lower in shaded plants than in sun-grown plants, regardless of the N level. Glutamine synthetase activity was greater in sun-grown plants than in shaded individuals at a given N level and decreased with decreasing N application. Our results suggest that the photoprotective and antioxidant capacity per amount of photons absorbed was up-regulated by a low N supply; nevertheless, this capacity, regardless of the light conditions, was not enough to prevent oxidative damage, as judged from the increases in the H(2)O(2) and malondialdehyde concentrations and electrolyte leakage. We demonstrated that N fertilization could adequately protect the coffee plants against photodamage independently of the anticipated positive effects of Non the photosynthetic capacity.

da Silva L., P. E. R. Marchiori, C. P. Maciel, E. C. Machado, and R. V. Ribeiro. 2010. Photosynthesis, water relations and growth of young coffee plants according to phosphorus availability. Pesquisa Agropecuaria Brasileira, 45:965-972.
Reference ID: 21643
Notes: #21643e
Abstract: The objective of this work was to evaluate how high soil phosphorus (P) availability affects the photosynthesis and growth of young coffee arabica plants (Coffea arabica) Four months old coffee seedlings of the Ouro Verde cultivar, cultivated in good hydric conditions, were exposed to three P availability treatments P dosage recommended in the literature (RP), two times the recommended dosage (P+), and without P (P-) Seventy days after treatment application, evaluations of leaf gas exchange, photochemical activity, leaf water potential, plant hydraulic conductance (K(1)), dry matter partitioning, leaf contents of pigments and carbohydrates, and leaf chemical composition were done The treatment without P caused reduction in photosynthesis, leading to lower plant growth The plants of the P+ treatment showed the highest leaf P concentrations (similar to 1 9 g kg(1)), with

increasing leaf CO(2) assimilation and instantaneous carboxylation efficiency, and higher photochemical activity - higher effective quantum efficiency of photosystem II and apparent electron transport rate - when compared to plants exposed to RP treatment Plants exposed to the double P recommended dosage exhibited higher K(1), higher leaf carbohydrate content and higher chlorophyll content, resulting in higher dry matter production as compared to RP and P.

de Lima L. M., E. A. Pozza, H. N. Torres, A. A. A. Pozza, M. Salgado, and L. H. Pfenning. 2010. Relationship between nitrogen/potassium with Phoma spot and nutrition of coffee seedlings cultivated in nutrient solution. Tropical Plant Pathology, 35:223-228.
Reference ID: 21644
Notes: #21644e
Abstract: Relationship between nitrogen/potassium with Phoma spot and nutrition of coffee seedlings cultivated in nutrient solution This work was carried out to evaluate different dosages of N and K amended through roots via nutrient solution on the intensity of Phoma spot in coffee seedlings, and to determine the dry matter and the concentration of macro and micronutrients in the aerial part of coffee seedlings inoculated with Phoma tarda. Treatments encompassed 5 dosages of K (4, 5, 6, 7 and 8 mmol/L) combined to 5 dosages of N (3, 7, 11, 15 and 19 mmol/L), in 25 treatments and three replicates. This assay was repeated three times at 20 C. By increasing the amended N, there was a linear increase of 34.8% for AUIPC (Area under incidence progress curve) and 34.3% for AUSPC (Area under severity progress curve). By increasing the K, there was a square-shaped reduction for both AUIPC and AUSPC. The dry matter of coffee seedlings increased linearly with the increase in the amended N. By increasing the amended N, a corresponding increase in shoot N content was observed. Dosages of potassium significantly influenced the N, K, Ca, S and B contents in the shoot of coffee seedlings. Thus, balanced fertilization, besides minimizing nutritional problems, can be manipulated to reduce the number of fungicide applications in this pathosystem.

Rezende R., C. Helbel Jr, R. Souza, F. M. Antunes, and J. Frizzone. 2010. Initial growth of two coffee cultivars in different hydric regimes and fertigation dosages: Crescimento inicial de duas cultivares de cafeeiro em diferentes regimes hídricos e dosagens de fertirrigação. Engenharia Agricola, 30:447-458.
Reference ID: 21645
Notes: #21645e
Abstract: The experiment was conducted at the Technical Center for Irrigation, Maringá State University. The objective was to evaluate the effects of different water regimes (irrigation and no irrigation) and fertilization-irrigation, combined with different manure doses for N (15; 30; 45 and 60 g m-1), P (3; 6; 9 and 12 g m-1) and K (15; 30; 45 and 60 g m-1), during the initial growth phase of two coffee cultivars, in the north-western region of the state of Paraná. The following culture growth variables were evaluated: top diameter, height of plant and number of total plagiotropic branches. Fertilization-irrigation and irrigation affected the initial development of coffee, increasing the values of all evaluated variables. Interaction between water regimes and fertilization-irrigation with NPK doses was significant for certain growth variables, however results didn't present a common trend, that would indicate which dose was adequate for each water regime during the initial growth phase of the coffee shrub.

do Amaral J. F. T., H. E. P. Martinez, B. G. Laviola, E. I. F. Filho, and C. D. Cruz. 2010. Bean production efficiency and relative allocation of nutrients of four coffee varieties: Eficiência na produção de frutos e alocação relativa de nutrientes em cultivares de cafeeiro. Revista Ceres, 57:253-262.
Reference ID: 21646
Notes: #21646e
Abstract: Considering the low productivity of plants in soil of lower natural fertility and the high cost of fertilizers, the selection of cultivars more efficient in the absorption and use of mineral nutrients is a necessity. Four coffee varieties were evaluated for mineral nutrient use efficiency in the production of beans, as well as the relative allocation of these nutrients in reproductive organs. The experiment was carried-out in field conditions in an experimental area of the Universidade Federal de Viçosa, Viçosa, Minas Gerais State, Brazil. The treatments were distributed in randomized blocks design, in a factorial arrangement (4 x 3) x 4, consisting of four coffee varieties (Acaiá IAC-474-19, Icatu Amarelo IAC-3282, Rubi MG-1192 and Catuaí Vermelho IAC-99), three fertilization levels (lower, adequate and high), with four replications. The plot useful area consisted of nine plants with spacing of 2 x 1 m. The variety Icatu Amarelo IAC-3282 was the most productive in the condition of low nutrient input, while Rubi MG-1192 and Catuaí Vermelho IAC-99 were more productive with high nutrient input. The production of dry coffee per unit of P, Ca, Mg and B accumulated in the plant was larger at the high fertilization level. The varieties Rubi MG-1192 and Catuaí Vermelho IAC-99 showed greater efficiency of nutrient use for production of beans at the high level of fertilization. Considering the mean of relative allocation of nutrients in the beans, of the four varieties, at the usual level of fertilization, it was found that they have 3 8.1 % of N, 46.3% of P, 40.2% of S, 42.7% of K, 13.2% of the Ca, 25.0% of Mg, 40.6% of the Cu, 19.5% of Zn and 17.7% of B.

Sotomayor-Ramirez D., J. Ramirez-Avila, E. Mas, and G. A. Martinez. 2008. Erosion and nutrient loss reduction with an alternative planting method for coffee (Coffea arabica). Journal of Agriculturre of The University of Puerto Rico, 92:153-169.
Reference ID: 21647
Notes: #21647e
Abstract: Coffee (Coffea arabica) planting in the interior mountainous region of Puerto Rico is usually performed on steep slopes after vegetation removal. The construction of individual terraces around the tree, such as the "Media Luna" planting method, prior to planting could reduce sediment and nutrient losses and could increase yields by improved on-site water and nutrient retention. Experiments were conducted to test the hypothesis that the "Media Luna" planting technique could reduce sediment, total phosphorus (TP), and total Kjeldahl nitrogen (TKN) in runoff during and after the establishment of a coffee plantation in Puerto Rico. The experiments were conducted on a commercial farm where the predominating soils were Mucara (Dystric Eutrudepts) in Phase 1, and Humatas (Typic Haplohumults) in Phase 2. In Phase 1 (recent plantings), sediment and nutrient runoff losses were similar in the conventional countour planting method and in the "Media Luna" treatments. Nutrient concentrations in runoff increased in events following fertilization. Recently loosened unconsolidated sediment material in the "Media Luna" treatment may be more susceptible to losses during the initial establishment phase. In phase 2 (mature plantings), sediment and nutrient losses were greater from soils planted with the conventional contour planting method than from those with the "Media Luna" treatment. The lower TP concentrations measured during

Phase 2 suggests that the "Media Luna" technique could be a beneficial practice for coffee production in some areas of Puerto Rico.

Santos F. D., P. E. de Souza, E. A. Pozza, J. C. Miranda, E. A. Carvalho, L. H. M. Fernandes, and A. A. A. Pozza. 2008. Organic fertilization, nutrition and the progress of brown eye spot and rust in coffee trees. Pesquisa Agropecuaria Brasileira, 43:783-791.
Reference ID: 21648
Notes: #21648e

Effgen T. A. M., R. R. Passos, J. S. D. Lima, E. N. Borges, M. C. J. D. Dardengo, and E. F. dos Reis. 2008. Chemical Soil Attributes and Productivity of Crops of Conilon Coffee Submitted the Diffetent Management in the South of the Espirito Santo State. Bioscience Journal, 24:7-18.
Reference ID: 21649
Notes: #21649e
Abstract: The work had as objective to evaluate, in different sampling site, the chemical attributes of soils cultivated with conilon coffee crops under different management. Soil samplings were taken in the depths of 0.00 - 0.20 m and 0.20 - 0.40 m at the upper part of the canopy projection of the coffee plants, in relation to the slope of the land. It was used for this study representative coffee crops of the South of the Espirito Santo State. The manuring and the liming promoted improvements in the chemical properties of the soil under management M1, (irrigation for leak, liming every two years, fertilization, mow and use of the coffee straw). The phosphorus and potassium soil content were not influenced by the sampling site, being affected only for the management employed. Independently of the sampling site, management and evaluation depths the calcium and magnesium content in the soil were below of the levels considered appropriate for the coffee conilon, indicating the need of the use of the practice of the liming. The return of the coffee straw in the crop under management M1 contributed to the increase of the content of COT and CTC in the depth of 0.00 - 0.20 m of the soil. The largest yield of the coffee was observed in the culture management M1 and in the upper third. The results reflect the importance of the soil analysis for the evaluation of the chemical conditions of the soil under cultivation with conilon coffee.

de Godoy L. J. G., T. D. Santos, R. L. V. Boas, and J. B. Leite. 2008. Relative chlorophyll index and nitrogen status of fertigated coffee plants during the crop season. Revista Brasileira De Ciencia Do Solo, 32:217-226.
Reference ID: 21650
Notes: #21650e
Abstract: The chlorophyll meter (SPAD-502, Minolta) is a portable device that measures the relative chlorophyll index (RCI) in a simple, fast and non-destructive way in the field. This index is correlated with leaf N concentration in several crops, and allows the correction of N deficiency, optimizing fertigation. The objective of this study was to test RCI as an indicator of the nitrogen status in coffee trees to adjust fertigation during the development cycle. The experiment was carried out in Botucatu, state of Sao Paulo, Brazil, in an area with two-year old coffee plants of cultivar "Red Catuai", spaced at 2.5 x 0. 8 m, under drip irrigation. The experiment had a randomized block design with four replications and five treatments: control treatment under irrigation and without fertilization, and four N rates using fertigation with 33, 66, 100, and 133 % of the recommended annual N rate (52.8, 105.6, 160. 0

and 212.7 kg ha(-1), respectively). The fertilizer treatments were split in weakly applications. The RCI increased linearly with the N rates and the yield was significantly correlated with RCI, from flowering to harvest. However, there was no correlation between beans yield with the leaf N concentration. The RCIs of high yielding coffee plants were 81.5-83.2 (flowering and beginning of fruit filling), 76.2-78.3 (fruit expansion) 68.3 - 69.8 (beginning of grain formation), 64.0-65.9 (during grain formation) and 61.7-62.7 SPAD units (grain maturation). The chlorophyll meter can be used throughout the coffee development cycle to define the likelihood of N response in coffee trees.

Favarin J. L., G. C. Vitti, D. D. Neto, J. L. Favarin, and P. R. Salgado. 2007. Relationship between zinc content in coffee plants and soil availability according to the soil extractant. Revista Brasileira De Ciencia Do Solo, 31:1191-1196.
Reference ID: 21651
Notes: #21651e
Abstract: Two species of coffee (Coffea arabica L. and Coffea canephora Pierre) are cultivated in Brazil, but most research on Zn fertilization to date has focused on C. arabica. This study was carried out to determine the functional relationship between soil Zn availability determined by DTPA and Mehlich-1 extractors and Zn content in coffee plants belonging to the species C. arabica, cv. Mundo Novo IAC 379-19 (MN) and C. canephora, cv. Apoata IAC 2258 (AP), as well as grafted plants (MN/AP). The treatments were a 3 x 3 factorial combination of cultivars (MN, AP and MN/AP) and Zn doses (0, 10 and 20 mg dm(-3)). The plant Zn content, in relation to soil Zn availability, does not depend on the extractant, but varies with the coffee species or grafted species combination. The DTPA and Mehlich-1 extractants were similarly efficient to quantify the soil Zn availability, independent of the coffee species (C. arabica and C. canephora). Zn uptake peaked at soil Zn contents of 5.6 mg dm(-3) (DTPA) and 6.6 mg dm(-3) (Mehlich-1) for Mundo Novo (C. arabica) cultivar. Based on the Zn doses employed in the present study, the maximum Zn uptake of C. canephora (cv. Apoata) and grafted plants (MN/AP) could not be determined, independently of the soil extractants.

Augusto H. S., H. E. P. Martinez, N. F. Sampaio, C. D. Cruz, and A. W. Pedrosa. 2007. Foliar nutrient contents in cultivars of Coffea arabica L. at condensed spacings. Ciencia E Agrotecnologia, 31:973-981.
Reference ID: 21652
Notes: #21652e
Abstract: Coffee-tree condensed plantings provide reduction in the loss of the soil nutrients by erosion, lixiviation and oxidation of the organic matter, and even increase nutrient recycling. This experiment aimed evaluates the influence of different spacing among rows on the nutrient foliar contents of coffee-tree varieties, and was performed in randomized blocks with 24 treatments and six replications. The employed varieties IAC 44, IAC 99, MG 1192, Katipo, MG 6851 and UFV 3880 were planted with a spacing of 0,75 m among plants and 1,0; 1,5; 2,0 and 2,5m among rows. Each plot was composed of 4 rows of 4,50 m of length, being the evaluations realized in two inner rows. At the beginning of the experiment the soil was plowed for incorporation of the limestone. The seedlings were planted in holes of 0,30 x 0,30 x 0,40 m. At the planting each hole received 200g of Natural Phosphate of Araxa, 50g of Simple Super phosphate. 15 days after the planting each plant received 2 L/hole of cattle manure. The reminded fertilizations were made according to the usual procedures for coffee-plant orchards. Samples of leaves were

collected and analyzed to determine the macro and micronutrient contents 21 and 34 months after planting. It was concluded that the condensed planting influenced the foliar contents of P, K and Mg 34 months after the panting.

Laviola B. G., H. E. P. Martinez, R. B. de Souza, and V. H. Alvarez. 2007. Dynamics of calcium and magnesium in leaves and fruits of Arabic coffee. Revista Brasileira De Ciencia Do Solo, 31:319-329.
Reference ID: 21653
Notes: #21653e
Abstract: Knowledge on mineral nutrient dynamics in coffee trees is important to identify the period of greatest nutritional requirement by the plant, allowing the improvement of fertilization techniques. The aim of our research was to study Ca and Mg dynamics in coffee fruits from anthesis to maturation and compare it with the dynamics of the same elements in leaves of productive branch leaves. The experiment was carried out with three Arabic coffee varieties (Catuai Vermelho IAC-99, Rubi MG-1192 and Acaia IAC-474-19) in three independent trials (low, sufficient and high fertilizer levels), arranged in randomized blocks with two replications using a split-plot scheme in time. The varieties presented the highest Ca and Mg fruit concentrations in the initial growth stage and decreasing concentrations in the stages of fast fruit expansion. In the stages of ceasing fruit growth and fruit formation-maturation little or no variation was observed in the Ca and Mg fruit concentrations. In the 3rd and 4th pair of leaves of the productive branches Ca and Mg concentrations decreased in the beginning of the reproductive period and recovered afterwards. In general, the fertilization levels influenced the Ca and Mg concentration in fruits and leaves of the varieties of Arabic coffee plant throughout the reproductive period. However, Ca and Mg concentrations in leaves and fruits were not only influenced by the fertilizer levels, but by other factors as well that determine the distribution rate of the mineral elements in the coffee plants, such as fruit load.

Rodrigues L. A., H. E. P. Martinez, J. C. L. Neves, R. F. Novais, and S. M. de Mendonca. 2006. Nutritional response of Catuai and Icato coffee plants to soil subsurface liming. Revista Brasileira De Ciencia Do Solo, 30:985-995.
Reference ID: 21654
Notes: #21654e
Abstract: The Ca/Al ratio is determinant for root deepening in the soil subsurface layer. Liming this layer can improve root growth and nutrient absorption. Thus, a greenhouse trial was carried out using soil columns. Two varieties of coffee plants (Catuai and Icatu), one Al-sensitive and the other Al-tolerant, respectively, were evaluated in limed and surface-fertilized soil, whereas 0.0; 0.49, 1.7, 2.9; 4. 1; 6.6 and 9.3 t ha(-1) of limestone were applied to the subsurface soil. Plants were cultivated for 6.5 months in soil accommodated in PVC columns, subdivided in three rings. In the two lower rings Al saturation varied from 0 to 93%. Limestone application in the subsurface raised the Ca and Mg contents in the shoot and roots, and P concentration in the upper leaves of both varieties. Following subsurface limestone application, Ca utilization efficiency decreased for both varieties, by the shoot as well as by roots. The P utilization efficiency by the shoot decreased only in the Icatu variety. Subsurface limestone application reduced the Al content in the aerial part of Icatu and in Catuai roots. The leaf concentration of P, Ca and Mg remained at adequate levels in both varieties, indicating that fertilization and acidity

correction of the surface soil layers were efficient at maintaining the plant nutrient levels, independent of Al levels in the soil subsurface.

Alvarez V. V. H., L. E. Dias, P. B. Leite, R. B. de Souza, and E. S. Ribeiro. 2006. Root pruning and fertilization for growth of coffee plants cultivated in soil columns. Revista Brasileira De Ciencia Do Solo, 30:111-119.
Reference ID: 21655
Notes: #21655e
Abstract: The effects of soil fertility levels, root pruning and localized fertilization on root and shoot growth in 'Catuai' coffee plants were studied in a greenhouse experiment. Sub-superficial (30-70 cm) samples of a Red-Yellow Latosol (Oxisol) were packed in PVC columns consisting of three 15 cm high rings of 20 cm diameter. Four treatments with three fertility levels [low (FB), medium (FM) and high (FA), and medium without root pruning with only two rings (FM2)] were installed before planting by adding three levels of liming and three doses of poultry manure. The P and K doses at planting were applied in inverse amounts of the soil fertility levels. After eight months of cultivation, the lowest ring was removed, and roots were pruned. This ring was replaced by another one filled with soil with four fertilization rates [low (AB), medium (AM), medium plus poultry manure (AM2) and high (AA)], representing localized fertilization. After 17 months of cultivation the shoot and root system were evaluated. Plant height and number of branches decreased with the level of soil fertility, due to the lower P and K doses applied along the increasing fertility level. The same trend was observed for shoot dry matter production, but root system growth was not affected. Growth and dry matter production of shoots and roots was not affected by root pruning, except when poultry manure was applied in localized fertilization at medium fertility level, at which a negative effect was observed. The localized fertilization had no affect on shoot and root growth in the FB pots, but caused positive and quadratic effects in the FM pots and a linear increase in the growth of 'Catuai' coffee plants for the FA treatment. The results showed that planting fertilization as a function of the fertility level was sufficient for FB, balanced for FM and insufficient for FA.

Tristão F. S. M., S. A. L. de Andrade, and A. P. D. da Silvera. 2006. Arbuscular mycorrhizal fungi on the development of coffee plantlets using different organic substrates: Fungos micorrízicos arbusculares na formação de mudas de cafeeiro, em substratos orgânicos comerciais. Bragantia, 65:649-658.
Reference ID: 21656
Notes: #21656e
Abstract: A greenhouse experiment with an alleatory factorial 9 x 4 scheme was carried out to evaluate the effects of different substrates and species of arbuscular mycorrhizal fungi (AMF) on the development of coffee plants, cultivar Catuaí Amarelo, IAC 62. Nine substrates were used: seven commercial organic substrates - four substrates containing composted pinus peel (Rendmax, fertilized Vida Verde, non- fertilized Vida Verde and Terra do Paraíso), three containing coconut fiber (Golden Mix-11, Golden Mix- 47 and Golden Mix 80) and two using soil - a mixture of 70% soil and 30% cattle manure, usually used by the producer, and soil alone. The AMF were Glomus intraradices, Glomus etunicatum and Gigaspora margarita, and a control without AMF inoculation. The plants were harvested 200 days after transplanting and the following variables were analyzed - height, number of leaves, stem diameter, shoot dry weight, root fresh weight, shoot P content, mycorrhizal colonization, total extraradical mycelium, acid phosphatase activity and

photosynthetic pigments. Better plant growth conditions were obtained in the substrate Vida Verde without fertilization, regardless of mycorrhiza. Plants colonized by G. margarita and cultivated in the conventional substrate (soil + manure) and Vida Verde with fertilization showed higher P amounts and index of P utilization efficiency, which reverted in better growth and biomass production, resulting in higher symbiotic efficiency. Mycorrhizal plants, cultivated in soil + manure, showed higher chlorophyll values and lower acid phosphatase activity in coffee leaves.

Ricci M. D. S., B. J. R. Alves, S. C. de Miranda, and F. F. de Oliveira. 2005. Growth rate and nutritional status of an organic coffee cropping system. Scientia Agricola, 62:138-144.
Reference ID: 21657
Notes: #21657e
Abstract: In view of the low N concentration in organic fertilizers, it is necessary to use high rates of such fertilizers to attend coffee crop requirements. Hence, N is the most limiting nutrient for organic coffee production. The objective of this work was to evaluate the influence of sunn hemp (Crotalaria juncea) organic fertilization on the growth and nutritional status of coffee cultivars, as well as to quantify plant biomass and N input derived from biological nitrogen fixation, and their effect on soil chemical characteristics. The experiment consisted of six coffee (Coffea arabica) cultivars intercropped with and without sunn hemp sown in November 2001 and pruned at mid-height 76 days later. At 175 days, the standing biomass of the legume was cut, measuring dry mass, total N, P, K, Ca, Mg, and N-15 natural abundance, resulting 16 t ha(-1) of dry mass and the recycling of 444, 21, 241, 19 1, and 44 kg ha(-1) of N, P, K, Ca, and Mg, respectively. Cultivars 'Obata' and 'Catuai Vermelho' presented the highest growth rates in terms of plant height, while cultivars 'Icatu' and 'Oeiras' presented the lowest rates. Biological nitrogen fixation associated to the legurne introduced more than 200 kg ha(-1) of N, which is a demonstration that N fertilization in organic cropping systems is a valuable alternative. Intercropping lead to a constant coffee leaf N content during the entire cropping cycle, contrary to what was observed in plots grown without sunn hemp.

Martins D. R., O. A. de Camargo, and O. C. Bataglia. 2005. Bean and beverage quality in coffee crops treated with sewage sludge: Qualidade do grão e da bebida em cafeeiros tratados com lodo de esgoto. Bragantia, 64:115-126.
Reference ID: 21658
Notes: #21658e
Abstract: The objective of this study was to evaluate the effect of the application of sewage sludge (LE) in a commercial coffee crop on the quality of the beverage as evaluated by the activity the enzyme of polyphenoloxidase (PPO) and sensory analysis. The work was carried out under commercial field conditions at the Santa Eliza Farm, Patrocínio Paulista, State of São Paulo, Brazil, in 2001 and 2002 with coffee cultivar Acaiá, groupped in six treatments according to the dose and frequency of application of the sewage sludge. All plots received mineral fertilization according to soil analysis and to the different treatments as follow: treatment 1: plots B2, B3, B4 and B5, without sludge; treatment 2: plots C5 and C6, 9.0 t ha-1 of LE (1998), 4.8 t ha-1 (1999) ,11.8 t ha-1 (2000) and 4.2 t ha-1 (2002); treatment 3: plots D5 and D6, 9.0 t ha-1 of LE (1998), 4.8 t ha-1 (1999), 11.8 t ha-1 (2000) and 4.2 t ha-1 (2002); treatment 4: plots E1 and E2, 9.0 t ha-1 of LE (1998) and 4.2 t ha-1 (2002); treatment 5: plots E3 and E4, 9.0 t ha-1 of LE (1998), 4.8 t ha-1 (1999) and 4.2 t ha-1 (2002); treatment 6: plots H1, H2, H3, H4 and H5, 22.4 t ha-1 (1999).

Visual analysis of the beans was performed regarding to type and size. Beverage quality was evaluated by cup test and by PPO activity. Sewage sludge had no effect on the quality of the beverage. There was low agreement between the classifications obtained according to PPO activity and that of the cup test for the two years.

Prezotti L. C. and A. C. da Rocha. 2004. Coffee nutrition as a function of plant density and NPK fertilization: Nutrição do cafeeiro arábica em função da densidade de plantas e da fertilização com NPK. Bragantia, 63:239-251.
Reference ID: 21659
Notes: #21659e
Abstract: Although increasing in productivity, high-density tree planting provides reduction of the production per plant, increases the efficiency of recovery of nutrients by plants, and can contributes to the reduction of the amount of fertilizers to be applied per plant. Due to evaluate the answer of coffee tree plants (Coffea arabica L.) to N (100, 300, 500 e 700 kg.ha-1 of N); P (0, 60, 120 and 180 kg.ha-1 of P2O5) and K (100, 300, 500 and 700 kg.ha-1 of K2O) application, on work was carried out in a coffee cultivated at four densities (3,333; 5,000; 10,000 and 20,000 plants/ha). Database obtained at five harvests showed no significant differences of productivity as function of planting densities. Answers in productivity were obtained more strongly related to N and P doses. Answers to K application were less expressive. N and P foliar levels were little influenced by the doses of N and P2O5 applied by soil each year. K foliar levels were strongly influenced by the doses of K2O. Foliar levels of N and K were highest in coffee high-density tree when compared with those cultivated in wider spacing. The major variation on chemical soil characteristics was the highest levels of reduction on H+Al observed in coffee high-density tree coffee.

Silva E. B., F. D. Nogueira, and P. T. G. Guimarães. 2003. Nutritional status of coffee tree evaluated by DRIS in response to potassium fertilization. Revista Brasileira De Ciencia Do Solo, 27:247-255.
Reference ID: 21660
Notes: #21660e
Abstract: Two field experiments were conducted on two experimental EPAMIG Farms (Minas Gerias State), in order to evaluate the nutritional coffee status by the nutritional balance index (NBI) supplied by DRIS in response to potassium fertilization. The experimental design was a split plot scheme of randomized blocks, carried out on a Red Latosol distroferric (RLdf)9 of Sao Sebastiao do Paraiso and a Yellow Red Latosol distrofic (YRLd) of Patrocinio. Three K sources were applied in the plots: potassium chloride (KCl), potassium sulfate (K2SO4), and potassium nitrate (KNO3), and four K doses (0, 100, 200, and 400 kg ha(-1)) in the subplots, with four repetitions. Yield and leaf nutrient contents were observed from 1,995 to 1998 for the calculation of DRIS for a diagnosis of the nutritional state of the coffee plant, and of the grain quality (measured by polyphenyloxidase enzyme activity). The response to potassium fertilization was consistently evaluated by the nutritional state diagnosis of the coffee tree with DRIS, as grain yields were more intensely influenced by the nutrient excess of the applied sources than the coffee beverage quality.

Malavolta E., J. L. Favarin, M. Malavolta, C. P. Cabral, and R. Heinrichs. 2002. Nutrients repartition in the coffee branches, leaves and flowers. Pesquisa Agropecuaria Brasileira, 37:1017-1022.
Reference ID: 21661
Notes: #21661e
Abstract: The nutrients repartition in the coffee (Coffea arabica L.) branches, leaves and flowers were studied at anthesis of the first reproductive phase for Mundo Novo IAC 388-17 cultivar grafted on Apoata IAC 2258 (4,000 plants ha(-1)) and Catuai Amarelo IAC 62 (5,000 plants ha(-1)) cultivars. At flowering, the reproductive branches were collected using its median third part computing 37 and 29 flowering branches of Mundo Novo and Catuai Amarelo cultivars, respectively, where the flowers, leaves and branches were separated. The coffee flowers are an important physiological drain of nutrients, changeable among cultivars; the nutrients accumulation by Mundo Novo and Catuai Amarelo cultivars was verified before the anthesis, at the beginning of Spring season, and the total Mg extraction by flowers represents 52% of the flowers, leaves and branches extraction, indicating that the coffee fertilization must initiate before flowering phase.

Silva E. B., F. D. Nogueira, and P. T. G. Guimarães. 2002. Potassium fertilization and the quality of processed coffee beans: Qualidade de grãos de café beneficiados em resposta à adubação potássica. Scientia Agricola, 59:173-179.
Reference ID: 21662
Notes: #21662e
Abstract: Climate and soil strongly influence the quality of processed coffee (Coffea arabica L.) beans. This work studied the influence of potassium fertilization on the quality of processed coffee beans grown on two Oxisols (Rhodic Acrudox and Xanthic Acrustox). Trials were set up in a completely randomized split plot block design, to test the influence of three sources and four potassium rates - potassium chloride (KCl), potassium sulphate (K2SO4) and potassium nitrate (KNO3) at 0; 100; 200 and 400 kg ha-1, applied to plants of cv. Catuaí Vermelho (3.5 x 0.7 m; one plant per hole), on the enzyme activity of poliphenyloxidase, coloration index and total sugars of processed coffee beans. The quality of beans grown under K2SO4 and KNO3 fertilization was better than that of beans grown under KCl fertilization; results of K2SO4 and KNO3 fertilizations were significantly better for the Rhodic Acrudox. Best grain quality was observed for the application of 200 kg K ha-1 as KCl and K2SO4 and 100 kg K ha-1 as KNO3.

Ramalho J. C., T. L. Pons, H. W. Groeneveld, H. G. Azinheira, and M. A. Nunes. 2000. Photosynthetic acclimation to high light conditions in mature leaves of Coffea arabica L.: role of xanthophylls, quenching mechanisms and nitrogen nutrition. Australian Journal of Plant Physiology, 27:43-51.
Reference ID: 21663
Notes: #21663e
Abstract: Young coffee plants (Coffea arabica L. cv. Catuai), originally from a shaded habitat, were separated in three groups to be grown under different levels of N fertilization: 0.3 mmol N supplements were given to the soil every 7 days (high N treatment, 2N), every 15 days (medium N treatment, 1N) and every 45 days (low N treatment, 0N). These plants were later exposed to a high sunlight irradiance (noon PPFD up to 1500 mu mol m(-2) s(-1)) for a period of 12 or 15 days. Among others, the values of electron transport capacity, maximum carboxylation activity, photosynthetic capacity (A(max)) and several fluorescence parameters (F-v/F-m, F-

v'/F-m', q(P), phi(e)) first showed a reduction (until the 4th-7th day) in all N treatments, followed by an N-dependent recovery. The 2N plants were less affected in the first few days and, at the end of the stress period, showed a better recovery for most of the studied parameters and the highest increase in the saturating PPFD for net photosynthesis and Amax. The present work shows that the ability to acclimate displayed by the mature leaves of 2N plants was accompanied by an increase in energy dissipation mechanisms. These include an increase in the 'high energy' quenching and, mostly, the presence of higher contents of some xanthophylls (zeaxanthin and lutein) and carotenes, which helped to decrease the energetic overcharge in the photosystems. Pigment changes in mature leaves suggest that N can promote specific mechanisms of acclimation others than those that might be expected from a preferential partition of the element N into photosynthetic components.

Da Matta F. M., J. A. T. do Amaral, and A. B. Rena. 1999. Growth periodicity in trees of Coffea arabica L. In relation to nitrogen supply and nitrate reductase activity. Field Crops Research, 60:223-229.
Reference ID: 21664
Notes: #21664e
Abstract: Vegetative growth of branches and leaf area gain in field-grown Arabica coffee trees in Vicosa, southeastern Brazil, exhibited active and quiescent phases. Nitrogen supplementation during the cool season did not prevent growth decline, nor did it alter the overall pattern of the tree growth; however, it enabled the plants to grow faster following the quiescent growth phase. Growth was related poorly to both nitrate content and nitrate reductase activity in leaves. In roots, N-fertilization in addition to accounting for greater content of nitrate, amino acids and ammonium was also associated with the maintenance of the nitrate reductase activity, but nitrate reduction was apparently nil in leaves during most of the cool season.

Ramalho J. C., T. L. Pons, H. W. Groeneveld, and M. A. Nunes. 1997. Photosynthetic responses of Coffea arabica leaves to a short-term high light exposure in relation to N availability. Physiologia Plantarum, 101:229-239.
Reference ID: 21665
Notes: #21665e
Abstract: It is known that the coffee (Coffea arabica L.) plant which is originally from shade habitats would have a limited ability to grow under full sun. Previous work has shown that nitrogen fertilisation can reduce the leaf damage when the plants are exposed to high light intensities during several days. In the present work we aimed to study the effects of the high irradiance during the first hours and evaluate the positive contribution of nitrogen fertilisation in the case of short-term exposure to strong light. Young plants (1.5-2 years old) grown in 1.5 kg of a mixed soil were supplemented with a nutrient solution containing 15 mM nitrogen in the form of NH4NO3, every 7 days (2N treatment), 15 days (1N treatment) and 45 days (0N treatment). Top mature leaves were exposed to a photosynthetic photon flux density of 1500 mu mol m(-2) s(-1) for a maximal period of 8 h, and changes in photosynthesis and pigment composition were monitored along the period of high light exposure. Photosynthetic capacity, leaf conductance to water vapour, electron transport capacity and maximum carboxylation activity, as well as some leaf fluorescence parameters (minimal fluorescence, photochemical efficiency of PSII and quantum yield of photosynthetic electron transport) were reduced by the stress, with a generally stronger impact observed in the ON plants. The photochemical

quenching was affected only in the ON plants, while the non-photochemical quenching increased in 2N plants but decreased in the ON ones. The results showed that 2N plants presented a better initial status of the photosynthetic parameters and of the content of photoprotective pigments. Those plants showed ability to trigger some protective mechanisms, as observed by the tendency to increase the xanthophyll pool content, specially in zeaxanthin and in non-photochemical quenching. Also, protein content presented a tendency to increase after 1.5 h, which was maintained until the end of the high light period, We conclude that nitrogen availability is a key factor in the acclimation process to high light.

Babbar L. I. and D. R. Zak. 2015. Nitrogen Cycling in Coffee Agroecosystems - Net N Mineralization and Nitrification in the Presence And Absence of Shade Trees. Agriculture, Ecosystems & Environment, 48:107-113.
Reference ID: 21666
Notes: #21666e
Abstract: Coffee (Coffea arabica L.) agroecosystems in Costa Rica receive relatively large inputs of N through fertilization (approximately 30 g N m-2 year-1). However, little is known regarding the rate at which N is mineralization from organic matter and its subsequent transformation within the soil. We studied the seasonal and spatial variation of N transformations in coffee plantations with and without shade trees in the Central Valley of Costa Rica. Net N mineralization and net nitrification, assayed using an in situ incubation procedure, were measured at monthly intervals for 1 year. Both net N mineralization and net nitrification displayed marked seasonal variation; the significantly lowest rates occurred during the dry season (January - March). The mean annual rate of net N mineralization was 14.8 g N m-2 year-1 in shaded and 11.1 g N m-2 year-1 in unshaded plantations; 95% of mineralized N was oxidized to NO3- in both plantation types. Even though N availability was greater in unshaded plantations, related studies indicate that leaching losses are less than those from unshaded plantations. In combination, these results suggest that N is cycled more conservatively in shaded plantations than in unshaded plantations.

Teklay T. 2007. Decomposition and nutrient release from pruning residues of two indigenous agroforestry species during the wet and dry seasons. Nutrient Cycling in Agroecosystems, 77:115-126.
Reference ID: 21667
Notes: #21667e
Abstract: The decomposition of leaves from Cordia africana Lam. and Albizia gummifera G. F.Gmel was investigated during the wet and dry seasons at Wondo Genet (Ethiopia). Litterbags of leaves were buried in soils under farmland and shaded-coffee agroforestry systems. Residual matter was recovered after 4, 8, 12, and 16 weeks and analysed for nitrogen (N), phosphorus (P), potassium (K), cellulose, lignin, soluble polyphenol and condensed tannin content. Mass-loss and release of N, polyphenols and condensed tannins were greater from Albizia leaves than from Cordia leaves, suggesting that a high polyphenol content does not necessarily retard decomposition. The rates of mass loss and release of the majority of leaf constituents were considerably faster during the wet season than during the dry season. Lignin decomposition, however, proceeded more rapidly during the dry season, and no significant seasonal differences were observed for polyphenol decomposition. The decomposition kinetics of most leaf components during the wet season were best described by a single-exponential model, but a quadratic model provided the best fit during the dry season. Initial leaf chemistry and season were

important decomposition factors, while land-use effects were negligible. However, land-use effects showed distinct seasonal differences, with leaf litter decomposing more rapidly in soil under shaded-coffee than under farmland management, especially during the wet season. This study also demonstrated that polyphenol content does not show the predictive effects it has been attributed to have and that other constituents, such as condensed tannins, would be better suited for this purpose.

Lopez-Bellido L., V. Munoz-Romero, P. Fernandez-Garcia, and R. J. Lopez-Bellido. 2014. Ammonium accumulation in soil: the long-term effects of tillage, rotation and N rate in a Mediterranean Vertisol. Soil Use and Management, 30:471-479.
Reference ID: 21668
Notes: #21668e
Abstract: Plant nutrition requires organic nitrogen to be mineralized before roots can absorb it. A 13-year field study was conducted on typical rain-fed Mediterranean Vertisol to determine the effects of tillage system, crop rotation and N fertilizer rate on the long-term NH4+-N content in the soil profile (0-90cm). The experiment was designed as a randomized complete block with a split-split plot arrangement and three replications. The main plots tested the effects from the tillage system (no-tillage and conventional tillage); the subplots tested crop rotation with 2-year rotations (wheat-wheat, wheat-fallow, wheat-chickpea, wheat-faba bean and wheat-sunflower) and the sub-subplots examined the N fertilizer rate (0, 50, 100 and 150kgN/ha). Soil NH4+-N content was greatest in the rainiest years and greater under the no-tillage (NT) system than the conventional tillage (CT) system (57 and 48kg/ha, respectively). The deepest soil (30-60 and 60-90cm) contained a greater NH4+-N content (21.0 and 21.4kg/ha, respectively) than the shallowest soil (19.5kg/ha in 0-30cm). This observation may be related to Vertisol characteristics, especially crack formation that allows greater mineralization in the deepest layers by displacing organic matter.

Glab T. 2014. Effect of soil compaction and N fertilization on soil pore characteristics and physical quality of sandy loam soil under red clover/grass sward. Soil & Tillage Research, 144:8-19.
Reference ID: 21669
Notes: #21669e
Abstract: During the 20th century grassland production systems were intensified with higher rates of nitrogen usage and increasing heavy vehicular activity. This tendency is reflected in the higher soil degradation risk. However, in recent years European agri-environmental policies have promoted low-input grassland management practices. These changes in fertilization intensity may interact with the effects of machine traffic in affecting soil physical properties. The objective of this study, was to investigate the influence of soil compaction caused by tractor traffic and N fertilization levels on a soil pore system under a clover/grass mixture during the period from 2010 to 2012. This experiment was established in a split-plot design with fertilization as a main plot and soil compaction as a subplot. The N fertilizer treatments used were: untreated control (N0), 80 kg N ha(-1) (N80) and 160 kg N ha(-1) (N160). Four compaction treatments were applied using the following number of tractor passes: untreated control (P0), two passes (P2), four passes (P4) and six passes (P6). Undisturbed soil samples were collected in 2010-2012 in order to determine the water retention parameters and morphometric characterization of soil pores. The soil water characteristic curve was determined using pressure plates. The

soil macropore system was also characterized using image analysis on the sections of soil samples hardened with polyester resin.
The mineral fertilization did not significantly affect any physical parameters of soil at the trial. The intensive wheeling resulted in a higher value of bulk density and penetration resistance and lower values of total porosity. The soil compaction has distinctly influenced the soil water retention characteristics in the high matric potential range, which corresponds mainly with large pores (transmission pores and fissures) and storage pores. The result of changes in soil porosity was to increase the plant available water capacity. On the other hand, the relative field capacity indicated that in compacted soil under grassland plants, the biological activity was limited by insufficient soil aeration. This conclusion is in agreement with the results in plant production, which showed decrease in root and above ground biomass as the result of compaction.

Cornwell E. 2014. Effects of different agricultural systems on soil quality in Northern Limon province, Costa Rica. Revista de Biologia Tropical, 62:887-897.
Reference ID: 21670
Notes: #21670e
Abstract: Conversion of native rainforest ecosystems in Limon Province of Costa Rica to banana and pineapple monoculture has led to reductions in biodiversity and soil quality. Agroforestry management of cacao (Theobroma cacao) is an alternative system that may maintain the agricultural livelihood of the region while more closely mimicking native ecosystems. This study compared physical, biological and chemical soil quality indicators of a cacao plantation under organic agroforestry management with banana, pineapple, and pasture systems; a native forest nearby served as a control. For bulk density and earthworm analysis, 18 samples were collected between March and April 2012 from each ecosystem paired with 18 samples from the cacao. Cacao had a lower bulk density than banana and pineapple monocultures, but greater than the forest ($p<0.05$). Cacao also hosted a greater number and mass of earthworms than banana and pineapple ($p<0.05$), but similar to forest and pasture. For soil chemical characteristics, three composite samples were collected in March 2012 from each agroecosystem paired with three samples from the cacao plantation. Forest and pineapple ecosystems had the lowest pH, cation exchange capacity, and exchangeable nutrient cations, while cacao had the greatest ($p<0.05$). Total nutrient levels of P and N were slightly greater in banana, pineapple and pasture than in cacao; probably related to addition of chemical fertilizer and manure from cattle grazing. Forest and cacao also had greater %C, than other ecosystems, which is directly related to soil organic matter content ($p<0.0001$). Overall, cacao had more favorable physical, biological and chemical soil characteristics than banana and pineapple monocultures, while trends were less conclusive compared to the pastureland. While organic cacao was inferior to native forest in some soil characteristics such as bulk density and organic carbon, its soil quality did best mimic that of the native forest. This supports the organic cultivation of cacao as a desirable alternative to banana and pineapple monoculture.

Wu J., M. J. Wu, C. P. Li, and G. H. Yu. 2014. Long-Term Fertilization Modifies the Structures of Soil Fulvic Acids and Their Binding Capability with Al. Plos One, 9.
Reference ID: 21671
Notes: #21671e
Abstract: The binding characteristics of organic ligands and minerals in fulvic acids (FAs) with Al are essential for understanding soil C sequestration, remain poorly

understood. In this study, Fourier transform infrared (FTIR) spectroscopy combined with two-dimensional correlation spectroscopy (2DCOS) analysis was applied for the first time to explore the binding of Al with organic ligands and minerals in soil FAs. For these analyses, two contrasting treatments were selected from a long-term (i.e., 22-year) fertilization experiment: chemical (NPK) fertilization and swine manure (SM) fertilization. The results showed that the long-term application of organic and inorganic fertilizers to soils had little effect on the compositions of the fluorescent substances and organic ligands in the soil FAs. However, long-term SM fertilization increased the weathered Al and Si concentrations in the soil FAs compared with long-term chemical fertilization. Furthermore, organic ligands in the soil FAs were mainly bound with Al in the NPK treatment, whereas both organic ligands and minerals (Al-O-Si, Si-O) were bound with Al under the M fertilization conditions. Both transmission electron microscopy (TEM) images and X-ray diffraction spectra demonstrated that amorphous and short-range-ordered nanominerals were abundant in the soil FAs from the SM plot in contrast to the soil FAs from the NPK plot. This result illustrates the role nanominerals play in the preservation of soil FAs by during long-term organic fertilization. In summary, the combination of FTIR and 2D correlation spectroscopy is a promising approach for the characterization of the binding capability between soil FAs and Al, and a better understanding FA-Al binding capability will greatly contribute to global C cycling.

Bonanomi G., R. D'Ascoli, R. Scotti, S. A. Gaglione, M. G. Caceres, S. Sultana, R. Scelza, M. A. Rao, and A. Zoina. 2014. Soil quality recovery and crop yield enhancement by combined application of compost and wood to vegetables grown under plastic tunnels. Agriculture, Ecosystems & Environment, 192:1-7.
Reference ID: 21673
Notes: #21673e
Abstract: Vegetable cultivation under plastic tunnels is a steadily growing agricultural sector but concern developed over environmental sustainability of this farming system. Our aim was to identify organic amendments with a biochemical quality that effectively balance the trade-off between organic carbon recovery, in terms of increasing soil organic C stock, and nutrient mineralization. A three-year field experiment was carried out in two farms of southern Italy characterized by plastic tunnel cultivation and contrasting soil characteristics. Two compost-wood mixtures were used, with final C/N ratio of 15 and 25, and supplied in two doses (30 and 60 Mg ha(-1)). Vegetable yield was assessed by monitoring 14 cropping cycles, and soil quality by determining 18 soil parameters including chemical and biological properties. Crop yields were significantly higher in amendment plots, compared to unamended control plots under plastic tunnel, for 12 out of 14 cropping cycles. Combined application of compost and wood allowed an effective recovery of soil C content within three years. Soil amendments improved soil biological functions as revealed by a general trend of positive effects on dehydrogenase, phosphatase and beta-glucosidase as well as on soil respiration. The higher C/N ratio mixture determined only a short-term restriction of mineral nitrogen availability. Organic amended plots showed a significant increase in soil exchangeable Na+ and electrical conductivity compared with untreated controls. Compost-woody combination can be used to recover soil carbon stock and fertility and, at the same time, to support vegetable production under plastic tunnels. However, the possible increase of soil salinity after compost amendment may negatively affect soil quality in the long-term.

Achat D. L., M. L. Daumer, M. Sperandio, A. C. Santellani, and C. Morel. 2014. Solubility and mobility of phosphorus recycled from dairy effluents and pig manures in incubated soils with different characteristics. Nutrient Cycling in Agroecosystems, 99:1-15.

Reference ID: 21674

Notes: #21674e

Abstract: Phosphorus (P) nutrition of plants in croplands is managed by fertilization. Commercial P fertilizers are manufactured from phosphate rocks, which are non-renewable and the only fossil resource of P. As an alternative, P in human and animal wastes can be recovered and concentrated in products that can be used as P fertilizers. Here, we studied four recycled P products derived from pig manures (hereafter referred as "RPPM") and another one derived from dairy effluents ("RPDE"). The RPDE product is composed of Ca-P (partly as hydroxyapatite, HA), while RPPM products include recovered struvite (ST) and Ca-P in variable proportions. The objective was to assess the ability of RPPM and RPDE products to increase available P in a range of soils differing in their characteristics (seven soils used), and to compare these recycled P products with a standard fertilizer [commercial triple super phosphates (TSP)], reference HA and reference ST. To this end, products were mixed to the soils and the mixtures were incubated at 75 % water holding capacity and 28 A degrees C. After incubation, the amounts of phosphate ions (iP) in solution (Q(W)) and isotopically exchangeable iP (E) in soils were quantified using an isotopic labeling (P-32) and dilution procedure. In each soil, Q(W) and E were significantly affected by treatments (control and P-treated soils) and increased due to the application of the different products. However, reference HA and RPDE products were generally less effective than TSP, reference ST and RPPM products. The soil response (variation in Q(W) or E) in TSP treatment was compared to those in other treatments. It enabled the calculation of a relative effectiveness index. Relative effectiveness of HA and RPDE varied among soils (from 5 to 124 %) and increased with decreasing soil pH. Results however showed that the RPDE product tends to be more effective than reference HA, probably due to different degrees of crystallization of Ca-P. Relative effectiveness of RPPM products (80-116 %) was high in all soils and was similar to that of reference ST (90-104 %). To conclude, the present study suggests that RPDE products are effective only in acidic or slightly acidic soils. In contrast, P recycling from pig manures through chemical precipitation can provide effective P fertilizers, independently on soil conditions.

Wang L. T., Z. H. Tong, G. D. Liu, and Y. C. Li. 2014. Characterization of biomass residues and their amendment effects on water sorption and nutrient leaching in sandy soil. Chemosphere, 107:354-359.

Reference ID: 21675

Notes: #21675e

Abstract: In this study, we evaluated the efficiency of two types of biomass residues (fermentation residues from a bioethanol process, FB; brown mill residues from a papermaking process, BM) as amendments for a sandy soil. The characteristics of these residues including specific surface areas, morphologies and nutrient sorption capacity were measured. The effects of biorefinery residues on water and nutrient retention were investigated in terms of different particle sizes and loadings. The results indicated that bio-based wastes FB and BM were able to significantly improve water and nutrient retention of sandy soil. The residues with larger surface areas had better water and nutrient retention capability. Specifically, in the addition of 10%

loading, FB and BM was able to improve water retention by approximately 150% and 300%, while reduce 99% of ammonium and phosphate concentration in the leachate compare to the soil control, respectively.

Diwani T. N., F. Asch, M. Becker, and F. Mussgnug. 2013. Characterizing farming systems around Kakamega Forest, Western Kenya, for targeting soil fertility-enhancing technologies. Journal of Plant Nutrition and Soil Science, 176:585-594.
Reference ID: 21676
Notes: #21676e
Abstract: Kakamega district in Western Kenya represents the smallholder farming systems typical for much of the densely populated humid highlands in East Africa. A specific feature, however, is the presence of a protected forest reserve (Kakamega Forest National Park), covering some 20% of the district area. Year-round crop production with little use of external inputs is resulting in declining soil fertility and crop yields. Technologies to counteract fertility constraints are rarely implemented, as they do not consider system diversity or farm-specific characteristics. We surmised that farm type-specific targeting of technology options to address soil fertility-related production constraints would reduce the anthropogenic pressure on the resources of the adjacent Kakamega rainforest reserve. Based on Kenyan national census data, we selected 168 farms in physical proximity of the Kakamega forest and characterized them regarding production system and soil attributes. Cluster and principal component analyses identified five distinct farm categories. Three representative farms from each cluster group were subsequently selected to establish labor-use patterns, draw resource-flow maps, and determine NPK balances. Small subsistence-oriented farms were most common (> 50%), with maize yields of 0.9 t ha(-1) (Cluster 1). Most farmers relied on the forest to provide fire wood, animal feed, and medicinal plants. Mixed farms, combining subsistence maize with industrial crops, were differentiated by soil type, with tea being grown on Ferralsol (Cluster 3), and sugar cane being grown on Acrisol (cluster 4). The dependence on forest resources was limited to animal grazing and the collection of feed stuff (Cluster 3), or the extraction of medicinal plants (Cluster 4). Only few farms showed a high degree of market orientation of the food-crop production. These comprised either small farms with high investments in fertilizer and maize yields close to 2 t ha(-1) (Cluster 2), or larger farms (1.6-3.9 ha) with low fertilizer but high hired-labor use (Cluster 5). Their reliance on forest resources was generally low. Resource flows showed mainly patterns of nutrient export in subsistence farms, and more complex flow patterns, involving several farm compartments, in the diversified farms. Partial nutrient balances were strongly negative for N and K, irrespective of soil or farm type. Soil-fertility characteristics reflected the nutrient balances with generally low C and N in all farms on Acrisol, and low P in farms not applying mineral fertilizers or farmyard manure. The proposed typology is expected to improve the targeting of technologies addressing soil fertility-related production constraints, and to reduce the pressure on forest resources. This is of particular importance in the case of small-scale subsistence and mixed farms close to the forest margin.

Bar-Yosef B. and J. B. Asher. 2013. Simulating the effect of potassium fertilization on carbon sequestration in soil. Journal of Plant Nutrition and Soil Science, 176:375-386.
Reference ID: 21677
Notes: #21677e

Abstract: The impact of horticultural management on carbon sequestration in soils has been limited so far to tillage and nitrogen fertilization. Our objective was to evaluate by mathematical modeling the effect of potassium fertilization on CO2 binding in cropland soils. The developed model integrates three subunits: (1) A published simulator of crop dry-matter (DM) production in response to N, P, K fertilization, but not DM partitioning; (2) a published soilcropatmosphere model predicting crop yield and DM partitioning as a function of N but not K fertilization; (3) an original model computing the organic-inorganic carbon transformations, inorganic-carbon reactions and transport in soil, CO2 diffusion, and soil carbon sequestration. The model described the K-fertilization effect on C binding in soil as a function of the soil pH, the Ca2+ concentration in the soil solution, hydraulic properties, air temperature, and crop DM production, and partitioning characteristics. In scenarios of corn (Zea mays L.) growth in clayey soil and wheat (Triticum aestivum L.) in loam soil, the computed K-induced CO2 sequestration amounted to approximate to 14.5 and 24kg CO2 (kg K)1, respectively (0 vs. 100kg ha1 K application). The soil CO2 sequestration declined by 8% when corn grew in sandy instead of clayey soil and by 20% when the temperature was 10 degrees C higher than the temperature prevailing in mild semiarid zones. All predicted CO2-sequestration results were approximately 30-fold higher than the 0.6kg CO2 emitted perkg of K manufactured in industry.

Jafarnejadi A. R., G. Sayyad, M. Homaee, and A. H. Davamei. 2013. Spatial variability of soil total and DTPA-extractable cadmium caused by long-term application of phosphate fertilizers, crop rotation, and soil characteristics. Environmental Monitoring and Assessment, 185:4087-4096.
Reference ID: 21678
Notes: #21678e
Abstract: Increasing cadmium (Cd) accumulation in agricultural soils is undesirable due to its hazardous influences on human health. Thus, having more information on spatial variability of Cd and factors effective to increase its content on the cultivated soils is very important. Phosphate fertilizers are main contamination source of cadmium (Cd) in cultivated soils. Also, crop rotation is a critical management practice which can alter soil Cd content. This study was conducted to evaluate the effects of long-term consumption of the phosphate fertilizers, crop rotations, and soil characteristics on spatial variability of two soil Cd species (i.e., total and diethylene triamine pentaacetic acid (DTPA) extractable) in agricultural soils. The study was conducted in wheat farms of Khuzestan Province, Iran. Long-term (27-year period (1980 to 2006)) data including the rate and the type of phosphate fertilizers application, the respective area, and the rotation type of different regions were used. Afterwards, soil Cd content (total or DTPA extractable) and its spatial variability in study area (400,000 ha) were determined by sampling from soils of 255 fields. The results showed that the consumption rate of di-ammonium phosphate fertilizer have been varied enormously in the period study. The application rate of phosphorus fertilizers was very high in some subregions with have extensive agricultural activities (more than 95 kg/ha). The average and maximum contents of total Cd in the study region were obtained as 1.47 and 2.19 mg/kg and DTPA-extractable Cd as 0.084 and 0.35 mg/kg, respectively. The spatial variability of Cd indicated that total and DTPA-extractable Cd contents were over 0.8 and 0.1 mg/kg in 95 and 25 % of samples, respectively. The spherical model enjoys the best fitting and lowest error rate to appraise the Cd content. Comparing the phosphate fertilizer consumption rate with spatial variability of the soil cadmium (both total and DTPA extractable) revealed the high correlation between the consumption rate of P fertilizers and soil Cd

content. Rotation type was likely the main effective factor on variations of the soil DTPA-extractable Cd contents in some parts (eastern part of study region) and could explain some Cd variation. Total Cd concentrations had significant correlation with the total neutralizing value ($p < 0.01$), available P ($p < 0.01$), cation exchange capacity ($p < 0.05$), and organic carbon ($p < 0.05$) variables. The DTPA-extractable Cd had significant correlation with OC ($p < 0.01$), pH, and clay content ($p < 0.05$). Therefore, consumption rate of the phosphate fertilizers and crop rotation are important factors on solubility and hence spatial variability of Cd content in agricultural soils.

Bi C. J., Z. L. Chen, J. Wang, and D. Zhou. 2013. Quantitative Assessment of Soil Health Under Different Planting Patterns and Soil Types. Pedosphere, 23:194-204.
Reference ID: 21679
Notes: #21679e
Abstract: Soil health assessment is an important step toward understanding the potential effects of agricultural practices on crop yield, quality and human health. The objectives of this study were to select a minimum data set for soil health evaluation from the physical, chemical and biological properties and environmental pollution characteristics of agricultural soil and to develop a soil health diagnosis model for determining the soil health status under different planting patterns and soil types in Chongming Island of Shanghai, China. The results showed that the majority of the farmland soils in Chongming Island were in poor soil health condition, accounting for 48.9% of the survey samples, followed by the medium healthy soil, accounting for 32.2% of the survey samples and mainly distributed in the central and mid-eastern regions of the island. The indicators of pH, total organic carbon, microbial biomass carbon and Cd exerted less influence on soil health, while the soil salinization and nitrate accumulation under a greenhouse cropping pattern and phosphate fertilizer shortage in the paddy field had limited the development of soil health. Dichlorodiphenyltrichloroethanes, hexachlorocyclohexanes and Hg contributed less to soil health index (SHI) and showed no significant difference among paddy field, greenhouse and open-air vegetable/watermelon fields. The difference of the SHI of the three soil types was significant at $P = 0.05$. The paddy soil had the highest SHI values, followed by the gray alluvial soil, and the coastal saline soil was in a poor soil health condition, indicating a need to plant some salt-tolerant crops to effectively improve soil quality.

Silva F. C., M. M. da Silva, and P. L. Libadi. 2013. Nitrogen application in the maize, under no tillage system: effects in the soil physical quality and agronomics characteristics. Semina-Ciencias Agrarias, 34:3513-3527.
Reference ID: 21680
Notes: #21680e
Abstract: This research was developed in the experimental area of ESALQ-USP, city of Piracicaba, state of Sao Paulo, in a soil of sandy-clay texture and aimed to evaluate the soil physical quality and maize agronomic characteristics with maize crop under different N doses and different tillage systems. The experimental design consisted of randomized blocks with four replicates. Treatments consisted of three nitrogen doses (N) (60, 120, and 180 kg ha(-1)) and a control. The ammonium sulfate fertilizer was applied at 30 kg ha(-1) N during seeding, and the rest was applied as sidedressing when the plants had between six and eight leaves. Were determined the bulk density, microporosity, macroporosity and total porosity of soil, at depths of 0.05, 0.15, 0.25, 0.35 m, and the maize components yield. The soil

physical properties tend to change over time and N levels, especially with regard to soil macroporosity and microporosity, conditioned by the structural change of the soil.

Raut N., P. Dorsch, B. K. Sitaula, and L. R. Bakken. 2012. Soil acidification by intensified crop production in South Asia results in higher N2O/(N-2+N2O) product ratios of denitrification. Soil Biology & Biochemistry, 55:104-112.
Reference ID: 21681
Notes: #21681e
Abstract: Agricultural soils emit significant amounts of N2O to the atmosphere, and annual emissions are in some proportion to the input of reactive nitrogen to the system. Hence the ongoing intensification of cropping systems in South Asia will result in increased emissions of N2O. The prospects are potentially worse than those predicted by the increasing doses of N-fertilizers, however. The reason for this is that intensive cropping systems may acidify the soils, which could increase the N2O/(N-2 + N2O) product ratio of denitrification due to interference with the expression of the different enzymatic steps in this process (Liu et al., 2010 FEMS Microbiol Ecol 72407-417). We investigated this phenomenon for agricultural soils in the central mid-hills of Nepal. We sampled soils from fields that had been under intensified cultivation for >= 20 years, and adjacent fields with more traditional cultivation, in areas with permanently drained soils as well as areas with frequent flooding. The characteristic kinetics of NO. N2O and N-2 production by denitrification in these soils was measured by anoxic incubations after flooding and drainage of the soils with 2 mM NO3-, to secure similar NO3-concentrations for all soils. The results demonstrate that intensification invariably lowered the soil pH and increased the N2O/(N-2 + N2O) product ratios of denitrification. This effect of intensification was observed both for incubations with and without C-substrates (glutamic acid) added. The transient accumulation of NO varied grossly between sites, but was not affected by intensification. The results demonstrate convincingly that the intensification has resulted in higher intrinsic propensity of the soils to emit N2O to the atmosphere, and the correlation with pH suggests that acidification is responsible. This causal relationship is underpinned by emerging evidence that low pH interferes with the assembly of the enzyme N2O-reductase. We conclude that the ongoing intensification of agriculture in South Asia may result in severely increasing N2O emissions unless acidification of the soil is counteracted.

Mugnai S., E. Masi, E. Azzarello, and S. Mancuso. 2012. Influence of Long-Term Application of Green Waste Compost on Soil Characteristics and Growth, Yield and Quality of Grape (Vitis vinifera L.). Compost Science & Utilization, 20:29-33.
Reference ID: 21682
Notes: #21682e
Abstract: Soil properties are one of the main factors affecting the yield and qualitative value of grapes. Therefore, application of compost in a vineyard may affect grape production and chemical composition of berries. For these reasons, we started a field trial in 2001 to determine the long-term effects of compost application on growth, yield and quality of V. vinifera cv. Chardonnay grapes grown in a Tuscan vineyard (Italy). In summary, the results demonstrated that long-term addition of compost to a vineyard can be beneficial to soil characteristics, including organic matter and nitrate content, and had no or limited effects on plant growth and grape quality. Contrasting results were observed for production parameters, however, an average result from the nine years of trials shows that compost application

maintained a similar average yield throughout the years, when compared to chemical fertilizers.

Sampaio T. F., I. A. Guerrini, C. Backes, J. C. A. Heliodoro, H. S. Ronchi, K. M. Tanganelli, N. C. de Carvalho, and F. C. Oliveira. 2012. Soil Physical Characteristics after the Application of Sewage Sludge as Soil Conditioner. Revista Brasileira De Ciencia Do Solo, 36:1637-1645.
Reference ID: 21683
Notes: #21683e
Abstract: The recovery of degraded areas is a slow process and requires the addition of organic residues to improve the soil physical properties. It is known that sewage sludge has a high content of organic matter and nutrients, acting as soil conditioner and supplying nutrients to soil and plants. In a degraded Entisol (typic Quartzipsamment) area, on the Fazenda Entre Rios of the company Suzano Bahia Sul Pulp and Paper, in Itatinga-SP, native Atlantic Forest species were planted. The area was treated with increasing doses of sewage sludge (0; 2.5; 5; 10; 15; and 20 t ha(-1)), which was compared with chemical fertilization and control (no sludge and no fertilizer). The objective was to evaluate the effects of sewage sludge on soil physical characteristics. The use of higher doses of sewage sludge increased aggregate formation and soil porosity, until 12 months after application. Soil humidity and porosity (macro, micro and total) increased until six months after application of the highest sewage sludge rate, whereas microporosity was influenced until 12 months after application.

Mori Y., M. Yoshida, and S. I. Wada. 2012. Effect of Soil Characteristics and Potassium Application Rate on the Plant-Absorbable Potassium Forms and Transport Mechanisms in Soil. Journal of the Faculty of Agriculture Kyushu University, 57:485-488.
Reference ID: 21684
Notes: #21684e
Abstract: Although the demand for saving potassium (K) fertilizer application is increasing, the evaluation of available K by exchangeable K that is operationally defined as 1 M ammonium acetate-extractable K has limitations. In order to investigate the contribution of soil K forms and transport mechanisms for K uptake, pot experiment was performed using two soils with varying K application rate. The spinach grown in vermiculite-rich soil absorbed considerable amount of K from nonexchangeable fraction and the transport mechanism was mainly by diffusion, whereas the plant cultivated in volcanic ash soil, which contain less vermiculite, mostly absorbed exchangeable K and the contribution of mass flow was substantially high. Exchangeable K and soil solution K in vermiculite-rich soil did not much increased at the high rate of K application. A part of applied K might become readily absorbable-nonexchangeable K. To evaluate K supplying capacity of soil, it is necessary to quantify not only exchangeable K but also the K fixation and the amount of K released from nonexchangeable sites. In soil whose K fixation capacity is low, the transport of K from soil might be modeled by solute transport and cation exchange.

Garcia A., A. Jimena, M. M. Martinez, and V. Gutierrez. 2012. Effect of phosphate - solubilizing bacteria and compost on the nutritional characteristics of the oil palm crop (Elaeis guineensis Jacq.) in Casanare, Colombia: Efecto de la adición de bacterias solubilizadoras de fósforo, y compost sobre características nutricionales del cultivo de palma de aceite (Elaeis guineensis Jacq.) en Casanare, Colombia. Agronomia Colombiana, 30:274-281.
Reference ID: 21685
Notes: #21685e
Abstract: In accordance with interest to include biological practices in fertilization programs for commercially important crops, the effect of a bioinoculant application based on phosphate solubilizing bacteria along with compost was evaluated on oil palm cultivation in the nursery stage and in a definitive area. The five treatments that were evaluated included: (C) compost, (CQ) compost and chemical fertilizers 50/50, (IC) compost and inoculant, (IQ) chemical fertilizers and inoculant and (ICQ) inoculant, compost and chemical fertilizers 50/50; as a positive control it was used a plant group fertilized with traditional chemical compounds. Organic matter was added at 2% (w/w) at nursery stage and 15 kg/plant in the definitive area. Response variables includedagronomic variables were evaluated (total height, height to bifurcation, bulb diameter and number of leaves) and soil physicochemical variables (pH, oxidizable organic carbon (OOC), extractable phosphorus and total boron), measured during 8 months in the nursery area and 6 months in the definitive area. The results showed that the evaluated compost constitutes an alternative for palm fertilization in the definitive area, as source of nutrients that meet crop demand at this stage of the crop, matching the nutritional levels of the control plants (P=0.005). Meanwhile, in the nursery area, chemical fertilization is essential to ensure the quality of the plants during the first stage of growth, since, at this stage, plants require high amount of N, which is not supplied by the compost. Finally, it was not possible to demonstrate the promoting effect of the microbial inoculant on plant growth, so it is necessary to complement this research in regard to this product.

Zhao N. and Y. Z. Lu. 2012. Effects of Different Fertilization Treatments on Soil Humic Acid Structure Characteristics. Spectroscopy and Spectral Analysis, 32:1856-1859.
Reference ID: 21686
Notes: #21686e
Abstract: The present article used soil humic acid as research object to study effects on the structure characteristics of soil humic acid under the condition of applying cake fertilizer, green manure, straw fertilizer with the same contents of nitrogen and phosphorus. It used element analysis, micro infrared, and solid C-13-NMR for structure analysis, the results indicated that: The chemical composition and structure characteristics of humic acids were similar, but they also had many obvious differences. (1) The atomic ratios of H/C, O/C, and C/N were all different for the humic acids, the soil humic acid of cake fertilizer processing had the highest contents of H and N, green manure processing of soil humic acid contained the highest content of O, while straw fertilizer processing of soil humic acid contained highest content of C. (2) Infrared analysis displayed that the three soil humic acids contained protein. Cake fertilizer processing of soil humic acid contained the most amino compounds, green manure processing of soil humic acid contained the maximum contents of hydroxyl and aliphatic hydrocarbon, while straw fertilizer processing of soil humic acid contained the highest contents of alcohol and phenol. (3) Solid C-13-NMR data indicated that cake fertilizer processing of soil humic acid

contained the most carboxyl carbon, green manure processing of soil humic acid contained the highest contents of alkyl carbon and carbonyl carbon, while straw fertilizer processing of soil humic acids had the most alkoxy carbon and aromatic carbon.

Resende T. M., E. R. de Moraes, F. O. Franco, E. M. Arruda, J. R. Araujo, D. D. Santos, E. N. Borges, and B. T. Ribeiro. 2012. Evaluation of Physical Soil under Different Uses in Areas with Added Animal Waste in the Cerrado. Bioscience Journal, 28:179-184.
Reference ID: 21687
Notes: #21687e
Abstract: The region of Mining Triangle is inserted in the Cerrado, with 66.79% of its area under Oxisols Reds, who have low natural fertility and high levels of exchangeable aluminum, requiring correction and fertilization for insertion in the production process. The physical attributes of the soil are good indicators of its quality and permits monitoring of areas that suffered some type of interference, determining the best use of that which causes less degradation. Therefore, this study aimed to evaluate the structure of an Oxisol in the Cerrado area in the region of Minas Gerais, Uberlandia, MG, under different uses and receiving organic wastes. With the intervention of the research, wastes generated in the activities related to animal production can leave the condition of polluting the environment to the condition of basic materials of high added value for agriculture, therefore, beyond action fertilizer that are present and conditioning effects repair of physical attributes of soils, could mean, then, a factor of adding value both for the activity of intensive rearing, agriculture and environment. The transformation of the native savannah in production environments changed the soil structure. The conversion to pasture areas and crops (corn and sugar cane) decreased macroporosity and increased soil density. This conversion also influenced the state of aggregation of soil, measured by the increase in the dispersion of clay fraction.

Yan Y., H. He, X. Zhang, Y. Chen, H. Xie, Z. Bai, P. Zhu, J. Ren, and L. Wang. 2012. Long-term fertilization effects on carbon and nitrogen in particle-size fractions of a Chinese Mollisol. Canadian Journal of Soil Science, 92:509-519.
Reference ID: 21688
Notes: #21688e
Abstract: Long-term fertilization effects on carbon and nitrogen in particle-size fractions of a Chinese Mollisol. Can. J. Soil Sci. 92: 509-519. The response of soil organic matter (SOM) dynamics to long-term fertilization may be deduced from changes in the accumulation and distribution of different soil organic carbon (SOC) and nitrogen (N) pools. The SOC and N in particle-size fractions were therefore measured to assess the influences of pig manure and synthetic fertilizer application on the characteristics of these pools. A long-term fertilization experiment, established in 1979 in the Mollisol area (Gongzhuling, China) was used for this study. Composite soil samples (0-20 cm) were collected in 2005 from 12 treatment plots that had received annual applications of pig manure, synthetic fertilizers or combinations of both. Soils were fractionated into fine clay (<0.2 mu m), coarse clay (0.2-2 mu m), silt (2-50 mu m), fine sand (50-250 mu m) and coarse sand (250-2000 mu m) and then SOC and N contents in each particle-size fraction were measured. Although most of the SOC and N were associated with clay and silt fractions, the large proportion of silt in the soil mass played a key role in the retention of SOC and N. The application of pig manure alone increased accumulation of SOC and N in each particle-size

fraction, but preferential enrichment was found in the coarse sand fraction. This indicates that pig manure is efficient in restoring SOM in the temperate Chinese Mollisol under a tilled maize (Zea mays L.) monocropping system and having a long frozen period in winter. The application of synthetic fertilizers had no clear effect on SOC and N accumulation or their distribution in particle-size fractions. However, the combined application of pig manure and synthetic fertilizers enhanced the accumulation of SOC and N in all particle-size fractions, and led to a shift of SOC and N from fine to coarse particles. We extended the hierarchy model for SOC protection to consider a shift in SOC accumulation from fine to coarse particles, depending on the initial SOC content of the specific soil. The findings reveal a clear positive interaction between pig manure and synthetic fertilizers that may improve the quantity of SOM in the temperate Chinese Mollisol.

Abdulkadir A., S. K. Sangare, H. Amadou, and J. O. Agbenin. 2015. Nutrient Balances and Economic Performance in Urban and Peri-Urban Vegetable Production Systems of Three West African Cities. Experimental Agriculture, 51:126-150.
Reference ID: 21689
Notes: #21689e
Abstract: Urban and peri-urban (UPA) cultivation supplies fresh vegetables and employment for the increasing number of urban inhabitants. It is characterized by the use of large nutrient inputs to increase productivity and often associated with negative environmental risks. For these reasons, this study quantified nutrient (nitrogen, N; phosphorus, P; and potassium, K) flows and economic performance of UPA gardening of the three West African cities of Kano, Nigeria; Bobo Dioulasso, Burkina Faso; Sikasso, Mali, during a 2-year period using the Monitoring for Quality Improvement (MonQI) toolbox considering inflows and outflows sources. Average annual N, P and K balances were positive for all gardens in the three cities with N balances of 279, 1127 and 74 kg N ha(-1) in Kano, Bobo Dioulasso and Sikasso, respectively, except for annual K deficits of 222 and 187 kg K ha(-1) in Kano and Sikasso, respectively. Nitrogen use efficiencies were 63%, 51% and 87% in Kano, Bobo Dioulasso and Sikasso, respectively, with poor P use efficiencies due to excess application in all three cities. However, a high K efficiency was observed in Bobo Dioulasso (87%) while applications of K were lower than required in Kano and Sikasso with efficiencies of 121% and 110%, indicating possible K mining. The average annual gross margins from gardening indicated a statistically higher ($p < 0.05$) return of US$3.83 m(-2) in Bobo Dioulasso than returns obtained in Kano (US$0.92 m(-2)) and Sikasso (US$1.37 m(-2)). Although an economically vibrant activity, intensive UPA vegetable production needs to be reviewed for strategic planning towards improving N and P use efficiencies in order to maintain its productivity as well as safeguard the environment. Appropriate K fertilization is necessary to avoid long term K depletion in Kano and Sikasso UPA gardening.

Manyanga M. A., P. L. Mafongoya, and T. P. Tauro. 2014. Soil macrofauna order diversity and abundance under improved fallows and organic matter transfer system in Zimbabwe. African Journal of Ecology, 52:506-513.
Reference ID: 21690
Notes: #21690e
Abstract: Sustainable crop production is dependent on improvement of soil health using different management strategies. A study was conducted in the 2008/09 cropping season to investigate soil macrofauna order diversity and abundance under

organic matter transfer system and improved fallows in a high rainfall (>800 mm year(-1)) area of Zimbabwe. Macrofauna were sampled using monoliths to a depth of 25 cm and Shannon-Wiener diversity was used for diversity testing. Order diversity varied significantly with treatment under both systems. Under improved fallows, Leucaena trichandra had the highest fauna orders (6) followed by Calliandra colorthysus (5), then Acacia anguistissima (4) while Leucaena pallida and miombo forest had the least orders. Crotalaria juncea had the highest faunal orders (5), among organic material transfer system while other treatments had >= 3 orders. Unfertilized maize had one order. Calliandra colorthysus had the highest order diversity followed by maize stover > cattle manure > Cr. juncea > fully fertilized maize > unfertilized maize. Major groups identified were termites, earthworms, beetles, millipedes and ants. All taxa combined, cattle manure and miombo forest had the highest macrofauna abundance. This study showed that application of organic nutrient resources and use of improved fallows significantly influenced soil macrofauna order diversity and abundance.

Shaheen S. M., P. S. Hooda, and C. D. Tsadilas. 2014. Opportunities and challenges in the use of coal fly ash for soil improvements - A review. Journal of Environmental Management, 145:249-267.
Reference ID: 21691
Notes: #21691e
Abstract: Coal fly ash (CFA), a by-product of coal combustion has been regarded as a problematic solid waste, mainly due to its potentially toxic trace elements, PTEs (e.g. Cd, Cr, Ni, Pb) and organic compounds (e.g. PCBs, PAHs) content. However, CFA is a useful source of essential plant nutrients (e.g. Ca, Mg, K, P, S, B, Fe, Cu and Zn). Uncontrolled land disposal of CFA is likely to cause undesirable changes in soil conditions, including contamination with PTEs, PAHs and PCBs. Prudent CFA land application offers considerable opportunities, particularly for nutrient supplementation, pH correction and ameliorating soil physical conditions (soil compaction, water retention and drainage). Since CFA contains little or no N and organic carbon, and CFA-borne P is not readily plant available, a mixture of CFA and manure or sewage sludge (SS) is better suited than CFA alone. Additionally, land application of such a mixture can mitigate the mobility of SS-borne PTEs, which is known to increase following cessation of SS application. Research analysis further shows that application of alkaline CFA with or without other amendments can help remediate at least marginally metal contaminated soils by immobilisation of mobile metal forms.
CFA land application with SS or other source of organic carbon, N and P can help effectively reclaim/restore mining-affected lands. Given the variability in the nature and composition of CFA (pH, macro- and micro-nutrients) and that of soil (pH, texture and fertility), the choice of CFA (acidic or alkaline and its application rate) needs to consider the properties and problems of the soil. CFA can also be used as a low cost sorbent for the removal of organic and inorganic contaminants from wastewater streams; the disposal of spent CFA however can pose further challenges.
Problems in CFA use as a soil amendment occur when it results in undesirable change in soil pH, imbalance in nutrient supply, boron toxicity in plants, excess supply of sulphate and PTEs. These problems, however, are usually associated with excess or inappropriate CFA applications. The levels of PAHs and PCBs in CFA are generally low; their effects on soil biota, uptake by plants and soil persistence,

however, need to be assessed. In spite of this, co-application of CFA with manure or SS to land enhances its effectiveness in soil improvements.

Cunningham R. K. and J. C. Burridge. 1960. The Growth of Cacao (Theobroma cacao) With and Without Shade. Annals of Botany, 24:458-462.
Reference ID: 21692
Notes: H 8.1.4 #21692e
Abstract: Evidence is presented that young plants of cacao can tolerate high light intensities if provided with adequate water and nutrient supplies.

Bhardwaj D., M. W. Ansari, R. K. Sahoo, and N. Tuteja. 2014. Biofertilizers Function as Key Player in Sustainable Agriculture By Improving Soil Fertility, Plant Tolerance and Crop Productivity. Microbial Cell Factories, 13:1-10.
Reference ID: 21693
Notes: H 23 #21693e
Abstract: Current soil management strategies are mainly dependent on inorganic chemical-based fertilizers, which caused a serious threat to human health and environment. The exploitation of beneficial microbes as a biofertilizer has become paramount importance in agriculture sector for their potential role in food safety and sustainable crop production. The eco-friendly approaches inspire a wide range of application of plant growth promoting rhizobacteria (PGPRs), endo- and ectomycorrhizal fungi, cyanobacteria and many other useful microscopic organisms led to improved nutrient uptake, plant growth and plant tolerance to abiotic and biotic stress. The present review highlighted biofertilizers mediated crops functional traits such as plant growth and productivity, nutrient profile, plant defense and protection with special emphasis to its function to trigger various growth- and defense-related genes in signaling network of cellular pathways to cause cellular response and thereby crop improvement. The knowledge gained from the literature appraised herein will help us to understand the physiological bases of biofertlizers towards sustainable agriculture in reducing problems associated with the use of chemicals fertilizers.

Verma R. K., A. Yadav, R. S. Verma, L. U. Rahman, and K. Khan. 2014. Intercropping of aromatic crop Pelargonium graveolens with Solanum tuberosum for better productivity and soil health. Journal of Environmental Biology, 35:1165-1171.
Reference ID: 21694
Notes: #21694e
Abstract: Farmers in hilly regions experience low production potential and resource use efficiency due to low valued crops and poor soil health. Geranium (Pelargonium graveolensL) is a vegetatively propagated initially slow growing, high value aromatic crop. Potato (Solarium tuberosumL.) is also vegetatively propagated high demand cash crop. Afield experiment was carried out in temperate climate to investigate the influence of geranium intercropping at different row strips (1:1 and 1:2) and plant density (60x45,75x45 and 90x45cm) with potato intercrop on biomass,oil yield, monetary advantage and soil quality parameters. The row spacing 60x45cm and row strip1:1 was found to be superior and produced 92 t ha(-1) and 14 kg ha(-1)biomass and oil yield, respectively. The row strip 1:2 intercrop earned a maximum $2107, followed by $ 1862 with row strip 1:1 at 60x45cm plant density. Significant variations were noticed in soil organic carbon (C), total N (N-t), available nutrients, soil microbial biomass (C-mic) and nitrogen (N-mic) content. Maximum improvement of C-org (41.0 %) and N-t(27.5%) with row strip 1:1 at 75 x 45cm plant density. While

higher soil respiration rate, C-mic, N-mic and qCO(2)was found with 1:2 row strip at 60 x 45 plant density. The buildup of C-org and C-mic intercrop can promote long term sustainability on productivity and soil health.

Das A., R. Lal, D. P. Patel, R. G. Idapuganti, J. Layek, S. V. Ngachan, P. K. Ghosh, J. Bordoloi, and M. Kumar. 2014. Effects of tillage and biomass on soil quality and productivity of lowland rice cultivation by small scale farmers in North Eastern India. Soil & Tillage Research, 143:50-58.
Reference ID: 21695
Notes: #21695e
Abstract: Intensive tillage-based production systems along with residue removal, grazing and/or burning of crop residues/biomass and poor nutrient replenishment through inadequate fertilizer and manure use are the major causes of soil degradation and unsustainable agriculture in hills of North Eastern India. Thus, a 4-year study (2003-07) was conducted during rainy (wet) seasons at Indian Council of Agricultural Research (ICAR) Research Complex for North Eastern Hill (NEH) Region, Umiam, India (950 m a.s.l.). Objective of the study was to assess the effect of different tillage systems (individual or combinations of spading, trampling and hand weeding) on rice (Oryza sativa L.) productivity and soil (Typic Paleudalf) quality under in-situ residue management in lowland conditions. Transplanting in manually weeded unpuddled field was termed no-till (NT). In comparison, individual or combinations of spading, trampling (one partial manual puddling to incorporate weeds) and weeding was termed minimum tillage (MT). Treatment involving the maximum tillage included 4 spading + 2 trampling + 2 weedings, and was termed the conventional tillage (CT). The latter is practiced widely by farmers' in the region. Nine tillage treatments were laid out in a Randomized Block Design (RBD) and replicated thrice in a fixed plot size of 5 m x 5 m. Increasing tillage intensity (combinations of spading along with trampling and weeding) increased grain yields. Agronomic yields obtained with 2 spading + 1 trampling + 1 weeding (MT option) was statistically (p = 0.05) similar to that under CT. In general, the weed biomass was more under NT and MT than CT, and also contributed 2-4, 0.8-2 and 0.78-1.9 times more N, P and K respectively, towards nutrient recycling than that under CT. However, the amount of N, P and K recycled through rice straw was more under CT than MT and NT. Weed biomass played a major role as a nutrient source in MT systems and contributed towards yield stabilization and improvement in soil quality. The soil organic carbon (25.2 g/kg), soil microbial biomass carbon (198.7 mu g/g dry soil) and dehydrogenase activity (25.84 mu g TPF/g dry soil) in NT were 11.5, 17 and 107%, respectively, more than those under CT. These parameters under MT systems were 6-13, 2-15 and 35-88%, respectively, more compared to those under CT. The bulk density (rho b) under CT (1.18 Mg/m(3)) was significantly higher than those observed under MT systems of only one spading or one trampling (1.15 Mg/m(3)). The net return was the highest with MT system comprising of 2 spading + 1 trampling + 2 weeding ($367.5/ha), and that was 25.5% higher than that with CT. The net return per dollar (NRP) invested decreased with increasing tillage intensity. In-situ rice residue retention along with weed biomass recycling (MT) for 4-years improved soil quality, reduced cost of production and stabilized productivity in a low-input marginal (marginal soil and small scale farmers) hill agriculture.

Suzuki K., R. Matsunaga, K. Hayashi, N. Matsumoto, R. Tabo, S. Tobita, and K. Okada. 2014. Effects of traditional soil management practices on the nutrient status in Sahelian sandy soils of Niger, West Africa. Geoderma, 223:1-8.
Reference ID: 21696
Notes: #21696e
Abstract: In the Fakara region of the Sahel zone, Niger, West Africa, farmers have been implementing traditional soil management practices such as the application of dry farmyard manure (FYM) and household waste (HHW), livestock corralling, and fallows. Previous studies, however, have not accumulated enough data on the effects of these practices on the soil nitrogen (N) pool in the Sahelian sandy soils. The objectives of this study were to evaluate the effects of these traditional practices on each N pool and on other nutrients. As the indicator of available N, phosphate buffer extractable organic nitrogen (PEON) was employed. Total N was significantly higher in the fields adjacent to houses (H) and suburban fields where FYM had been applied for 10 years (FYM10) or 5 years (FYM5), compared with that in the no-treatment fields (NT) which had received no organic matter (OM) and chemical fertilizer for several decades. FYM 10, H, and reserved fallows (RF) showed significantly higher levels of PEON than of NT. The amounts of total N and PEON in soils from all corralling practices, and all normal fallows were at the same level compared with NT. Similarly, the mineral N pool was higher for the soils from H, FYM10, and mixed corralling with sheep and goats.
The principal component analyses (PCA) showed that all eigenvalues of soil pH, exchangeable potassium (K), available phosphorus (P), total N and carbon (C), PEON and mineral N in principal component 1 (PC1) were positive, thus relating strongly to soil management practices which can enhance the essential nutrients: the pool of N, P, and K, and C pool in soil. For PC2, the eigenvalues of mineral N, exchangeable K, and pH were positive, strongly relating to soil management practices which can enhance cations in soil. In comparison with NT the eigenvalues of PC1 of the managements with OM application were higher than in NT while those for the normal fallows without OM application were as low as those in NT. The eigenvalues of PC2 were higher for H and all corralling practices compared with the values for NT. We understood that the practices of transporting manure and corralling are important for the improvement of the fertility of Sahelian soils. Furthermore, the findings suggest that corralling is a more economical and useful practice than the others; livestock are moved around and drop manure directly on the farmland, thus the loss of OM in transportation and the labor requirement are also low.

Ahmad W. and F. Khan. 2014. Remediation of soil past erosion effects through amendments and agronomic practices. Journal of the National Science Foundation of Sri Lanka, 42:45-62.
Reference ID: 21697
Notes: #21697e
Abstract: In Pakistan there has been a trend to shift agriculture towards steep lands, where soil erosion is one of the most significant ecological restrictions to sustainable agricultural production. This study was focused to find ways to ameliorate the soil fertility degraded by past soil erosion. Different cropping patterns viz maize-wheat-maize rotation (C1), maize-lentil-maize rotation (C2) and maize-wheat+lentil intercrop-maize rotation (C3) and different soil treatments, namely, the control (T1), 50 NP (also called the farmer's practice) (T2), 100 % NPK or the recommended dose of NPK (T3) and 20 t ha(-1) farmyard manure integrated with 50 % N and 100 % PK

(T4) were tested in a randomized complete block (RCB) design with split plot arrangements. Integrated use of organic manure (farmyard manure) and inorganic NPK fertilizers (T4) produced the highest wheat grain yield (4730 kg ha(-1)), which was 9 % higher than the 100 % inorganic NPK (T3, 4349 kg ha(-1)) and more than twice the control (T1, 2072 kg ha(-1)). The increase in lentil grain yield in T4 (1112 kg ha(-1)) was 7.4 % higher than in the recommended NPK levels for lentils (T3, 1035 kg ha(-1)) and 79% higher than the control. A significant nutrient enrichment and an improvement in soil fertility parameters was recorded by T4 over T3. This was further augmented by the application of cereal-legume rotation (C2) in the traditional cereal-cereal rotation (Cl) and their combination showed a significantly improved residual effect on soil fertility in the subsequent year. In conclusion the degraded soil fertility of Missa gullied soil cannot be ameliorated to its full potential with only the recommended dose of mineral fertilizers. 50 % N from organic fertilizer sources and the inclusion of legumes in the crop rotation is necessary to ensure agricultural sustainability on such soils.

Ahmad M., Z. A. Zahir, M. Jamil, F. Nazli, M. Latif, and M. F. U. Z. Akhtar. 2014. Integrated Use of Plant Growth Promoting Rhizobacteria, Biogas Slurry and Chemical Nitrogen for Sustainable Production of Maize Under Salt-Affected Conditions. Pakistan Journal Of Botany, 46:375-382.
Reference ID: 21698
Notes: #21698e
Abstract: Salinity is one of the most critical constraints hampering agricultural production throughout the world, including Pakistan. Some plant growth promoting rhizobacteria (PGPR) have the ability to reduce the deleterious effect of salinity on plants due to the presence of ACC-deaminase enzyme along with some other mechanisms. The integrated use of organic, chemical and biofertilizers can reduce dependence on expensive chemical inputs. To sustain high crop yields without deterioration of soil fertility, it is important to work out optimal combination of chemical and biofertilizers, and manures in the cropping system. A pot trial was conducted to study the effect of integrated use of PGPR, chemical nitrogen, and biogas slurry for sustainable production of maize under salt-stressed conditions and for good soil health. Results showed that sole application of PGPR, chemical nitrogen and biogas slurry enhanced maize growth but their combined application was more effective. Maximum improvement in maize growth, yield, ionic concentration in leaves and nutrient concentration in grains was observed in the treatment where PGPR and biogas slurry was used in the presence of 100% recommended nitrogen as chemical fertilizer. It also improved the soil pH, ECe, and available N, P and K contents. It is concluded that integrated use of PGPR, biogas slurry and chemical nitrogen not only enhanced maize growth, yield and quality but also improved soil health. So, it may be evaluated under field conditions to get sustained yield of maize from salt-affected soils.

Mekuria W., A. Noble, O. Sengtaheuanghoung, C. T. Hoang, D. Bossio, N. Sipaseuth, M. McCartney, and S. Langan. 2014. Organic and Clay-Based Soil Amendments Increase Maize Yield, Total Nutrient Uptake, and Soil Properties in Lao PDR. Agroecology and Sustainable Food Systems, 38:936-961.
Reference ID: 21699
Notes: #21699e
Abstract: In the Lao People's Democratic Republic (PDR), increasing food security remains a challenge since smallholder agricultural systems, which are the main

source of food production, are under serious threat due to poor soil fertility and climate variability. This study was undertaken in Lao PDR to investigate the impacts of organic and clay-based soil amendments on maize yield, total nutrient uptake, and soil properties. Structured field experiments were established over two consecutive years (2011 and 2012) with maize as the test crop at the Veunkham and Naphok sites. Ten treatments were applied in a randomized complete block design with three replications. The treatments were control, rice husk biochar (applied at a rate of 10 t ha(-1)), bentonite clay (10 t ha(-1)), compost (4 t ha(-1)), clay-manure compost (10 t ha-1), rice husk biochar compost (10 t ha(-1)), and their combinations. All treatments were applied in 2011. Significant ($p < 0.05$) treatment effects in maize grain yields, total nutrient uptake, and soil properties were observed. At Veunkham, differences between the control and amended soils in yield ranged from 0.9 to 3.3 t ha(-1) in 2011 and from 0.2 to 1.3 t ha(-1) in 2012, whereas differences at Naphok varied between 0.2 and 2.2 t ha(-1) in 2011 and from 0.2 to 1.7 t ha(-1) in 2012. At both sites, in most of the treatments, yields in 2012 were significantly ($p < 0.05$) lower than 2011; this was attributed to a late season drought. Differences between the control and amended soils in yield can be attributed to the improvements in total N and P uptake, soil pH, exchangeable Ca++ and Mg++, and cation-exchange capacity following the application of soil amendments. The results of this study confirm that the soil amendments under consideration can be effective in improving agricultural productivity, while improving key soil properties indicating that soil amendments could be an option for intensification of agricultural productivity.

Singha A., T. Adak, K. Kumar, S. K. Shukla, and V. K. Singh. 2014. Effect of Integrated Nutrient Management on Dehydrogenase Activity, Soil Organic Carbon and Soil Moisture Variability in a Mango Orchard Ecosystem. Journal of Animal & Plant Science, 24:843-849.
Reference ID: 21700
Notes: #21700e
Abstract: The organic carbon content in the soils of mango orchards in subtropical region of Uttar Pradesh, is very low affecting the soil quality and nutrient release pattern. The microbial and enzyme activities of the soil are closely related to the organic matter content and influenced by hydrothermal regimes of the soil. Keeping this in view, effect of different organic and inorganic substrates was studied on dehydrogenase activity, soil organic carbon and moisture content in mango orchard soil. The soil samples across three different depths with respect to their dehydrogenase activity indicated spatial variation across soil depths and treatments. The univariate analysis showed higher variability of dehydrogenase activity in the soil surface layer as compared to the deeper depths. The highest dehydrogenase activity was observed as 2.09, 1.58 and 1.30 g TPF g(-1) hr(-1) and the lowest as 0.92, 0.50 and 0.21 g TPF g(-1) hr(-1) in 0-10, 10-20 and 20-30 cm depth, respectively. The results recognized that NPK application had a major role in dehydrogenase activity. Frequency distribution reveled that even after a short-term use of organic and inorganic amendments, improvement of SOC content was not above 0.50%. Higher moisture content was observed from the treatments where organic mulching and biofertilizers were added when compared with control. The results thus indicated that mango orchard soils of low fertility regions of semi-arid areas should be amended with organic substrates to enhance moisture retention, organic carbon build up and microbial activity.

Leon J. D. and N. W. Osorio. 2014. Role of Litter Turnover in Soil Quality in Tropical Degraded Lands of Colombia. Scientific World Journal.
Reference ID: 21701
Notes: #21701e
Abstract: Land degradation is the result of soil mismanagement that reduces soil productivity and environmental services. An alternative to improve degraded soils through reactivation of biogeochemical nutrient cycles (via litter production and decomposition) is the establishment of active restoration models using new forestry plantations, agroforestry, and silvopastoral systems. On the other hand, passive models of restoration consist of promoting natural successional processes with native plants. The objective in this review is to discuss the role of litter production and decomposition as a key strategy to reactivate biogeochemical nutrient cycles and thus improve soil quality in degraded land of the tropics. For this purpose the results of different projects of land restoration in Colombia are presented based on the dynamics of litter production, nutrient content, and decomposition. The results indicate that in only 6-13 years it is possible to detect soil properties improvements due to litter fall and decomposition. Despite that, low soil nutrient availability, particularly of N and P, seems to be major constraint to reclamation of these fragile ecosystems.

Coelho M. S., E. D. Mendonca, P. C. de Lima, G. P. Guimaraes, and I. M. Cardoso. 2013. Quality of Soil Organic Matter under Coffee Intercropped with Green Manure. Revista Brasileira De Ciencia Do Solo, 37:1576-1586.
Reference ID: 21702
Notes: #21702e
Abstract: The input of organic residues associated with the humification process promotes improvement of soil properties and enables the sustainability of the production system. Aside from supplying the coffee with nutrients, pulse crops can improve the quality of soil organic matter by forming humic substances. The purpose of this study was to evaluate the effect of green manures legumes on the quality of humic substances in soils under coffee under two environmental conditions in the region of Zona da Mata, in Minas Gerais. The species forage peanut, calopo, stylosanthes, velvetbean and spontaneous species were grown for four years on two family farms. After four years, soil was sampled and the humic substances were extracted and purified to obtain fulvic acids (FA) and humic acids (HA). The elemental sample composition (CHNO analyzer), UV-visible, infrared and thermogravimetry of the purified material were analyzed. The results showed that HA have a higher molecular weight, hydrophobicity, condensation, and aromatic compounds with higher C content, providing greater structural stability than FA. The humic substances in the environment facing south, with lower light incidence, lower temperatures and higher humidity, were structurally more stable and decay-resistant than the humic substances extracted from soil northwest-oriented soil surfaces. In the treatment with calopo, FA contained low C and high O levels, characterizing compounds of lower structural stability than FA in the treatments with stylosanthes, velvetbean and spontaneous species. In HA, the use of legumes showed similar results.

Wu F. Y., J. H. C. Wan, S. C. Wu, and M. H. Wong. 2012. Effects of earthworms and plant growth-promoting rhizobacteria (PGPR) on availability of nitrogen, phosphorus, and potassium in soil. Journal of Plant Nutrition and Soil Science, 175:423-433.
Reference ID: 21703
Notes: #21703e
Abstract: Both earthworms and plant growthpromoting rhizobacteria (PGPR) are ubiquitous and important for promoting circulation of plant macronutrients. Two series of laboratory experiments were conducted to investigate the effects of earthworm casts and activities on the growth of PGPR, and the inoculation of earthworms and PGPR on the availability of N, P, and K in soils, respectively. During a short incubation period (034 h), the extracts of earthworm (Pheretima guillelmi)-worked soil significantly ($p < 0.05$) increased the abundance of the three species of PGPR, including N-fixing bacteria (NFB) (Azotobacter chroococcum HKN-5), phosphate-solubilizing bacteria (PSB) (Bacillus megaterium HKP-1), and K-solubilizing bacteria (KSB) (B. mucilaginous HKK-1), in Luria-Bertani (LB) broth. There were synergistic effects of dual inoculation of earthworms and PGPR on increasing the concentrations of NH4+-N, (NO3- + NO2-)-N, NaHCO3-extractable P, and NH4OAc-extractable K in the corresponding soils. Bioavailable N (the sum of NH4+-N and [NO3- + NO2-]-N) in the dual inoculation was 4 to 24 times those inoculated with earthworms or NFB alone, respectively. The significantly higher concentrations of bioavailable N and P in the dual inoculation of earthworms and NFB or PSB may be due to the higher abundance of PGPR and/or higher activities of urease and acid phosphatase than those of single inoculation of NFB or PSB, respectively. Dual inoculation of earthworms and PGPR would be most effective in reducing the need for chemical fertilizers in agriculture.

Singh K., B. Singh, and R. R. Singh. 2013. Effect of land rehabilitation on physicochemical and microbial properties of a sodic soil. Catena, 109:49-57.
Reference ID: 21704
Notes: #21704e
Abstract: Sodic soils are widely distributed in arid and semiarid regions of the world and suffer from high values of pH, exchangeable sodium percentage (ESP), sodium adsorption ratio (SAR) and low fertility. But little is known about the effect of long term land rehabilitation on soil physicochemical and microbial properties of sodic soils, Therefore, the specific objectives of this study were (i) to evaluate the effect of long term (five decades) rehabilitation of sodic land through cropping system on soil physicochemical and microbial properties, (ii) to assess seasonal variation in soil properties of different lands and (iii) to calculate increase in soil fertility through gain percent. For this purpose, changes in soil properties (physicochemical and microbial properties) of rehabilitated sodic land (RSL) were compared with adjacent degraded sodic land (DSL) and non-sodic soil (NSS). When compared to DSL, soil pH, exchangeable sodium percentage (ESP) and sodium adsorption ratio (SAR) were significantly lower in RSL and NSS, while, soil organic carbon (SOC), available nutrients, microbial biomass (MB), microbial counts and enzyme activities (dehydrogenase, beta-glucosidase, protease, alkaline, phosphatase and acidic phosphatase) were significantly higher in RSL and NSS. Seasonal fluctuations in soil properties varied significantly from the annual mean and changes were not always identical for all the lands. Microbial biomass and enzyme activities were negatively correlated with soil sodicity parameters (pH, EC, ESP and SAR) except alkaline phosphatase activity. On the basis of gain %, respective decrease in soil pH, EC, ESP and SAR was 44, 78, 61 and 86% and increase in SOC, total nitrogen (N-t)

MBC, fungal population, dehydrogenase and protease activities was 65, 88, 73, 65, 66 and 63%. Rehabilitation of degraded sodic land through cropping showed 79% (mean gain %) improvement in soil quality. Our findings conclude that rehabilitation of degraded sodic lands through cropping showed a considerable increase in soil fertility.

Yao R. J., J. S. Yang, T. J. Zhang, P. Gao, S. P. Yu, and X. P. Wang. 2013. Short-term effect of cultivation and crop rotation systems on soil quality indicators in a coastal newly reclaimed farming area. Journal of Soils and Sediments, 13:1335-1350.
Reference ID: 21705
Notes: #21705
Abstract: Soil quality (SQ), a measure of the sustainability of land use and soil management practices, can be assessed by indicators including soil physical, chemical, and biological properties. Our primary objectives were to investigate the influence of consecutive cultivation and different crop rotation systems on individual SQ indicators and to examine the impact of rotation systems on SQ using soil quality index (SQI) model.
A site-specific selection of 17 potential SQ indicators representing soil chemical and physical attributes (0-10 cm) and groundwater features on 60 sampling locations and 10 representative soil profiles was chosen in a typical coastal newly reclaimed farmland of north Jiangsu Province, China. Using ANOVA analysis, the crop rotation effect was analyzed by comparing SQ indicators between rice/rape rotation soil and cotton/barley rotation soil. An overall SQI was calculated to examine whether plant biomass indices exactly responded to the SQI value.
Results indicated that cultivation had significant effect on some soil profile characteristics, including SOM, SOCD, AP, CEC, AK, ECe, and I (f). Crop rotation systems also had significant influence on some SQ indicators. Compared with cotton/barley rotation soil, rice/rape rotation soil was characterized by higher organic matter, undifferentiated nutrient storage and salinity/alkalinity, lower water accommodation and infiltration, and adverse groundwater conditions. Cotton/barley rotation had higher SQI values over rice/rape rotation (0.523 vs. 0.422). SQ indicators of SAR(e), ECe, and WTg contributed the most to the overall SQI value for each rotation system. Plant biomass indices significantly correlated with the SQI values for both rotation systems, suggesting that the SQI values essentially reflected the status of SQ.
Such results allowed us to conclude that cotton/barley rotation system contributed more to the improvement of SQ than rice/rape rotation system in coastal farming area. Also, we suggested SOCD, AK, rho (b), WTg, and ECg as the minimum data set for SQ assessment, as they had potential in discriminating the effect of rotation systems on SQ between the rotation systems used here.

Anda M., J. Shamsuddin, and C. I. Fauziah. 2013. Increasing negative charge and nutrient contents of a highly weathered soil using basalt and rice husk to promote cocoa growth under field conditions. Soil & Tillage Research, 132:1-11.
Reference ID: 21706
Notes: #21706e
Abstract: Technology intervention is a key success to restore properties and productivities of a highly weathered soil (Oxisols). The main challenge is to find materials with the ability to generate soil negative charge, release various nutrients and suppress toxic elements. The objective of this study was to increase negative

charge and nutrient content, and suppress Al and Mn toxicities of an Oxisol using finely ground basalt and rice husk compost (RHC) to promote cocoa growth under field conditions. Factorial field experiment of 4 x 4 used finely ground basalt and rice husk compost and arranged in a randomly complete block design and planted to cocoa as a test crop. Finely ground basalt and rice husk compost were incorporated to the soil at 0-20 cm depth and rates varied from 0 to 20 t ha(-1) each. Soils were periodically sampled for 24 months for analyses of soil negative charge, organic C content, various cations, pH and toxic elements. Results showed the rice husk compost (RHC) application significantly increased soil organic C content. The solid state cross polarization magic angle spinning (13)carbon nuclear magnetic resonance (CP/MAS C-13 NMR) indicates RHC application was able to increase soil organic C functional groups (O-alkyl, di-O-alkyl and carboxyl C), accompanied by the appearance of aromatic, alkyl and methoxyl C as new functional groups. The carboxyl C plays a major role in generating soil negative charge, suggesting RHC is suitable to restore organic C and negative charge of Oxisols. Basalt, RHC and their combination were able to increase markedly the negative charge of Oxisols as revealed by the decreases in pH(0) and point zero net charge (PZNC) values. The decrease in pHo and PZNC values resulted in the increase of net negative charge of an Oxisol from 0.8 (a control soil) to 2.8, 4.1 and 5.0 cmol(c) kg(-1) for basalt, RHC and their combinations, respectively. In situ soil solution study (a new technique) under field conditions showed basalt and RHC applications either singly or in combination significantly increased the concentrations of Ca, Mg, K, Na and Si, while concentrations of toxic Al and Mn significantly reduced below a toxic level. Overall improvement of Oxisol chemical properties attributed by basalt and RHC applications significantly increased cocoa growth as revealed by the increase in height and stem diameter of cocoa which are two to three times faster than the control within a 24-month period.

Dai Z. M., J. Meng, N. Muhammad, X. M. Liu, H. Z. Wang, Y. He, P. C. Brookes, and J. M. Xu. 2013. The potential feasibility for soil improvement, based on the properties of biochars pyrolyzed from different feedstocks. Journal of Soils and Sediments, 13:989-1000.
Reference ID: 21707
Notes: #21707e
Abstract: Biochars have been considered as useful soil amendments due to their beneficial properties in improving soil fertility, carbon (C) sequestration, and soil decontamination. In our study, a series of biochars produced from different types of feedstocks at two pyrolysis temperatures (300 and 500 A degrees C) were characterized to evaluate their different potentials as soil amendments. Ten types of feedstocks were used to prepare biochars at the pyrolysis temperatures of 300 and 500 A degrees C, for 2 h. Chemical and physical analyses, X-ray diffraction (XRD), scanning electron microscopy (SEM), and Fourier Transform Infrared (FTIR) analyses were conducted to determine differences in biochar properties. Then, soil incubation studies were used to investigate the relationships between these biochar properties and their different ameliorant values in soil. The pH, ash, total C, total potassium, total phosphorus, total base cation concentrations, surface areas, and total pore volumes of biochars produced at 500 A degrees C were higher than at 300 A degrees C, while the reverse applied for yields, total oxygen and total hydrogen, and average pore widths and particle sizes. Cluster analysis suggested that biochars derived from similar feedstock types belonged in the same category. The SEM, XRD, and FTIR analyses of typical biochars from the

different categories suggested both variations and similarities in their characteristics. In addition, the results from soil incubation experiments were consistent with the conclusions made from biochar characteristics analysis. Biochars derived from swine manures, fruit peels, and leaves with high pH and macro-nutrients appeared appropriate to increase soil pH and soil nutrient availability; whereas, biochars from wetland plant residues with high C concentrations and Brunauer-Emmett-Teller were better for soil C sequestration and contaminant adsorption.

Meng Q. F., J. S. Yang, R. J. Yao, and G. M. Liu. 2013. Soil quality in east coastal region of China as related to different land use types. Journal of Soils and Sediments, 13:664-676.
Reference ID: 21708
Notes: #21708e
Abstract: Purpose: The impacts of different land use practices on soil quality were assessed by measuring soil attributes and using factor analysis in coastal tidal lands. The study provided relevant references for coastal exploitation, land management and related researches in other countries and regions. Materials and methods: Measured soil attributes include physical indicators [bulk density (rho(b)), total porosity (f(t)) and water-holding capacity (WHC)], chemical indicators [pH, electrical conductivity (EC), total nitrogen (TN), soil organic matter (SOM), available N, available P and available K] and biological indicators (urease activity, catalase activity and phosphatase activity), and 60 soil samples were collected within five land use types [(1) intertidal soils, (2) reclaimed tidal flat soils, (3) farmland soils, (4) suburban vegetable soils, (5) industrial area soils) in Jianggang village of Dongtai county, Jiangsu province of China. Results and discussion: The results from the investigation indicated that selected soil properties reduced to three factors for 0-20-cm soil depth; "Soil fertility status" (factor 1), "Soil physical status" (factor 2) and "Soil salinity status" (factor 3). For the first factor, the measured soil attributes with higher loadings were TN and SOM, which represented soil fertility feature, and for the second and third factors, the measured soil attributes with higher loadings were rho(b) and available K as well as EC, which reflected soil physical properties and soil salinity feature, respectively. Conclusions: Changes in different land use types due to plants (corn, wheat and green vegetable) and application of fertilizers were characterized by promoted soil quality, including improvements in chemical properties (increasing SOM concentration, TN and nutrient available to plants; decreasing EC), improvements in soil physical properties (decreasing rho(b); increasing f(t) and WHC) and enhancements in soil enzyme activities. Judging from the soil quality indices, the soil quality was affected by different land use practices and decreased in sequence of suburban vegetable soils, farmland soils, industrial area soils, reclaimed tidal flat soils and intertidal soils in the study area.

Linstadter A. and G. Baumann. 2013. Abiotic and biotic recovery pathways of arid rangelands: Lessons from the High Atlas Mountains, Morocco. Catena, 103:3-15.
Reference ID: 21709
Notes: #21709e
Abstract: Dryland rangelands are fragile ecosystems which are vulnerable to overgrazing and other forms of unsustainable land use. Their subsequent degradation is a phenomenon which results in a persistent decrease in productivity. To come to a functional understanding of degradation and restoration pathways,

interactions between abiotic and biotic processes need to be disentangled. We studied soil and vegetation response to grazing removal along a steep climatic aridity gradient on the southern slopes of the High Atlas Mountains, Morocco. Data were collected on four altitudinal levels (semidesert, sagebrush steppe, woodsteppe and Oromediterranean shrubland), and for three grazing treatments (grazed, 1-year and 7-year exclosures). Grazing removal led to site-specific, functionally different pathways of rangeland recovery. At least at one of the four sites, we found either an accumulation of sand, the Aeolian component, or total nitrogen in the topsoil. Total standing crop, shrub ANPP and shrub performance (ANPP(re1), i.e. ANPP indexed on initial biomass) also increased with grazing removal. An increased shrub density led to an increased water storage capacity and/or nutrient content of the soil. However, this improvement in plant resources was not connected to the observed increase in shrub performance. Thus we only found evidence for biotic recovery having a positive feedback on abiotic recovery.
We conclude that correlations between biotic and abiotic recovery processes have to be interpreted carefully, as they may not necessarily be functionally connected. Moreover, the performance of perennial plants (ANPP(re1)) is, if interpreted together with abiotic parameters, a useful indicator for distinguishing functionally different pathways of pasture degradation and restoration in drylands.

Sharma K. L., J. K. Grace, M. Raj, S. B. Mittal, J. Singh, S. K. Sharma, P. S. Sangwan, M. S. Sidhpuria, K. P. R. Vittal, P. K. Mishra, G. M. Sankar, U. K. Mandal, G. Ravindrachary, G. R. Korwar, B. Venkateswarlu, M. Madhavi, P. N. Gajbhiye, D. S. Chandrika, and K. U. Rani. 2013. Improvement and Assessment of Soil Quality under Long-Term Conservation Agricultural Practices in Hot, Arid Tropical Aridisol. Communications in Soil Science and Plant Analysis, 44:1033-1055.
Reference ID: 21710
Notes: #21710e
Abstract: Soils in the hot, arid topical regions are low in organic matter and fertility and are structurally poor. Consequently, these soils suffer on account of poor physical, chemical, and biological soil quality traits, leading to miserably low crop yields. Long-term use of conjunctive nutrient management and conservation tillage practices may have a profound effect on improving the quality of these soils. Therefore, the objective of this study was to identify the key soil quality indicators, indices, and the best soil- and nutrient-management practices that can improve soil quality on long-term basis for enhanced productivity under a pearl milletbased system. The studies were conducted for the Hissar Centre of All-India Coordinated Research Project at the Central Research Institute for Dryland Agriculture, Hyderabad. Conjunctive nutrient-use treatments and conservation tillage significantly influenced the majority of the soil quality parameters in both the experiments. In experiment 1, the key soil quality indicators that significantly contributed to soil quality in a rainfed pearl milletmung bean system were available nitrogen (N, 35%), available zinc (Zn; 35%), available copper (Cu; 10%), pH (10%), available potassium (K; 5%), and dehydrogenase assay (5%). The three best conjunctive nutrient-use treatments in terms of soil quality indices (SQI) were T3, 25 kg N (compost) (1.52) > T6, 15 kg N (compost) + 10 kg N (inorganic) + biofertilizer (1.49) > T5, 15 kg N (compost) + 10 kg N (green leaf manure) (1.47). In experiment 2, under a rainfed pearl millet system, the key indicators and their percentage contributions were electrical conductivity (15%), available N (19%), exchangeable magnesium (Mg; 18%), available manganese (Mn; 13%), dehydrogenase assay (19%), microbial biomass carbon (C; 5%), and bulk density (11%). The three best tillage + nutrient

treatments identified from the viewpoint of soil quality were T1, conventional tillage (CT) + two intercultures (IC) + 100% N (organic source/compost) (1.74) > T3, CT + two IC + 100% N (inorganic source) (1.74) > T4, low tillage + two IC + 100% N (organic source/compost) (1.70). The findings of the present study as well as the state-of-the-art methodology adopted could be of much interest and use to the future researchers including students, land managers, state agricultural officers, growers/farmers, and all other associated stakeholders. The prediction function developed between long-term pearl millet crop yields (y) and soil quality indices (x) in this study could be of much use in predicting the crop yields with a given change in soil quality index under similar situations.

Liu S. H., Y. H. Kang, S. Q. Wan, S. F. Jiang, S. P. Liu, and J. X. Sun. 2013. Effect of drip irrigation on soil nutrients changes of saline-sodic soils in the Songnen Plain. Paddy and Water Environment, 11: 603-610.
Reference ID: 21711
Notes: #21711e
Abstract: A field experiment was carried out to research the changes and spatial distributions of soil nutrients in saline-sodic soil for different number of cultivated years under drip irrigation. The distributions of available potassium (AK), available phosphorus (AP), nitrate nitrogen (NO3 (-)-N), ammonium nitrogen (NH4 (+)-N), as well as the amount of total nitrogen (TN), total phosphorus (TP) and organic carbon (OC) in the 0-40 cm soil layers in saline-sodic soils planted with Leymus chinensis for 1, 2, and 3 years were studied. The results showed that the distance from the emitter had an obvious effect on soil nutrients. Drip irrigation had substantial effects on levels of AK, AP, and NO3 (-)-N. The contents of AK, AP, and NO3 (-)-N were very high in the area near the emitter in the horizontal direction. In the vertical direction, levels of all of the available and total soil nutrients decreased with increased soil depth. Levels of AK, AP, NO3 (-)-N, NH4 (+)-N, TN, TP, and OC all increased with continued cultivation of crops on saline-sodic soil using drip irrigation. Compared to the nutrients found in soils from the natural L. chinensis grasslands, the contents of AK and TP were higher in the drip-irrigated soils, although the contents of AP, NO3 (-)-N, and NH4 (+)-N were broadly comparable. Given the rate of improvements in nutrient levels, we forecast that the nutrients in drip-irrigated saline-sodic soils should match those of the natural L. chinensis grasslands after 3-6 years of cultivation.

Srivastava P. K., B. D. Shenoy, M. Gupta, A. Vaish, S. Mannan, N. Singh, K. Tewari, and R. D. Tripathi. 2012. Stimulatory Effects of Arsenic-Tolerant Soil Fungi on Plant Growth Promotion and Soil Properties. Microbes and Environments, 27:477-482.
Reference ID: 21712
Notes: #21712e
Abstract: Fifteen fungi were obtained from arsenic-contaminated agricultural fields in West Bengal, India and examined for their arsenic tolerance and removal ability in our previous study. Of these, the four best arsenic-remediating isolates were tested for plant growth promotion effects on rice and pea in the present study. A greenhouse-based pot experiment was conducted using soil inocula of individual fungi. The results indicated a significant ($P<0.05$) increase in plant growth and improvement of soil properties in inoculated soils compared to the control. A significant increase in plant growth was recorded in treated soils and varied from 16-293%. Soil chemical and enzymatic properties varied from 20-222% and 34-760%, respectively, in inoculated soil. Plants inoculated with inocula of Westerdykella and

Trichoderma showed better stimulatory effects on plant growth and soil nutrient availability than Rhizopus and Lasiodiplodia. These fungi improved soil nutrient content and enhanced plant growth. These fungi may be used as bioinoculants for plant growth promotion and improved soil properties in arsenic-contaminated agricultural soils.

Alburquerque J. A., C. de la Fuente, M. Campoy, L. Carrasco, I. Najera, C. Baixauli, F. Caravaca, A. Roldan, J. Cegarra, and M. P. Bernal. 2012. Agricultural use of digestate for horticultural crop production and improvement of soil properties. European Journal of Agronomy, 43:119-128.
Reference ID: 21713
Notes: #21713e
Abstract: The usefulness of a digestate from an anaerobic codigestion process as a fertiliser product was evaluated in a field experiment using two horticultural crops (watermelon and cauliflower), during two successive growing seasons. The effects of the digestate were compared with those of a traditional organic amendment (cattle manure) and a conventional mineral fertiliser. Digestate addition to soil provided a source of available nutrients (nitrogen and phosphorus) in the short-term and had positive effects on soil biological properties such as microbial biomass and enzyme activities, compared to the non-amended soil. The digestate application to soil led to yields comparable to the mineral fertilisation for the summer watermelon crop. However, for the winter cauliflower crop, only plots treated with the mineral fertiliser had good production. Nitrogen from the digestate is rapidly and highly available for plant growth in the short-term but also can be easily lost, together with a slow rate of microbial processes due to low temperatures, could reduce the fertilising capacity of the digestate. This seemed to be the main limiting factor for the winter cauliflower crop, where digestate or cattle manure, used as basal dressing, were not enough to satisfy the crop demand for nitrogen during its whole growth cycle.

Llado S., A. M. Solanas, J. de Lapuente, M. Borras, and M. Vinas. 2012. A diversified approach to evaluate biostimulation and bioaugmentation strategies for heavy-oil-contaminated soil. Science of the Total Environment, 435:262-269.
Reference ID: 21714
Notes: #21714e
Abstract: A diversified approach involving chemical, microbiological and ecotoxicity assessment of soil polluted by heavy mineral oil was adopted, in order to improve our understanding of the biodegradability of pollutants, microbial community dynamics and ecotoxicological effects of various bioremediation strategies. With the aim of improving hydrocarbon degradation, the following bioremediation treatments were assayed: i) addition of inorganic nutrients; ii) addition of the rhamnolipid-based biosurfactant M-AT10; iii) inoculation of an aliphatic hydrocarbon-degrading microbial consortium (TD); and iv) inoculation of a known hydrocarbon-degrading white-rot fungus strain of Trametes versicolor.
After 200 days, all the bioremediation assays achieved between 30% and 50% total petroleum hydrocarbon (TPH) biodegradation, with the T. versicolor inoculation degrading it the most. Biostimulation and T. versicolor inoculation promoted the Brevundimonas genus concurrently with other alpha-proteobacteria. beta-proteobacteria and Cytophaga-Flexibacter-Bacteroides (CFB) as well as Actinobacteria groups. However, T. versicolor inoculation, which produced the highest hydrocarbon degradation in soil, also promoted autochthonous Gram-positive bacterial groups, such as Firmicutes and Actinobacteria. An acute toxicity

test using Eisenia fetida confirmed the improvement in the quality of the soil after all biostimulation and bioaugmentation strategies.

Moura E. G., A. K. C. Oliveira, G. Coutinho, K. M. Pinheiro, and A. C. F. Aguiar. 2012. Management of a cohesive tropical soil to enhance rootability and increase the efficiency of nitrogen and potassium use. Soil Use and Management, 28:370-377.
Reference ID: 21715
Notes: #21715
Abstract: The efficiency in the use of nitrogen (N) and potassium (K) may be severely limited in soils with high rates of nutrient loss and that also tend to harden and restrict root growth. The choice of legume residues should take into account the nutrient supply and the need for soil improvement. We assessed the capacity of alley cropping systems to enhance root development, increase nutrient uptake and improve the use of N and K in maize. The experiment included six treatments with residues of four perennial Fabaceae: Clitoria + Gliricidia (C + G); Acacia + Gliricidia (A + G); Leucaena +Gliricidia (L + G); Leucaena + Clitoria (L + C); Leucaena + Acacia (L + A) and a control without legumes. We determined chemical and physical indicators, root length density (RLD) and an efficiency index. The results demonstrate the effects of amending soils with N and K with root growth constrained by hard-setting. The application of combined residues improved the physical properties of hard-setting soils and increased basic cations in the topsoil. A combination of residues with N and K fertilizer increased the maize yield. The relative efficiency and RLD in the L + A treatments were highest as a result of increased application through the residues containing N and K. The choice of residues for hard-setting soils should take into account the supply of nutrients as well as the improvement of soil properties.

Singh K., B. Singh, and R. R. Singh. 2012. Changes in physico-chemical, microbial and enzymatic activities during restoration of degraded sodic land: Ecological suitability of mixed forest over monoculture plantation. Catena, 96:57-67.
Reference ID: 21716
Notes: #21716e
Abstract: Degraded sodic lands in north India are rehabilitated under agriculture and forest sector as per national policies. Afforestation on such lands with monoculture and mixed species reclaims the soils with different efficiencies. We studied the physico-chemical and microbial properties along with enzymatic activities of degraded sodic land (control), rehabilitated sodic lands planted under Terminalia arjuna (R-TA), Prosopis juliflora (R-PJ) and mixed forest (R-MF) from two depths (0-15 and 15-30 cm). The properties of rehabilitated land uses were compared with the soils of corresponding reference (standard) land use under Tectona grandis (Ref-TG) plantation and mixed forest (Ref-MF) growing in the natural forest range of same biogeographic region to determine the status of improvement. The objective of the study was to determine efficient ecological model for the restoration of degraded sodic land. The bulk density, pH, electrical conductivity (EC) and exchangeable sodium percentage (ESP) reduced during restoration under both, pure plantations as well as mixed forest. Increase in water holding capacity (WHC), organic carbon, soil nutrients, microbial biomass (MB) [carbon, nitrogen and phosphorus], microbial counts, CO2 flux and enzymatic activities (dehydrogenase, beta-glucosidase, protease and acidic phosphatase) showed significant improvement in the soil quality of rehabilitated sites. At 0-15 cm soil depth in rehabilitated and reference land uses, in comparison to D-SL, organic carbon, nitrogen (total and available), available

phosphorus, exchangeable cations (Na+, Ca++ and Mg++), MB (carbon and nitrogen) and activities of all enzymes, except alkaline phosphatase, were significantly greater, while other soil properties showed land use specific trends. The overall gain percent in physico-chemical soil properties varied from 54% under plantations to 77% under mixed forest (R-MF). Corresponding gain in microbial biomass was 21% (R-TA) and 34% (R-PJ) under plantation soils against 90% in mixed forest soil. The enzyme activities (on average) have also attained maximum gain% under R-MF (77%) followed by R-PJ (47%) and R-TA (35%) in decreasing order which indicates that afforestation with multiple tree species is a relatively good option for sustainable rehabilitation of sodic lands.

Chakraborty S., I. B. Pangga, and M. M. Roper. 2012. Climate change and multitrophic interactions in soil: the primacy of plants and functional domains. Global Change Biology, 18:2111-2125.
Reference ID: 21717
Notes: #21717e
Abstract: Soil multitrophic interactions transfer energy from plants as the predominant primary producer to communities of organisms that occupy different positions in the food chain and are linked by multiple ecological networks, which is the soil food web. Soil food web sequesters carbon, cycles nutrients, maintains soil health to suppress pathogens, helps plants tolerate abiotic and biotic stress, and maintains ecosystem resilience and sustainability. Understanding the influence of climate change on soil multitrophic interactions is necessary to maintain these essential ecosystem services. But summarising this influence is a daunting task due to a paucity of knowledge and a lack of clarity on the ecological networks that constitute these interactions. The scant literature is fragmented along disciplinary lines, often reporting inconsistent findings that are context and scale-dependent. We argue for the differentiation of soil multitrophic interactions along functional and spatial domains to capture cross-disciplinary knowledge and mechanistically link all ecological networks to reproduce full functionalities of the soil food web. Distinct from litter mediated interactions in detritosphere or elsewhere in the soil, the proposed pathogen suppression and stress tolerance interactions operate in the rhizosphere. A review of the literature suggests that climate change will influence the relative importance, frequency and composition of functional groups, their trophic interactions and processes controlling these interactions. Specific climate change factors generally have a beneficial influence on pathogen suppression and stress tolerance, but findings on the overall soil food web are inconsistent due to a high level of uncertainty. In addition to an overall improvement in the understanding of soil multitrophic interactions using empirical and modelling approaches, we recommend linking biodiversity to function, understanding influence of combinations of climatic factors on multitrophic interactions and the evolutionary ecology of multitrophic interactions in a changing climate as areas that deserve most attention.

Mladenov M. K. and Y. G. Pelovski. 2012. Agrochemical Efficiency of Soil Conditioners on the Base of Wood Ash: Part I. Agrochemical Pot-Tests on Sweet Pepper (Capsicum annum L.) Variety ,,Sivria ST". Bulgarian Journal of Agricultural Science, 18:354-361.
Reference ID: 21718
Notes: #21718e
Abstract: The utilization of ashes from burning of different vegetal wastes in the agriculture, allow the structure improvement of the soils and the nutrient balance to

improve, as well as the regulation to pH of the soil solution. Some examinations show that the ashes can also improve the sorption properties and the water balance of the soils. There is data in the literature for the positive agrochemical efficiency, that comes from using the different composite mixtures on the base of the vegetal wastes, after different methods of treatment. Most frequently they use the methods of composting, but in the last years physicochemical methods of treatment and production of soil conditioners are develop are also used. In the current article we present a new data from realized investigation over efficiency on soil conditioners, obtained on the base of wood ash and green lye from cellulose production, through mixing with ammonium sulphate and sulphuric acid. The pot-tests for cultivation of sweet pepper (Capsicum annum L.) variety "Sivria ST" are done with two forms of the obtained conditioners in tablet form and in powder form. Based on the results it is proved that in the practice the agrochemical efficiency of the used soil conditioners and the optimal norms of manure are established.

Mladenov M. K. and Y. G. Pelovski. 2013. Agrochemical Efficiency Of Soil Conditioners On The Base Of Wood Ash: Part2. Agrochemical Pot And Tests On Sweet Pepper (Capsicum Annum L.) Varietys Ofiis. Bulgarian Journal of Agricultural Science, 19:1275-1282.
Reference ID: 21719
Notes: #21719e
Abstract: The investigations on new manure substances and substances which improve the pH and the structure of the soils are very important for improving of the agro-ecological condition of the soils, vegetable yield increasing, economization of raw materials and no to a least point for utilization of some types of wastes like a secondary raw materials in the agriculture. The presented in the current article data are continuation of done investigation over the efficiency of new mixtures for soil conditioners, which are produced on the base of wood ash and additional substances and wastes. Here are generalized the results from done pot-tests, which show the advisability of using of these soil conditioners at cultivation of sweet pepper (Capsicum annum l.) variety Sofiiska kapia. Based on the results it is proved that in the practice the agrochemical efficiency of the used soil conditioners and the optimal norms of manure are established.

Macci C., S. Doni, E. Peruzzi, G. Masciandaro, C. Mennone, and B. Ceccanti. 2012. Almond tree and organic fertilization for soil quality improvement in southern Italy. Journal of Environmental Management, 95:S215-S222.
Reference ID: 21720
Notes: #21720e
Abstract: The semi-arid Mediterranean region, characterized by long dry periods followed by heavy bursts of rainfall, is particularly prone to soil erosion. The main goal of this study is to evaluate the soil quality under different practices of bio-physical amelioration which involve the soil-plant system (almond trees) and microorganism-manure. This study, carried out in the South of Italy (Basilicata Region- Pantanello farm), considered two types of fertilization (mineral and organic) and three slope gradients (0, 2 and 6%), in order to evaluate the effects of management practices in resisting soil erosion.
Chemical (organic carbon and nitrogen), physical (soil shrinkage and bulk density) and biochemical (dehydrogenase activity and hydrolytic enzyme activities) parameters were selected as markers to follow agro-ecological changes with time. The organic treatment affected soil microbiological and physicochemical properties

by increasing soil nutrient availability, microbial activity, and improving soil structure. The consistently higher values of the hydrolytic enzyme activities (beta-glucosidase, phosphatase, urease and protease) often observed in the presence of plants and on the 0 and 2% slopes, suggested the stimulation of nutrient cycles by tree roots, which improve the conditions for soil microorganisms in carrying out their metabolic activity. In the 6% slope and, in particular, in the mineral fertilizer treatment, soil metabolism was lower as suggested by the dehydrogenase activity which was 50% lower than that found in the 0 and 2% slopes, this seemed to be related to a slowdown in the nutrient cycling and organic carbon metabolism. However, on this slope, in both mineral and organic treatments, a significant stimulation of hydrolytic enzyme activities and an improvement of soil structure (reduction of bulk density of about 10% and increase in total shrinkage from 20 to 60%) were observed with plants compared to the control soil. The combination of organic fertilization and almond trees resulted effective, also in the highest slope, in mitigating the degradation processes through the improvement of chemico-nutritional, biochemical and physical soil properties.

Malanson G. P., A. M. Verdery, S. J. Walsh, Y. Sawangdee, B. W. Heumann, P. M. McDaniel, B. G. Frizzelle, N. E. Williams, X. Z. Yao, B. Entwisle, and R. R. Rindfuss. 2014. Changing crops in response to climate: Virtual Nang Rong, Thailand in an agent based simulation. Applied Geography, 53:202-212.
Reference ID: 21721
Notes: #21721e
Abstract: The effects of extended climatic variability on agricultural land use were explored for the type of system found in villages of northeastern Thailand. An agent based model developed for the Nang Rong district was used to simulate land allotted to jasmine rice, heavy rice, cassava, and sugar cane. The land use choices in the model depended on likely economic outcomes, but included elements of bounded rationality in dependence on household demography. The socioeconomic dynamics are endogenous in the system, and climate changes were added as exogenous drivers. Villages changed their agricultural effort in many different ways. Most villages reduced the amount of land under cultivation, primarily with reduction in jasmine rice, but others did not. The variation in responses to climate change indicates potential sensitivity to initial conditions and path dependence for this type of system. The differences between our virtual villages and the real villages of the region indicate effects of bounded rationality and limits on model applications.

El-Sharkawy M. A. 2014. Global warming: causes and impacts on agroecosystems productivity and food security with emphasis on cassava comparative advantage in the tropics/subtropics. Photosynthetica, 52:161-178.
Reference ID: 21722
Notes: #21722e
Abstract: Earth's climate has experienced notable changes during the past 50-70 years when global surface temperature has risen by 0.8 degrees C during the 20th century. This was a consequence of the rise in the concentration of biogenic gases (carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, and ozone) in the atmosphere that contribute, along with water vapor, to the so-called 'greenhouse effect'. Most of the emissions of greenhouse gases have been, and still are, the product of human activities, namely, the excessive use of fossil energy, deforestations in the humid tropics with associated poor land use-management, and wide-scale degradation of soils under crop cultivation and animal/pasture

ecosystems. General Circulation Models predict that atmospheric CO2 concentration will probably reach 700 mol(CO2) mol(-1). This can result in rise of Earth's temperature from 1.5 to over 5 degrees C by the end of this century. This may instigate 0.60-1.0 m rise in sea level, with impacts on coastal lowlands across continents. Crop modeling predicts significant changes in agricultural ecosystems. The mid- and high-latitude regions might reap the benefits of warming and CO2 fertilization effects via increasing total production and yield of C-3 plants coupled with greater water-use efficiencies. The tropical/subtropical regions will probably suffer the worst impacts of global climate changes. These impacts include wide-scale socioeconomic changes, such as degradation and losses of natural resources, low agricultural production, and lower crop yields, increased risks of hunger, and above all waves of human migration and dislocation. Due to inherent cassava tolerance to heat, water stress, and poor soils, this crop is highly adaptable to warming climate. Such a trait should enhance its role in food security in the tropics and subtropics.

Gabriel L. F., N. A. Streck, L. O. Uhlmann, M. R. da Silva, and S. D. da Silva. 2014. Climate change and its effects on cassava crop. Revista Brasileira De Engenharia Agricola e Ambiental, 18:90-98.
Reference ID: 21723
Notes: #21723e
Abstract: The objective of this review is to ensemble information from the literature on the response of cassava to climate change. The growth rate of the most plants increases at elevated CO2 because it is the substrate for photosynthesis, however, the increase in temperature may offset the benefits of CO2 on crop productivity due to a shortening of the cycle and increase in respiration of maintenance. Results from greenhouse, field and numerical experiments indicate that the response of cassava crop to elevated CO2 is positive, i.e. the increase in atmospheric CO2 results in increase of storage root yield of cassava. The increase in temperature projected in future climate scenarios in general should not decrease storage root yield of cassava, mainly in Africa, where this crop has an important role on food security. Further studies should be made using the current knowledge in order to confirm previous studies on the response of cassava to elevated CO2 and temperature in regions where few studies have been conducted, like in Brazil.

Cruz J. L., A. A. C. Alves, D. R. LeCain, D. D. Ellis, and J. A. Morgan. 2014. Effect of elevated CO2 concentration and nitrate: ammonium ratios on gas exchange and growth of cassava (Manihot esculenta Crantz). Plant and Soil, 374:33-43.
Reference ID: 21724
Notes: #21724e
Abstract: This study evaluated how different nitrogen forms affect growth and photosynthetic responses of cassava to CO2 concentration. Cassava was grown in 14-L pots in a greenhouse at 390 or 750 ppm of CO2. Three nitrogen treatments were applied: (a) 12 mM NO3 (-), (b) 6 mM NO3 (-) + 6 mM NH4 (+), and (c) 12 mM NH4 (+).
Thirty-six days after treatments began, plants grown under elevated CO2 and fertilized only with NO3 (-) (750_NO3 (-)) had photosynthetic rates similar to plants grown under 390_NO3 (-), indicating significant photosynthetic acclimation to CO2. In contrast, photosynthetic rates at elevated CO2 increased as NH4 (+) increased in the nutrient solution, such that photosynthetic acclimation was reduced for plants fertilized with only NH4 (+). However, this positive effect of NH4 (+) on photosynthesis was not observed in more advanced growth stages, and the toxic

effects of NH4 (+) severely reduced total dry mass for these plants measured at the end of the experiment.
Our results indicate that cassava will respond with increased biomass accumulation in response to raising atmospheric CO2 levels, and that N form can have an important impact on the photosynthetic response. However, the positive effect of NH4 (+) fertilization on cassava photosynthetic CO2 response eventually led to a toxicity problem that reduced biomass production. The challenge is to determine how to manage NH4 (+) fertilization so that the photosynthetic benefit observed in the initial phase may persist throughout the crop cycle.

Rufino M. C., P. K. Thornton, S. K. Ng'ang'a, I. Mutie, P. G. Jones, M. T. van Wijk, and M. Herrero. 2013. Transitions in agro-pastoralist systems of East Africa: Impacts on food security and poverty. Agriculture, Ecosystems & Environment, 179:215-230.
Reference ID: 21725
Notes: #21725e
Abstract: Climate-induced livelihood transitions in the agricultural systems of Africa are increasingly likely. There is limited evidence on what such transitions might look like. We carried out fieldwork in 12 sites in Kenya, Tanzania and Uganda to understand changes in farming systems in the recent past, and to test the hypothesis that sedentary farmers in zones that may become warmer and drier in the future may be forced to increase their reliance on livestock vis-a-vis cropping in the future. We estimated the contribution of crop and livestock activities to incomes, food security and poverty. Householders were asked how to adapt farming in the future. We found no direct evidence for the hypothesised extensification of production across study sites. Human diets have changed considerably in the last 40 years, as cropping has been taken up by increasing numbers of pastoral households, even in marginal places. Maize and legumes predominate, but some householders are increasing their crop and diet diversity, particularly in locations with annual rainfall higher than 800 mm. At all sites people want more livestock. Food insecurity is common at all sites with an annual rainfall of 800 mm or less, and critical levels are seen at sites with <700 mm. Households are self-sufficient in securing adequate dietary energy from food production in 7 of the 12 sites, all with rainfall higher than 800 mm. Although many householders have some knowledge about drought-tolerant crops, few cultivate millet, sorghum and cassava. Policies aimed at increasing the consumption of cassava, sorghum, millet and pigeon pea could be highly beneficial for future food security in the region. Vulnerability in the drier locations is already high, and policies should support safety nets and market and infrastructural development. Households in the wetter areas need to manage risk and to increase crop productivity. A critical requirement is knowledge transfer concerning the growing and utilisation of unfamiliar and untraditional crops.

Enete A. A. 2013. Challenges of agricultural adaptation to climate change The case of cassava post-harvest in Southeast Nigeria. International Journal of Climate Change Strategies and Mangement, 5:455-470.
Reference ID: 21726
Notes: #21726e
Abstract: Purpose - Climate change is perhaps the most serious environmental threat to agriculture in Africa, because of its impact on pre- and post-harvest agricultural productivity. The purpose of this study is to provide empirical information on the challenges of cassava post-harvest adaptation to climate change. Design/methodology/approach - The study was conducted in two randomly selected

states of southeast Nigeria. Data collection was done in two phases; first, there was a rapid rural appraisal and then a detailed survey using a questionnaire administered to 320 randomly selected cassava processors, 40 from each of eight randomly selected cassava farming communities.
Findings - The respondents were predominantly women, who process, and grow cassava. The factors affecting their level of vulnerability were gender, household size and farm size. While women were more vulnerable than men, households with greater number of persons and/or larger farm size were less vulnerable. Women's vulnerability declined from the 25th income quantile through the 50th to the 75th while the positive effect of farm and household size increased through the same trend. Education was only positively important for the 75th income quantile. The factors constraining adaptation were scarcity of processing inputs, institutional, water and poverty constraints.
Originality/value - Available literature show that most of the recent studies on climate change and agriculture have tended to concentrate on pre-harvest. Ozor et at studied barriers to climate change adaptation among farm households of southern Nigeria. Enete and Onyekuru studied empirical evidence of challenges of agricultural adaptation to climate change, also among farmers of southeast Nigeria. Enete and Amusa presented a literature survey of challenges of agricultural adaptation to climate change. This study is, not only commodity specific, but also focused on post-harvest.

Gleadow R., A. Johnson, and M. Tausz. 2013. Crops for a future climate. Functional Plant Biology, 40:3-5.
Reference ID: 21727
Notes: #21727e
Abstract: The papers in this special issue were mainly derived from sessions at the International Botanical Congress in July 2011 in Melbourne, and at the ComBio meeting in Cairns, September 2011. They make contributions towards one of the most burning issues we face today: increasing sustainable crop production to provide sufficient high quality food to feed an ever increasing global human population, all in the face of climate change. Plant and crop science will have a major part in ensuring that agricultural production can meet these multiple demands. Contributions in this volume go beyond raising issues and highlighting potential effects of climate change factors, but also point out ways to better adapt to the inevitable.

Vandegeer R., R. E. Miller, M. Bain, R. M. Gleadow, and T. R. Cavagnaro. 2013. Drought adversely affects tuber development and nutritional quality of the staple crop cassava (Manihot esculenta Crantz). Functional Plant Biology, 40:195-200.
Reference ID: 21728
Notes: #21728e
Abstract: Cassava (Manihot esculenta Crantz) is the staple food source for over 850 million people worldwide. Cassava contains cyanogenic glucosides and can be toxic to humans, causing paralysing diseases such as konzo, and even death if not properly processed. Konzo epidemics are often associated with times of drought. This may be due to a greater reliance on cassava as it is drought tolerant, but it may also be due to an increase in cyanogenic glucosides. Episodic droughts are forecast to become more common in many cassava-growing regions. We therefore sought to quantify the effect of water-stress on both yield and cyanogenic glucoside concentration (CNc) in the developing tubers of cassava. Five-month-old plants were

grown in a glasshouse and either well watered or droughted for 28 days. A subset of droughted plants was re-watered half way through the experiment. Droughted plants had 45% fewer leaves and lower tuber yield, by 83%, compared with well-watered plants. CNc was 2.9-fold higher in the young leaves of droughted plants, whereas CNc in tubers from droughted plants was 4-fold greater than in tubers from well-watered plants. Re-watered plants had a similar biomass to control plants, and lower CNc than droughted plants. These findings highlight the important link between food quality and episodic drought.

Molyneux N., G. R. da Cruz, R. L. Williams, R. Andersen, and N. C. Turner. 2012. Climate Change and Population Growth in Timor Leste: Implications for Food Security. Ambio, 41:823-840.
Reference ID: 21729
Notes: #21729e
Abstract: The climate in Timor Leste (East Timor) is predicted to become about 1.5 degrees C warmer and about 10 % wetter on average by 2050. By the same year, the population is expected to triple from 1 to 2.5-3 million. This article maps the predicted changes in temperature and rainfall and reviews the implications of climate change and population growth on agricultural systems. Improved cultivars of maize, rice, cassava, sweet potato and peanuts with high yield performance have been introduced, but these will need to be augmented in the future with better adapted cultivars and new crops, such as food and fodder legumes and new management practices. The requirements for fertilizers to boost yields and terracing and/or contour hedgerows to prevent soil erosion of steeply sloping terrain are discussed. Contour hedges can also be used for fodder for improved animal production to provide protein to reduce malnutrition.

Rosenthal D. M., R. A. Slattery, R. E. Miller, A. K. Grennan, T. R. Cavagnaro, C. M. Fauquet, R. M. Gleadow, and D. R. Ort. 2012. Cassava about-FACE: Greater than expected yield stimulation of cassava (Manihot esculenta) by future CO2 levels. Global Change Biology, 18:2661-2675.
Reference ID: 21730
Notes: #21730e
Abstract: Globally, cassava is the second most important root crop after potatoes and the fifth most important crop overall in terms of human caloric intake. In addition to its growing global importance for feed, fuel, and starch, cassava has long been vital to food security in Sub-Saharan Africa. Climate change is expected to have its most severe impact on crops in food insecure regions, yet little is known about how cassava productivity will respond to climate change. The most important driver of climate change is globally increasing atmospheric CO2 concentration ([CO2]). However, the potential for cassava to enhance food security in an elevated [CO2] world is uncertain as greenhouse and open top chamber (OTC) study reports are ambiguous. Studies have yielded misleading results in the past regarding the effect of elevated [CO2] on crop productivity, particularly in cases where pots restricted sink growth. To resolve these conflicting results, we compare the response of cassava to growth at ambient (ca. 385 similar to ppm) and elevated [CO2] (585 similar to ppm) under field conditions and fully open air [CO2] elevation. After three and half months of growth at elevated [CO2], above ground biomass was 30% greater and cassava root tuber dry mass increased over 100% (fresh weight increased 89%). High photosynthetic rates and photosynthetic stimulation by elevated [CO2], larger canopies, and a large sink capacity all contributed to

cassava's growth and yield stimulation. Cassava exhibited photosynthetic acclimation via decreased Rubisco capacity early in the season prior to root tuber initiation when sink capacity was smaller. Importantly, and in contrast to a greenhouse study, we found no evidence of increased leaf N or total cyanide concentration in elevated [CO2]. All of our results are consistent with theoretical expectations; however, the magnitude of the yield increase reported here surpasses all other C3 crops and thus exceeds expectations.

Knox J., T. Hess, A. Daccache, and T. Wheeler. 2012. Climate change impacts on crop productivity in Africa and South Asia. Environmental Research Letters, 7.
Reference ID: 21731
Notes: #21731e
Abstract: Climate change is a serious threat to crop productivity in regions that are already food insecure. We assessed the projected impacts of climate change on the yield of eight major crops in Africa and South Asia using a systematic review and meta-analysis of data in 52 original publications from an initial screen of 1144 studies. Here we show that the projected mean change in yield of all crops is 8% by the 2050s in both regions. Across Africa, mean yield changes of 17% (wheat), 5% (maize), 15% (sorghum) and 10% (millet) and across South Asia of 16% (maize) and 11% (sorghum) were estimated. No mean change in yield was detected for rice. The limited number of studies identified for cassava, sugarcane and yams precluded any opportunity to conduct a meta-analysis for these crops. Variation about the projected mean yield change for all crops was smaller in studies that used an ensemble of > 3 climate (GCM) models. Conversely, complex simulation studies that used biophysical crop models showed the greatest variation in mean yield changes. Evidence of crop yield impact in Africa and South Asia is robust for wheat, maize, sorghum and millet, and either inconclusive, absent or contradictory for rice, cassava and sugarcane.

Jarvis A., J. Ramirez-Villegas, B. V. H. Campo, and C. Navarro-Racines. 2012. Is Cassava the Answer to African Climate Change Adaptation? Tropical Plant Biology, 5:9-29.
Reference ID: 21732
Notes: #21732e
Abstract: This paper examines the impacts of climate change on cassava production in Africa, and questions whether cassava can play an important role in climate change adaptation. First, we examine the impacts that climate change will likely have on cassava itself, and on other important staple food crops for Africa including maize, millets, sorghum, banana, and beans based on projections to 2030. Results indicate that cassava is actually positively impacted in many areas of Africa, with -3.7% to +17.5% changes in climate suitability across the continent. Conversely, for other major food staples, we found that they are all projected to experience negative impacts, with the greatest impacts for beans (-16%+/- 8.8), potato (-14.7 +/- 8.2), banana (-2.5%+/- 4.9), and sorghum (-2.66%+/- 6.45). We then examined the likely challenges that cassava will face from pests and diseases through the use of ecological niche modeling for cassava mosaic disease, whitefly, brown streak disease and cassava mealybug. The findings show that the geographic distribution of these pests and diseases are projected to change, with both new areas opening up and areas where the pests and diseases are likely to leave or reduce in pressure. We finish the paper by looking at the abiotic traits of priority for crop adaptation for a 2030 world, showing that greater drought tolerance could bring some benefits in all

areas of Africa, and that cold tolerance in Southern Africa will continue to be a constraint for cassava despite a warmer 2030 world, hence breeding needs to keep a focus on this trait. Importantly, heat tolerance was not found to be a major priority for crop improvement in cassava in the whole of Africa, but only in localized pockets of West Africa and the Sahel. The paper concludes that cassava is potentially highly resilient to future climatic changes and could provide Africa with options for adaptation whilst other major food staples face challenges.

Belotti A., B. V. H. Campo, and G. Hyman. 2012. Cassava Production and Pest Management: Present and Potential Threats in a Changing Environment. Tropical Plant Biology, 5:39-72.
Reference ID: 21733
Notes: #21733e
Abstract: Cassava is attacked by a complex of arthropod pests across the tropical regions of the world where the crop is grown. Root yield losses have been recorded for several pests, including mites, mealybugs, whiteflies, hornworm, lacebugs, thrips and burrower bugs. Agronomic characteristics such as vegetative propagation, a long growth cycle, drought tolerance, staggered planting dates and intercropping contribute to the considerable diversity of pests that feed on the crop. The dynamics of cassava production are evolving as trends in the food, feed and industrial starch sector are leading to an increased demand for high quality starches. The resulting shift to larger scale production units, expansion of cultivated area and modifications in crop management combined with the effects of climate change, especially warmer temperatures and altered rainfall patterns, affect the occurrence and dynamics of arthropod pests in cassava agro ecosystems. Data is presented to describe the effects of temperature and dry seasons on key pest species. Whiteflies, mites and mealybugs register a suitability increase in the same areas in South America: Northeastern Brazil, Northern Argentina, South-Central Bolivia, and Southwest Peru. In Africa increases are projected in Southeast Africa and Madagascar. In Asia, regions with greater projected suitability for these pest species are Coastal India and Southeast Asia. Future trends and important criteria that will influence the severity and management of key pests are discussed.

Tatsumi K., Y. Yamashiki, R. V. da Silva, K. Takara, Y. Matsuoka, K. Takahashi, K. Maruyama, and N. Kawahara. 2011. Estimation of potential changes in cereals production under climate change scenarios. Hydrological Processes, 25:2715-2725.
Reference ID: 21734
Notes: #21734e
Abstract: This survey proposed a new methodology - iGAEZ (improved GAEZ), developed based on the GAEZ (Global Agro-Ecological Zones) model, capable of simulating crop yields on a global scale for wheat, potato, cassava, soybean, rice, sweet potato, maize, green beans. iGAEZ determines the optimum criteria of crop parameter of growth cycles to ensure best realistic crop yield combinations under comprehensive consideration of climate and crop condition. Global-scale crop yields were calculated using iGAEZ model for the period of 1990-1999. Through comparing simulated yields and FAO statistics, iGAEZ has demonstrated a very good ability to reproduce realistic crop yields on a global scale. We also predicted the impact of global warming on crop yields from the 1990s to 2090s by projecting five GCM outputs for AR4 under SRES A1B scenarios. According to the result, temperature rise will make many cultivated areas (eastern part of USA, India, eastern China, Africa) less productive. On the other hand, the regions with cold weather under

current climate condition (Canada, northern Europe, northeastern China) become suitable for crop productivity under future climate scenario.

McKey D., T. R. Cavagnaro, J. Cliff, and R. Gleadow. 2010. Chemical ecology in coupled human and natural systems: people, manioc, multitrophic interactions and global change. Chemoecology, 20:109-133.
Reference ID: 21735
Notes: #21735e
Abstract: Chemical ecology provides unique perspectives for managing plant/human interactions to achieve food security. Allelochemicals function as chemical defences of crop plants, enhancing yields. While ingested allelochemicals can confer health benefits to humans, at higher concentrations they are often toxic. The delicate balance between their positive and negative effects in crop plants is influenced by many factors. Some of these-how environment affects optimal levels of defence, how metabolic interactions with nutrients affect toxicity of ingested allelochemicals-are the province of chemical ecology. These biological factors, however, interact with social factors, and neither can be studied independently. Chemical ecologists must work together with social scientists to understand the overall system. Here, we illustrate such an integrative approach, analysing the interactions between people and the major tropical crop manioc, which contains cyanogenic glucosides. Polymorphism for cyanogen levels in manioc facilitates analysis of how costs and benefits of crop defences vary among social systems. We first show how people/manioc interactions diversified in this crop's Amazonian homeland, then turn to the remarkable cultural adaptations of African farmers since manioc's introduction 400 years ago. Finally, we evaluate new coevolutionary challenges in parts of Africa where people are still unfamiliar with a potentially dangerous crop. Current environmental and social catastrophes have restricted farmers' options, resulting in acute problems in health of humans and ecosystems. We show that high cyanogen levels confer important agronomic advantages, but also impose costs and constraints that can only be understood when biology is coupled with analysis of social, cultural and economic factors. Detoxifying manioc technologically requires know-how, time, water and other resources. Detoxifying residual dietary cyanogens metabolically depends on being able to grow, or to buy, the nutrients required for detoxification, primarily sulphur-rich proteins. Solutions that appear adaptive today may not be in the future, as changing climate, rising atmospheric CO(2) levels and decreased access to fertilizers affect productivity of crops and the nutrient and allelochemical composition of the foods they are used to produce.

Adejuwon J. O. 2006. Food crop production in Nigeria. II. Potential effects of climate change. Climate Research, 32:229-245.
Reference ID: 21736
Notes: #21736e
Abstract: Two separate lines of investigation were adapted from the recommendations of the 1994 United States Country Studies Program (USCP). In one approach, arbitrary incremental scenarios were adopted to assess the response of crop yield to changes in the various elements of climate. Using the erosion productivity impact calculator (EPIC) crop model, tests were conducted to demonstrate how crop yield might respond to changes in rainfall, relative humidity (RH), temperature, solar radiation and CO2 concentration. The value of one element was altered incrementally while holding constant the values of the others. In the second approach, potential future changes in the yields of maize, sorghum, millet,

rice and cassava were simulated based on a scenario specifying mean conditions for 1961-9190 as a baseline and general circulation model (GCM) projections from this for 3 periods: 2010-2039, 2040-2069 and 2070-2099. The results predicted a possible increase in crop yield during the first half of the 21st century to be followed by a decrease during the second half. Enhanced crop yield was explained by projected increases in rainfall, solar radiation, atmospheric humidity and CO2 concentrations. Lower yields were explained in terms of continued global warming, as a result of which maximum and minimum temperatures approach the limits of tolerance for the modelled crops.

Kamukondiwa W. 1996. Alternative food crops to adapt to potential climatic change in southern Africa. Climate Research, 6:153-155.
Reference ID: 21737
Notes: #21737e
Abstract: This paper discusses the merits of an alternative food crop, cassava Manihot esculenta, as a means to alleviate the effects of climate-induced drought on human and livestock food security in southern Africa. Although both tubers and leaves of cassava can be processed for consumption, the crop is grown to a very limited extent in this region. However, local awareness of cassava's potential has increased over the last decade.

Valdivia C., M. K. Danda, D. Sheikh, H. S. James, V. Gathaara, G. Mbure, F. Murithi, and W. Folk. 2014. Using translational research to enhance farmers' voice: a case study of the potential introduction of GM cassava in Kenya's coast. Agriculture and Human Values, 31:673-681.
Reference ID: 21738
Notes: #21738e
Abstract: Genetically modified (GM) cassava is currently being developed to address problems of diseases that threaten the food security of farmers in developing countries. The technologies are aimed at smallholder farmers, in hopes of reducing the vulnerability of cassava production to these diseases. In this paper we examine barriers to farmers' voice in the development of GM cassava. We also examine the role of a translational research process to enhance farmers' voice, to understand the sources of vulnerability farmers in a group in Kenya's Coast face, and to determine if their concerns are consistent with those of the scientists in agriculture addressing farmers' needs. A two-way communication participatory process provided insights into the complex vulnerability context of farmers, their primary concerns with processing and markets of cassava in order to improve livelihoods, the lack of networks with two way communication flows, and the lack of information on GM technologies. The translational research engaged farmers and scientists in an iterative process where scientists are learning what farmers need, and farmers are learning about the potential benefits and risks from GM technologies, while at the same time expressing their concerns.

Diallo Y., M. T. Gueye, M. Sakho, P. G. Darboux, A. Kane, J. P. Barthelemy, and G. Lognay. 2013. Nutritional importance of cassava and perspectives as a staple food in Senegal. A review. Biotechnologie Agronomie Societe Et Environnement, 17:634-643.
Reference ID: 21739
Notes: #21739e

Abstract: Cassava is one of the main plants and starchy roots grown in the world. In 2008, the total yield of cassava in West Africa represented 29% of the world production. However, in many West African countries such as Senegal, cassava is not used as a staple food. In fact, the processing techniques used for cassava are poorly known. In addition, the chemical composition of local cassava varieties has not yet been determined, nor has their toxicity been assessed. In 2004, showing an aggressive agricultural policy and revived interest, the Senegalese government launched a major program for intensifying the production of cassava for food security purposes. Cassava is an important source of calories and can be an interesting option for imported rice and wheat. Although many food products made from cassava are well known in the region, their use in the Senegalese diet is rare. Nevertheless, these cassava products are found as delicacies in some restaurants, and are consumed by the Senegalese and many other Africans. The objective of the present study is to demonstrate the nutritional value and the dietary possibilities of using cassava as a staple food in Senegal.

Campo B. V. H., G. Hyman, and A. Belotti. 2011. Threats to cassava production: known and potential geographic distribution of four key biotic constraints. Food Security, 3:329-345.
Reference ID: 21740
Notes: #21740e
Abstract: Insect pests and plant diseases reduce cassava yields substantially, posing a threat to food security throughout the developing world. While agricultural scientists have recognized these threats, few assessments of the geographic distribution of cassava pests and diseases have been made at the global scale. The goal of this study is to make such an evaluation for four key biotic constraints to cassava production in developing countries: whiteflies, cassava green mites, cassava mosaic disease and cassava brown streak disease. Occurrence records were obtained from laboratory and biodiversity databases and from the scientific literature. These records were then used in ecological niche models to predict the potential distribution of cassava pests and diseases. The distribution maps were cross validated by holding back 20% of the occurrence records. Potential distribution maps were developed by combining the results of the best ecological niche models. Hotspots for potential cassava pest and disease outbreaks include the Mato Grosso in Brazil, northern South America, the African rift valley, the southern tip of India and much of Southeast Asia, where all four biotic constraints show high potential suitability. Our work highlights how potential geographical shifts in infestation hotspots for several cassava biotic constraints will require intensified monitoring, evaluation and research to prevent yield losses and ensure food security.

Udensi U. E., G. Tarawali, E. U. Favour, G. Asumugha, C. Ezedinma, B. C. Okoye, C. Okarter, P. Ilona, R. Okechukwu, and A. Dixon. 2011. Adoption of selected improved cassava varieties among smallholder farmers in South-Eastern Nigeria. Journal of Food Agriculture & Environment, 9:329-335.
Reference ID: 21741
Notes: #21741e
Abstract: Cassava is a dominant component in crop mixtures in South-Eastern Nigeria. It is a preferred food security crop among smallholder farmers, because it can tolerate drought, low soil fertility and its production requires minimum external inputs. Various constraints have been shown to affect the widespread adoption of improved cassava varieties. This study examines various factors influencing the

adoption of selected improved cassava varieties by smallholder farmers in Abia State, Nigeria, using the probit model. A multi-stage random sampling procedure was used to select 510 cassava farmers from 17 Local Government Areas of Abia State in 2007. Results of the study showed that 56.5% of the respondents were females. The majority (90.2%) consisted of those who were in their productive years. Most (78.8%) of the respondents were married, 83% attended formal schools; while75% had a household size of more than 5 persons. All the respondents were basically small-holder farmers; with 47% full time, 50% of the respondents had secured tenurial arrangements; 93% had more than 6 years of farming experience and 82.2% of them had adopted improved cassava varieties. Results indicated that 74% of 510 farmers who responded adopted improved cassava varieties, either solely or in combination with local varieties. The most popular varieties were NR-8082 (38.6% of total adopters), TME-419 (36.7%) and TMS-980505(12.9%). Marital status, household size, farm size, cassava maturity period and tenurial status were negatively and significantly related to adoption. Cassava yield and average income had a positive relationship with the adoption of the improved varieties. Implicit in these results is that policies should be aimed at introduction and prompt release of high yielding and early maturing cassava varieties, and converting tenurial arrangements of land to more secure forms.

Fermont A. M., A. Babirye, H. M. Obiero, S. Abele, and K. E. Giller. 2010. False beliefs on the socio-economic drivers of cassava cropping. Agronomy For Sustainable Development, 30:433-444.
Reference ID: 21742
Notes: #21742e
Abstract: General belief has it that cassava is (i) a subsistence crop, grown to avoid hunger (ii) by poor farmers, (iii) predominantly as an intercrop, (iv) requiring less labour than other crops and (v) no inputs. These beliefs influence policy, project development and implementation, and if wrong, may have far-reaching consequences for the success and sustainability of interventions. This study examines five beliefs about cassava and discusses consequences for interventions targeting cassava. From 2004 to 2006, 120 detailed farm surveys were carried out with smallholder farmers in 6 sites in central/eastern Uganda and western Kenya, whereby households were categorised in three wealth categories by local key informants. Through structured interviews and field visits, details on the importance of cassava, socio-economic indicators, food security, crop management and labour aspects were obtained. Our results show that cassava does ensure food security, but that the other beliefs are either myths or half truths. Besides supplying 27-41% of starchy staple food consumption, cassava also provided significant income (84 US$ yr(-1)), similar to that of maize (90 US$ yr(-1)). It is too simplistic to classify cassava as a 'poor man's crop' as in Uganda wealthier households marketed more (+16%), but in Kenya consumed less (-11%) cassava than poorer farmers. Cassava is not predominantly intercropped (30% of acreage in Uganda and 51% in Kenya), farmers do use inputs on cassava (36% of the households hire labour) and total labour requirements (287 mandays ha(-1)) were higher than for most crops. Contrary to expectations, we conclude that increasing cassava production will not improve food security - unless a disease epidemic is present - but instead will improve the scope for commercialisation of cassava. To ensure that projects designed to enhance cassava production benefit poor and/or labour deficit households, specific provisions are needed, including development of labour saving technologies.

Rusike J., N. M. Mahungu, S. Jumbo, V. S. Sandifolo, and G. Malindi. 2010. Estimating impact of cassava research for development approach on productivity, uptake and food security in Malawi. Food Policy, 35: 98-111.
Reference ID: 21743
Notes: #21743e
Abstract: Cassava in Malawi is the second most important staple food crop after maize. This paper assesses the impact of agricultural research for development approach in Malawi on cassava yields, per capita area planted to cassava and household calorie intake from cassava and maize. Given the growing interest over the past decade in agricultural research for development as an innovation systems approach for improving the delivery of research-derived benefits to smallholder farmers and having impact in Africa, this paper provides empirical evidence as to the effects of this framework. The paper concludes that Malawi's cassava research for development has contributed to measurable gains in area planted to cassava, cassava yields and household caloric intake.

Sitko N. 2008. Maize, food insecurity, and the field of performance in southern Zambia. Agriculture and Human Values, 26:3-11.
Reference ID: 21744
Notes: #21744e
Abstract: This paper explores the interrelationship between maize farming, the discourse of modernity, and the performance of a modern farmer in southern Zambia. The post-colonial Zambian government discursively constructed maize as a vehicle for expanding economic modernization into rural Zambia and undoing the colonial government's urban modernization bias. The pressures of neo-liberal reform have changed this discursive construction in ways that constitute maize as an obstacle to sustained food security in southern Zambia. Despite this discursive change, maize continues to occupy a central position in the farming systems of the region. I argue that the continued prevalence of maize in southern Zambia can be understood as a performance that allows farmers to maintain their identities as modern rural subjects. The paper concludes with the policy implications of the field of performance on two contemporary debates in Zambian food security: the use of GMO crops and the promotion of cassava as a drought tolerant alternative to maize.

Sautter C., S. Poletti, P. Zhang, and W. Gruissem. 2006. Biofortification of essential nutritional compounds and trace elements in rice and cassava. Proceedings of the Nutrition Society, 65:153-159.
Reference ID: 21745
Notes: #21745e
Conference hosted by Institute of Food Research at University of East Anglia, Norwich, 28 June to 1 July 2005
Abstract: Plant biotechnology can make important contributions to food security and nutritional improvement. For example, the development of 'Golden Rice' by Professor Ingo Potrykus was a milestone in the application of gene technology to deliver both increased nutritional qualities and health improvement to wide sections of the human population. Mineral nutrient and protein deficiency as well as food security remain the most important challenges for developing countries. Current projects are addressing these issues in two major staple crops, cassava (Manihot esculenta Crantz) and rice. The tropical root crop cassava is a major source of food for approximately 600 million of the population worldwide. In sub-Saharan Africa > 200 million of the population rely on cassava as their major source of dietary energy.

The nutritional quality of the cassava root is not sufficient to meet all dietary needs. Rice is the staple food for half the world population, providing approximately 20% of the per capita energy and 13% of the protein for human consumption worldwide. In many developing countries the dietary contributions of rice are substantially greater (29 center dot 3% dietary energy and 29 center dot 1% dietary protein). The current six most popular 'mega' rice varieties (in terms of popularity and acreage), including Chinese hybrid rice, have an incomplete amino acid profile and contain limited amounts of essential micronutrients. Rice lines with improved Fe contents have been developed using genes that have functions in Fe absorption, translocation and accumulation in the plant, as well as improved Fe bioavailability in the human intestine. Current developments in biotechnology-assisted plant improvement are reviewed and the potential of the technology in addressing human nutrition and health are discussed.

Allemann J., S. M. Laurie, S. Thiart, and H. J. Vorster. 2004. Sustainable production of root and tuber crops (potato, sweet potato, indigenous potato, cassava) in southern Africa. South African Journal of Botany, 70:60-66.
Reference ID: 21746
Notes: #21746e
Abstract: Africa, including South Africa, is faced with a problem of increasing rural poverty that leads to increasing urbanisation, joblessness, crime, food insecurity and malnutrition. Root and tuber crops such as sweet potato and potato, as well as cassava and indigenous potato are important crops for food security. The latter are also important due to their tolerance to marginal conditions. Potato and sweet potato are of great economic value in South Africa, with well-organised marketing chains and, for potato, a large processing industry. There is one cassava starch extraction factory in operation in South Africa. A number of diseases are of importance in potato in South Africa: early blight, late blight, bacterial wilt, scab and virus. Insect pests such as tuber moth and leaf miner are also constraints. In sweet potato the occurrence of viruses and weevils, as well as the availability of healthy planting material are the most important limiting factors in production. African Cassava Mosaic Disease (CMD) caused by a virus, is a problem in growing cassava. Plant biotechnology applications offer a number of sustainable solutions. Basic applications such as in vitro genebanking where large numbers of accessions can be maintained in a small space, meristem cultures to produce virus-free plants and mass propagation of popular cultivars in order to make planting material available for sustainable production. More advanced biotechnology applications that may be of value are molecular marker technology and genetic engineering. The latter can play a role in overcoming virus and potato tuber moth in potato, in resistance to CMD in cassava and possibly in sweet potato to incorporate virus and weevil resistance.

Van Cooten D. E. and A. K. Borrell. 1999. Enhancing food security in semi-arid eastern Indonesia through permanent raised-bed cropping: a review. Australian Journal of Experimental Agriculture, 39:1035-1046.
Reference ID: 21747
Notes: #21747e
Abstract: Much of south-eastern Indonesia is mountainous and characterised by a semi-arid tropical environment. Soil erosion is a significant environmental problem facing the region, affecting both productivity of the land and water quality. The challenge for the region is to secure year-round food production in such a fragile environment. More than 90% of rain falls in a distinct wet season between November

and April. Therefore, cropping in this region is dependent on matching crop growth with water supply. In particular, crop production depends on the efficient use of rainfall during the wet season, including avoidance of waterlogging, and efficient use of stored soil water during the dry season.
This paper summarises the results of a series of experiments undertaken in West Timer, Indonesia, between 1993 and 1999 aimed at developing a raised-bed cropping system. The objective of these studies was to better utilise the more fertile alluvial soils that are often susceptible to waterlogging during the wet season, allowing a range of crops to be grown in addition to rice.
Raised beds of height 0.2 m and width 1.5 m were constructed either manually or with an 8.5 hp two-wheeled hand tractor. A range of crops including soybeans, sorghum, maize, pigeon pea, yam bean and cassava were successfully grown on raised beds in the wet season in addition to rice, indicating that raised-bed technology overcomes the constraints of waterlogging in the wet season. Soybeans grew particularly well on raised beds, with December-sown crops producing almost twice the yield of January-sown crops (2.6 v, 1.4 t/ha). For rice and soybeans, early sown crops were better able to match growth with water supply, thereby avoiding end-of-season drought. Early sowing and harvesting of wet season crops enables a drought-resistant crop such as sorghum to be planted in late March or early April, utilising the stored soil moisture for grain production and also maintaining ground cover in the dry season.
It is argued that cropping systems based on permanent raised beds can reduce erosion in 2 ways. First, raised beds are a permanent structure and, with the inter-cropping and relay-cropping proposed, crops can provide all-year ground cover in lowland areas. Second, if sufficient food and cash crops are grown on raised beds to meet the basic needs of subsistence farmers, then upland cropping on steep slopes can be replaced by a variety of tree species, providing additional food, fodder, firewood and medicines. Together, these strategies have the capacity to enhance food production and security in the semi-arid areas of eastern Indonesia.

Prudencio Y. C. and R. Al-Hassan. 1994. The Food Security Stabilization Roles Of Cassava In Africa. Food Policy, 19:57-64.
Reference ID: 21748
Notes: #21748e
Abstract: The paper demonstrates that the role of cassava in stabilizing food security in Africa consists of bridging the seasonal food gap during the hungry season; serving as a backstop food reserve against crop failures and famine; and cushioning the downfall of per capita food production where environmental conditions and per capita resource levels are deteriorating. The empirical evidence provided by the Collaborative Study of Cassava in Africa (COSCA) indicates that the relative importance of cassava in the crop mix is positively related to population density, particularly in West Africa; negatively related to land quality; positively related to the environmental risk of crop failure; negatively related to modern inputs use; and negatively related to market accessibility.

Lobell D. B., M. B. Burke, C. Tebaldi, M. D. Mastrandrea, W. P. Falcon, and R. L. Naylor. 2008. Prioritizing Climate Change Adaptation - Needs for Food Security in 2030. Science, 319:607-610.
Reference ID: 21749
Notes: #21749e

Abstract: Investments aimed at improving agricultural adaptation to climate change inevitably favor some crops and regions over others. An analysis of climate risks for crops in 12 food-insecure regions was conducted to identify adaptation priorities, based on statistical crop models and climate projections for 2030 from 20 general circulation models. Results indicate South Asia and Southern Africa as two regions that, without sufficient adaptation measures, will likely suffer negative impacts on several crops that are important to large food-insecure human populations. We also find that uncertainties vary widely by crop, and therefore priorities will depend on the risk attitudes of investment institutions.

Rashid M. I., R. G. M. de Goede, L. Brussaard, J. Bloem, and E. A. Lantinga. 2014. Production-ecological modelling explains the difference between potential soil N mineralisation and actual herbage N uptake. Applied Soil Ecology, 84:83-92.
Reference ID: 21750
Notes: #21750e
Abstract: We studied two different grassland fertiliser management regimes on sand and peat soils: above-ground application of a combination of organic N-rich slurry manure and solid cattle manure (SCM) vs. slit-injected, mineral N-rich slurry manure, whether or not supplemented with chemical fertiliser (non-SCM). Measurements of field N mineralisation as estimated from herbage N uptake in unfertilised plots were compared with (i) potential N mineralisation as determined from a standard laboratory soil incubation, (ii) the contribution of groups of soil organisms to N mineralisation based on production-ecological model calculations, and (iii) N mineralisation calculated according to the Dutch fertilisation recommendation for grasslands. Density and biomass of soil biota (bacteria, fungi, enchytraeids, microarthropods and earthworms) as well as net plant N-uptake were higher in the SCM input grasslands compared to the non-SCM input grasslands. The currently used method in Dutch fertilisation recommendations underestimated actual soil N supply capacity by, on average, 102 kg N ha(1) (202 vs. 304 kg ha(1) = 34%). The summed production-ecological model estimate for N mineralisation by bacteria, fungi, protozoa, and enchytraeids was 87-120% of the measured potential soil N mineralisation. Adding the modelled N mineralisation by earthworms to potential soil N mineralisation explained 98-107% of the measured herbage N uptake from soil. For all grasslands and soil biota groups together, the model estimated 105% of the measured net herbage N uptake from soil. Soil biota production-ecological modelling is a powerful tool to understand and predict N uptake in grassland, reflecting the effects of previous manure management and soil type. The results show that combining production ecological modelling to predict N supply with existing soil N tests using aerobic incubation methods, can add to a scientifically based improvement of the N fertilisation recommendations for production grasslands.

Chinea E. and J. R. Arevalo. 2014. Effects of fertilization management on pasture productivity and nutrient composition. Grass and Forage Science, 69:415-424.
Reference ID: 21751
Notes: #21751e
Abstract: Biomass productivity in poor soils is limited by several factors, among which are climatic conditions and nutrients. The most important limiting nutrients in plant productivity are nitrogen and phosphorus, even in regions receiving <200 mm precipitation. In this study, we evaluated the improvement in pasture and soil quality using different fertilization management procedures over 2 years in phosphorus-deficient soils. Three different fertilizers were used: urban solid waste (USW),

ecofertilizer (EF) and calcium superphosphate (SP). The hypothesis that fertilization management significantly improves the quality of the soil and forage for cattle was also tested.
Results showed that biomass change depended on the year but not on the treatment. Different percentages of functional groups (graminoids, leguminoids and others) were compared by year and treatment. The results were similar for the three groups. In general, the sampled year was more important than the treatments. Soil composition did show some changes, e. g. higher levels of phosphorus in soils fertilized with USW than in the soils under other treatments. As for plant nutrient composition, control plots revealed lower levels of nutrients for graminoids and leguminoids, while the results were irregular in the case of the other species group. For the fertilized plots, USW and SP revealed better results in graminoids, whereas for leguminoids, EF was more nutrient effective in 2004. In 2003, the three fertilizers led to improvements in soil and forage quality compared with the controls. Given the dependence of the local population on goat produce, we suggest a restoration of degraded native pasture areas using these treatments. In particular, USW increases productivity but has minimal effects on functional group composition and soil nutrient cycles.

Abdulai A. and R. Goetz. 2014. Time-Related Characteristics of Tenancy Contracts and Investment in Soil Conservation Practices. Environmental & Resource Economics, 59:87-109.
Reference ID: 21752
Notes: #21752e
Abstract: We present a dynamic model that shows how different types of land tenancy contracts and their time-related characteristics influence farmers' decisions to invest in soil improvement and productive inputs. Using recent household and plot-level data from the Brong-Ahafo Region in Ghana, we analyze the impact of land tenancy arrangements, contract duration, as well as the number of times the contract has been renewed in the past on the intensity of investment in soil conservation measures such as ditches and farmyard manure and productive inputs like chemical fertilizer. The empirical findings generally confirm the predictions of the theoretical model and reveal that the intensity of investments on different plots cultivated by a given farmer varies significantly with the type of tenancy arrangement on the plot as well as the time-related characteristics of the contract.

Srinivasarao C., R. Lal, S. Kundu, M. B. B. P. Babu, B. Venkateswarlu, and A. K. Singh. 2014. Soil carbon sequestration in rainfed production systems in the semiarid tropics of India. Science of the Total Environment, 487:587-603.
Reference ID: 21753
Notes: #21753e
Abstract: Severe soil organic carbon (SOC) depletion is a major constraint in rainfed agroecosystems in India because it directly influences soil quality, crop productivity and sustainability. The magnitude of soil organic, inorganic and total carbon stocks in the semi-arid bioclimate is estimated at 2.9, 1.9 and 4.8 Pg respectively. Sorghum, finger millet, pearl millet, maize, rice, groundnut, soybean, cotton, food legumes etc. are predominant crop production systems with a little, if any, recycling of organic matter. Data from the long term experiments on major rainfed production systems in India show that higher amount of crop residue C input (Mg/ha/y) return back to soil in soybean-safflower (3.37) system practiced in Vertisol region of central India. Long term addition of chemical fertilizer and organic amendments improved the SOC

stock. For every Mg/ha increase in SOC stock in the root zone, there occurs an increase in grain yield (kg/ha) of 13, 101, 90, 170, 145, 18 and 160 for groundnut, finger millet, sorghum, pearl millet, soybean and rice, respectively. Long-term cropping without using any organic amendment and/or mineral fertilizers can severely deplete the SOC stock which is the highest in groundnut-finger millet system (0.92 Mg C/ha/y) in Alfisols. Some agroforestry systems also have a huge potential of C sequestration to the extent of 10 Mg/ha/y in short rotation eucalyptus and Leucaena plantations. The critical level of C input requirements for maintaining SOC at the antecedent level ranges from 1.1 to 3.5 Mg C/ha/y and differs among soil type and production systems. National level policy interventions needed to promote sustainable use of soil and water resources include prohibiting residue burning, reducing deforestation, promoting integrated farming systems and facilitating payments for ecosystem services. A wide spread adoption of these measures can improve soil quality through increase in SOC sequestration and improvement in agronomic productivity of rainfed agroecosystems.

Czaban J., E. Czyz, G. Siebelec, and J. Niedzwiecki. 2014. Long-lasting effects of bentonite on properties of a sandy soil deprived of the humus layer. International Agrophysics, 28:279-289.
Reference ID: 21754
Notes: #21754e
Abstract: Bentonite has been recognized as a very good material for the improvement of coarse textured soils. In microplot experiment, of a sandy soil deprived of the humus layer was enriched in 1973 with waste bentonite at the rates of 0, 3, 6 and 12 kg m(-2). Until 2002, the microplots were planted with different crops and regularly enriched with mineral and organic fertilizers. Since 2003, the microplots were left barren. In 2009, determinations of several features of the soils (in 5-30, 30-55 and 55-80 cm layers) showed that the historical amendment of the sandy soil with bentonite (especially its highest dose) ensured significantly higher contents of water, organic C, clay, silt and a sand fraction with particle diameter <0.1 mm in 5-30 cm layer. Proportions of non-dispersible clay in the total clay of bentonite soils in the two upper soil layers were significantly lower than those of the control soil. A significant increase in the penetrometer resistance was observed in 40-58 cm layers of the control soil and the soil with 3 kg m(-2) bentonite amendment, contrary to the soils with two highest bentonite doses.

Pardo T., M. P. Bernal, and R. Clemente. 2014. Efficiency of soil organic and inorganic amendments on the remediation of a contaminated mine soil: I. Effects on trace elements and nutrients solubility and leaching risk. Chemosphere, 107:121-128.
Reference ID: 21755
Notes: #21755e
Abstract: A mesocosm experiment, in columns, was conducted in a growth chamber to assess the viability of two organic materials (pig slurry and compost; in combination with hydrated lime) for the remediation of a highly acidic and trace elements (TEs) contaminated mine soil and the reduction of its associated leaching risks. Their influence on the evolution throughout the soil depth of the physicochemical properties (including TEs mobility) of the soil and soil solution (in situ periodic collection) and on Lolium perenne growth and foliar TEs accumulation was evaluated. Soluble and extractable concentrations of the different TEs were considerably high, although the organic amendments (with lime) and lime addition

successfully decreased TEs mobility in the top soil layer, as a consequence of a rise in pH and changes in the redox conditions. Compost and pig slurry increased the soluble organic-C and dissolved N, K and P of the soil, producing a certain downwards displacement of N and K. The organic amendments allowed the growth of L perenne in the soil, thus indicating improvement of soil conditions, but elevated TEs availability in the soil led to toxicity symptoms and abnormally high TEs concentrations in the plants. An evaluation of the functioning and ecotoxicological risks of the remediated soils is reported in part II: this allows verification of the viability of the amendments for remediation strategies.

Giostri A. F., L. F. M. Bond, A. C. V. Motta, I. C. Pimentel, P. C. D. Carvalho, and J. A. Dionisio. 2014. The effects of industrial waste from enzyme production on pasture growth and soil chemical properties. Acta Scientiarum-Agronomy, 36:247-257.
Reference ID: 21756
Notes: #21756e
Abstract: Farmers have used liquid waste from the enzyme industry as fertilizer. To determine the impact of liquid waste from enzymes (LWEs) on soil properties, plant growth and nutrient content in pasture, an experiment was conducted with five different rates of LWE application (0, 45, 90, 135 and 180 m(3) ha(-1)) to a Cambisol in August 2006. In August 2007, 60 m(3) ha(-1) of LWE was applied in every treatment. Soil was sampled on four different dates and at four different depths (0-10, 10-20, 20-40 and 40-60 cm) to verify changes in its chemical properties. Soil was improved in terms of acidity and availability of Ca2+, Mg2+, K+ and P in the 0-10 cm layer, indicating that the effect of LWE is corrective concerning these attributes. There was also improvement in pasture quality through increased levels of N, P and K in plants during the first year of waste application. The use of larger doses of LWE led to increases in productivity (42.6 kg dry weight m(-3) residues). These results indicate that the application of LWE is feasible for the fertilization of this grassland containing low-fertility acidic Cambisol.

Zhao X., J. W. Wang, S. Q. Wang, and G. X. Xing. 2014. Successive straw biochar application as a strategy to sequester carbon and improve fertility: A pot experiment with two rice/wheat rotations in paddy soil. Plant and Soil, 378:279-294.
Reference ID: 21757
Notes: #21757e
Abstract: A pot study spanning four consecutive crop seasons was conducted to compare the effects of successive rice straw biochar/rice straw amendments on C sequestration and soil fertility in rice/wheat rotated paddy soil.
We adopted 4.5 t ha(-1), 9.0 t ha(-1) biochar and 3.75 t ha(-1) straw for each crop season with an identical dose of NPK fertilizers.
We found no major losses of biochar-C over the 2-year experimental period. Obvious reductions in CH4 emission were observed from rice seasons under the biochar application, despite the fact that the biochar brought more C into the soil than the straw. N2O emissions with biochar were similar to the controls without additives over the 2-year experimental period. Biochar application had positive effects on crop growth, along with positive effects on nutrient (N, P, K, Ca and Mg) uptake by crop plants and the availability of soil P, K, Ca and Mg. High levels of biochar application over the course of the crop rotation suppressed NH3 volatilization in the rice season, but stimulated it in the wheat season.
Converting straw to biochar followed by successive application to soil is viable for soil C sequestration, CH4 mitigation, improvements of soil and crop productivity.

Biochar soil amendment influences NH3 volatilization differently in the flooded rice and upland wheat seasons, respectively.

Zhao Z. P., S. Yan, F. Liu, P. H. Ji, X. Y. Wang, and Y. A. Tong. 2014. Effects of chemical fertilizer combined with organic manure on Fuji apple quality, yield and soil fertility in apple orchard on the Loess Plateau of China. International Journal of Agricultural and Biological Engineering, 7:45-55.
Reference ID: 21758
Notes: #21758e
Abstract: To evaluate the effects of chemical fertilizer combined with organic manure on apple yield, quality and soil fertility, an experiment was conducted in an apple orchard on the Loess Plateau of China. Six treatments, i.e., 1) no nitrogen (N) with chemical phosphorus (P) and potassium (K) (PK), 2) no P with chemical N and K (NK), 3) no K with chemical N and P (NP), 4) N, P and K chemical fertilizers only (NPK), 5) swine manure (M) only (M), and 6) half chemical fertilizers combined with half swine manure (NPKM) were included with three replications for each. The NPKM treatment achieved 36.9 t/ha average annual yield, which was 42.5% greater than the yield of PK treatment. The average annual yields followed the sequence of NPKM>NPK>M>NK>NP>PK. In NPKM treatment 71.3% of the collected apples had an apple diameter greater than 80 mm compared with 58.2%, 41.5 % and 37.2% in NK, PK and NP treatments, respectively. The sugar to acid (S:A) ratio was the greatest in NPKM treatment. The results of Vitamin C, soluble solid and firmness showed that NPKM treatment had the highest values. The concentration of soil organic carbon (SOC) in the 0 to 20 cm depth of soil was significantly affected by addition of M. Compared to the antecedent soil properties, the SOCS in the NPKM and M treatments were increased by 28.8%, 29.4%, and TN contents were 56.5, 49.8% more for soil at 0-20 cm depths, respectively. The major soil nutrients of N, P and K were also significantly increased by M and NPKM treatments in surface soil for five years. The data support the conclusion that, for a production of 35-40 t/ha in an apple orchard on the Loess Plateau of China, the 25-30 t/ha organic manure, 160-200 kg/haN, 100-150 kg/ha P2O5 and 120-160 kg/ha K2O were the most suitable fertilizer application. The finding will be helpful for harmonious development of apple production technology, economic income increase for farmers, and improvement of the apple orchard ecosystem.

Park J. W., K. B. Park, J. S. Lee, and E. Y. Lee. 2014. Adaptability Study about Improvement of Sandy Soil using Ion Exchange Resins. Journal of Korea Society of Waste Management, 31:29-38.
Reference ID: 21759
Notes: #21759e
Abstract: This study was performed to investigate the feasibility of ion-exchange resins as soil amendment. To select resins, weinvestigate four kinds of ion exchange resins, which ions have the most adsorption efficiency of ions (N+, PO4, K+). Inthe Cation (H+) vs Anion (OH) = 1 : 2 (w : w), it showed that the highest N, P, K adsorption efficiency was about 80%and reached pH 6 ~ 7 & EC 1 ~ 2 dS/m after 20 min. The ability to maintain ion adsorption, it was investigated that thegentle curve of the residual ion ratio of nitrate nitrogen, available phosphorus, exchangeable potassium was maintained. On the other hand, the control(Slow release fertilizer) was significantly reduced under artificial rainfall conditions. Inaddition, the results of three consecutive crop test were showed that the growth of crops decreased 41.8% than the earlygrowth in the control group, whereas decreased 8.3% in the treatment

group (ion exchange resins). According to the resultsof soil analysis, it was reduced that the fertilizer ingredients (N 94%, P 74.5%, K 98.6%) in the control and reduced fertilizer ingredients (N 64%, P 60.3%)

Li J., F. D. Li, Q. Liu, Y. Zhang, G. S. Zhao, and Z. Ouyang. 2014. Influence of Long-Term Fertilization on Crop Production and Soil Quality of a Recent Alluvial Soil. Agronomy Journal, 106:143-150.
Reference ID: 21760
Notes: #21760e
Abstract: The Yellow River Delta (YRD) has been formed during the last 150 yr and is the youngest land in China. Identifying the current soil quality, the impact of long-term fertilization on crop production, and how to improve crop production in this region are of great concern to scientists and the government. The objectives of this research were to analyze the trends of wheat (Triticum aestivum L.) and corn (Zea mays L.) production and fertilizer application using data covering a period of about 25 yr, determine the current soil quality and compare the changes of that with soils collected in the second national soil census, and discuss the impact of long-term fertilization on crop production and soil quality in the YRD. Records indicated that crop production increased 2.1-fold from 1984 to 2008, with an approximate 3.5-fold increase in fertilizer application. A fuzzy comprehensive assessment of soil quality indicated an improvement during this same time period, but the average soil quality was still low relative to national standards, particularly due to low N availability. Although fertilization strategies appeared to have been successful in this region, declines in fertilizer use efficiency and the currently poor soil quality indicate a need for improved management strategies. Effective technology and education programs are required to improve fertilizer application practices and the management of soil quality, which would increase crop production.

Li S. Q., X. Y. Di, D. M. Wu, and J. T. Zhang. 2013. Effects of sewage sludge and nitrogen fertilizer on herbage growth and soil fertility improvement in restoration of the abandoned opencast mining areas in Shanxi, China. Environmental Earth Sciences, 70:3323-3333.
Reference ID: 21761
Notes: #21761e
Abstract: A field trial was conducted to investigate the effects of application of sewage sludge and nitrogen fertilizer on herbage growth and fertility improvement of raw mixed-loess soils at the west waste dump of Antaibao surface mine (ATB) in Shanxi, China. Four indigenous species present in mining areas, including Kentucky bluegrass, Erect milkvetch, Alfalfa and Alfalfa-ryegrass mixture were selected as the herbaceous plants in the field trial. The results showed that applying sewage sludge and nitrogen fertilizer, biomasses of all the four grasses were significantly increased when compared with those in the control group. After 100 days growth, applying sewage sludge had the greatest effects on biomass increasing for Kentucky bluegrass (17.54 times in the overground yields and 13.94 times in underground yields when compared with the control group) or Alfalfa-ryegrass mixture (5.34 and 7.20 times, respectively); meanwhile, the combined application of sewage sludge and nitrogen fertilizer also had the best effects. It was concluded that Kentucky bluegrass is the best pioneer species for quickly establishing vegetation in ATB abandoned opencast mining areas; municipal sewage sludge is an effective bio-fertilizer for the fertility improvement of raw mixed-loess soils; and the combined application of sewage sludge and nitrogen fertilizer in plots revegetated with Alfalfa-

ryegrass mixture is the best strategy to help quickly establish a self-sustaining vegetation system during the primary stage of reclamation in ATB abandoned opencast mining areas in China.

Yang S., Z. Zhang, L. Cong, X. Wang, and S. Shi. 2013. Effect of fulvic acid on the phosphorus availability in acid soil. Journal of Soil Science and Plant Nutrition, 13:536-533.
Reference ID: 21762
Notes: #21762e
Abstract: The incubation experiment was conducted to evaluate the influence of fulvic acid (FA) on phosphorus (P) movement and transformation in acid soil. FA at the rate of 0, 0.1, 0.2, 0.3 g and in combination with 0.19 g KH2PO4 was sprinkled uniformly on the surface of the filter paper on the soil cylinder for 21 days incubation, respectively. The result showed that the pH of soil treated with FA increased from the original value of 5.83 to the highest value of 6.27 in the surface soil layer after 21 days incubation. Due to the application of FA, exchangeable Al concentration evidently decreased in comparison to the only P treatment, which in turn significantly increased available P concentration. FA also increased the movement length of P that reached 4.5, 5.5 and 6.5 cm depth for treatments reinforced with 0.1, 0.2 and 0.3 g FA per column, respectively. As FA was added into soil, microbial population, organic matter content and cation exchange capacity (CEC) all clearly elevated. It is suggested that P fertilizer and FA are fertilized together may be considered as an optimum choice for the improvement of P availability and soil physicochemical conditions.

Sun L., Z. Liu, M. Zheng, Q. Cai, and H. Fang. 2013. Temporal variations of ecological security with soil and water loss stress in black soil region of northeast China: a case study on Baiquan County. SpringerPlus, 2:1-6.
Reference ID: 21763
Notes: #21763e
ICCLD in Zi'An City, PR China, 11-15 Oct 2010
Abstract: The deterioration of ecological situation with serious soil and water loss in black soil region of northeast China has attracted more attention due to its significant role on food security of China. To investigate the temporal characteristics of ecological status in typical black soil areas, Baiquan County is selected. Based on the model of Press-Status-Response (P-S-R), indicators are established and the ecological security situations with soil and water loss of Baiquan County are evaluated for the years of 1979, 1990, 2000 and 2005. The results show that the ecological insecurity indicator changes from 0.701 to 0.435 from 1979 to 2005, with a decrease of 37.9% for Baiquan County. And the contributions of physical and human factors to the temporal variations of the ecological security are discussed in detail. Moreover, several problems are recognized to be the potential threats to the ecological security in Baiquan county, including reduction of the effective thickness, excessive application of the fertilizer and low efficiency of the agricultural irrigation system. It is found that effective soil and water loss control actions have made great contribution to the improvement of the ecological security in Baiquan county. All these results and discussions are very helpful for the further investigation on the quantitative relationship between soil and water loss and ecological security in black soil region of northeast China.

Yang C. H., J. H. Lee, N. H. Baek, P. Shin, K. M. Cho, S. B. Lee, and G. B. Lee. 2013. Incorporation Effect of Green Manure Crops on Improvement of Soil Environment on Saemangeum Reclaimed Land during Silage Corn Cultivation. Korean Journal of Soil Science and Fertilizer, 46:187-192.
Reference ID: 21764
Notes: #21764e
Abstract: This study was carried out to investigate the incorporation effect of green manure crops (GMC) such as the hairy vetch on improvement of soil environment in reclaimed land during silage corn cultivation over the past two years. Plots consisted of conventional fertilization (CF) and incorporation of GMC were divided by addition rate of nitrogen fertilizer (100 kg ha-1) with 30 – 100% of non nitrogen fertilization (NNF). Soil physico-chemical properties and growth and yield potential of silage corn were examined. The tested soils showed strong alkali and saline properties with low contents of organic matter and available phosphate while contents of exchangeable sodium and magnesium were high. Soil salinity increased during cultivation of summer crop. However, corn was not affected by salt content. The fresh weight of GMC at incorporation time was 18,345 kg ha-1. Content of total nitrogen was 3.09% and the C/N ratio was 12.8 at incorporation time. Fresh and dry matter yield of silage corn were higher in the order of N30% reduction, CF, N50% reduction,N70% reduction, N100% reduction and NNF. Fresh and dry matter yield potential of silage corn for N30%reduction were comparable to those of CF. Bulk density of the soil decreased with incorporation of GMC,while porosity was increased. The soil pH decreased while content of exchangeable calcium, available phosphate, and organic matter increased. Also contents of exchangeable sodium and potassium decreased with incorporation of GMC. The data indicate that incorporation of hairy vetch can improve soil physical and chemical properties and reduce nitrogen fertilizer application especially for alkali saline reclaimed soil such as Saemangeum reclaimed land.

Lee C. H., S. S. Kang, K. Y. Jung, and P. J. Kim. 2013. Effect of Long Term Fertilization on Microbial Biomass, Enzyme Activities, and Community Structure in Rice Paddy Soil. Korean Journal of Soil Science and Fertilizer, 46:487-493.
Reference ID: 21765
Notes: #21765e
Abstract: The effects of long-term fertilization on soil biological properties and microbial community structure in theplough layer in a rice paddy soil in southern Korea were investigated in relation to the continuous application ofchemical fertilizers (NPK), straw based compost (Compost), combination these two (NPK + Compost) for last 40years. No fertilization plot (Control) was installed for comparison. Though fertilization significantly improvedrice productivity over control, the long-term fertilization of NPK and compost combination was more effective onincreasing rice productivity and soil nutrient status than single application of compost or chemical fertilizer. Allfertilization treatments had shown significant improvement in soil microbial properties, however, continuouscompost fertilization markedly increased soil enzyme and microbial activities as compared to sole chemicalfertilization. Results of microbial community structure, evaluated by EL-FAME (ester-linked fatty acid methylesters) method, revealed big difference among Control, NPK, and Compost. However, both Compost andCompost+NPK treatments belonged to the same cluster after statistical analysis. The combined application ofchemical fertilizer and organic amendments could be more rational strategy to improve soil nutrient

status andpromote soil microbial communities than the single chemical fertilizer or compost application.

Lobo T. F., H. Grassi, L. T. Bull, and L. L. Q. Moreira. 2013. Management of sewage sludge and mineral nitrogen in soil fertility over time. Semina-Ciencias Agrarias, 34:2705-2725.
Reference ID: 21766
Notes: #21766e
Abstract: The use of sewage sludge is a practice highly promising for the development of sustainable agricultural systems. The objective of this study was to assess the improvement in soil fertility management strategies on different sewage sludge and mineral nitrogen after seven application of this residue. The experiment was carried at the Sao Manuel Experimental Farm belonging to the faculty of Agronomic Sciences of UNESP, Botucatu, located in the county of Sao Manuel. It was adopted the experimental design in a randomized blocks consisting of six treatments and five repetitions defined as follows: T0 - without nitrogen fertilizer, T1 - mineral fertilizer nitrogen according to the crop needs, T2 - 50% nitrogen from sewage sludge and 50% in the form of chemical fertilizer, T3 - 100% of nitrogen recommended by the culture, from sewage sludge, T4 - 150% of nitrogen recommended by the culture, from sewage sludge and T5 - 200% of the nitrogen from the sewage sludge. It has done seven application of sewage sludge in crop (year 1 - sunflower, year 2 sunflower, year 3 - oats and bean, year 4 - triticale and sunflower, year 5 - wheat) and the first three applications were treated with sewage sludge and the other applications were composted sludge. In the depth 0-20 cm, the sewage sludge promoted an increase in levels of organic matter, P, S, H+Al, CEC and decreased in soil pH. In the depth of 20 to 40 cm the sewage sludge promoted a decrease in pH and increase in soil organic matter, P, H+Al, K, Ca, SB, CEC and S. Mineral N influence the increase in the depth S of 20-40 cm.

Nagumo T., S. Tajima, S. Chikushi, and A. Yamashita. 2013. Phosphorus Balance and Soil Phosphorus Status in Paddy Rice Fields with Various Fertilizer Practices. Plant Production Sciences, 16:69-76.
Reference ID: 21767
Notes: #21767e
Abstract: Excess phosphorus (P) has accumulated in Japanese paddy soils, due to fertilizer P inputs over crop requirement for several decades, and improvement of the excess of P is necessary in view of environmental conservation. This study aimed to evaluate the input/output balance of P related to soil P status in paddy rice systems, and to obtain a practical indication. Irrigated rice (Oryza sative L.) was cultivated on a gley soil from 1997 to 2006. Six field plots fertilized with commercial fertilizer, animal waste composts, green manure and none were included. Phosphorus input varied among plots from 0 to 73 kg ha(-1) yr(-1). Rice P uptake was approximately 20 kg ha(-1), indicating no response to the P input. This was attributed to a large amount of plant-available Bray- and Truog-P in our soils. In our fields, paddy rice could be cultivated with no P-containing fertilizer or amendment. As a result, increase in the P input led to an increase in partial P balance (PPB). Cumulative increase in PPB resulted in the increase in soil total P, whereas cumulative decrease of PPB tended to decrease it. Excess accumulation of the soil P results in a loss of P into the environment. We concluded that P fertilization should be restricted to 20 kg ha(-1) yr(-1) (corresponding to 46 kg ha(-1) yr(-1) as P2O5), based on evenly

balanced P input with the rice P uptake. It is also important to include all of the P-containing fertilizers and amendments when determining the amount of application.

Presley D. R., A. J. Sindelar, M. E. Buckley, and D. B. Mengel. 2012. Long-Term Nitrogen and Tillage Effects on Soil Physical Properties under Continuous Grain Sorghum. Agronomy Journal, 104:749-755.
Reference ID: 21768
Notes: #21768e
Abstract: Grain sorghum [Sorghum bicolor (L.) Moench] is an important grain crop grown in both highly productive and marginal areas in the central Great Plains because of the crop's ability to use the erratic precipitation observed in this region. More effective capture and storage of this limited rainfall is needed to improve the productivity and profitability of dryland agriculture. The objective of this study was to determine the effects of long-term tillage and N fertilization on soil physical and hydraulic properties after long-term continuous grain sorghum production. Variables included conventional tillage (CT) and no-till (NT) and four rates of N fertilizer. Selected soil quality indicators included soil organic carbon (SOC), bulk density (BD), wet aggregate stability (WAS), and ponded infiltration. No-till accumulated more SOC in the surface 0 to 5 cm, and was less dense at all depths than CT. When tillage was compared across all N rates, NT contained 30% greater SOC than CT at the 0 to 5 cm. Mean weight diameter (MWD) was larger with increasing N fertilization and eliminating tillage. Ponded infiltration rates were greatest for the high N fertilization rate under NT, and lowest for the 0 kg N ha(-1) rate under CT. In this long-term grain sorghum system, increasing N fertilization rate and NT both positively affected soil physical properties. These improvements in hydraulic properties will aid in more effectively capturing unpredictable precipitation, and further underscore the utility of NT management practices for the central Great Plains region.

Adak T., A. Singha, K. Kumar, S. K. Shukla, A. Singh, and V. K. Singh. 2014. Soil organic carbon, dehydrogenase activity, nutrient availability and leaf nutrient content as affected by organic and inorganic source of nutrient in mango orchard soil. Journal of Soil Science and Plant Nutrition, 14:394-406.
Reference ID: 21769
Notes: #21769e
Abstract: Changes in soil organic carbon, dehydrogenase activity, nutrient availability and leaf nutrient concentrations in a mango orchard soil was evaluated from four years (2007-2011) field experiment on a Typic Ustocrepts soil of subtropical region in Lucknow, India. Organic (FYM, vermicompost, mulching, Azotobacter, PSM and Trichoderma harzianum) and inorganic (N, P, K) substrates were applied each year within the tree basin. It was observed that soil and leaf nutrients concentrations significantly increased in organic and inorganic amended soils as compared to control. Vermicompost, organic mulching and microbial inoculation significantly enhanced soil organic carbon content, available nutrients, dehydrogenase activity and leaf nutrient concentrations. Dehydrogenase activity was highest (1.85 ìg TPF g-1 h-1) in organically treated soils. Surface soil (0-10 cm depth) showed higher dehydrogenase activity (1.29 to 1.85 ìg TPF g-1 h-1) as compared to lower soil depths in all the treatments.

Agwu A. E. and C. L. Anyaeche. 2007. Adoption of improved cassava varieties in six rural communities in Anambra State, Nigeria. African Journal of Biotechnology, 6:89-98.
Reference ID: 21770
Notes: #21770e
Abstract: A survey of 118 randomly selected cassava farmers was conducted in Ukpor, Amichi, Osumenyi,Ezinifite, Ekwulummili and Ebenator, communities in Nnewi South Local Government Area of AnambraState using structured interview schedule, to determine the use of improved cassava and local cassava in the area. Majority (64%) of the respondents cultivated both local and improved cassavacultivars. The improved cassava cultivars grown by the farmers were TMS 30572, TMS 30555 and TMS4(2) 1425 while 'akpuocha', 'udukanani' and 'achirinaka' were the most popular local cultivars grown inthe area.However, TMS 30572 and 'udukanani' were the most widely grown cassava cultivars with 78.8and 77.1% of the respondents cultivating them, respectively. Specifically, many of the farmerscultivated TMS 30572 for its high yield, perceived low level of HCN in products, high product quality,pests/disease resistance, ability to shade off weeds and early maturity. Similarly, greater proportion ofthe farmers cultivated 'udukanani' for its late maturity, ease of harvest and colour of tubers while otherscultivated it for its ability to store longer after processing and the palatability of its products. The majorfactors that limit the effective use of improved cassava cultivars in the area were non-availability of important agrochemicals, high cost of labour and lack of finance. The study recommended investigation of the 'udukanani' cultivar to determine its suitability for future cultivar development.

Anwar-ul-Haq M., J. Akhtar, M. Saqib, A. Hussain, and T. Hussain. 2014. Integrated use of farm manure and mineral fertilizers to maintain soil quality for better cotton (Gossypium hirsutum L.) production. Pakistan Journal of Agricultural Science, 51:413-420.
Reference ID: 21771
Notes: #21771e
Abstract: A field experiment was conducted on cotton crop to evaluate the effect of farm manure (FM) alone and in combination withthe mineral fertilizers. FM was treated with the 1% application of effective microorganism prepared with molasses to enrichthe status of FM as FM-Fermented. Cotton Varity Krishma was cultivated in field with treatments viz. control, FM @ 20Mgha-1, FM-Fermented@ 20 Mg ha-1, ½ NPK+FM (20 Mg ha-1), ½ NPK+ FM-Fermented (20 Mg ha-1) and NPK (175-85-60 kgha-1). The experiment was laid out according to randomized complete block design with four replications. At flowering stage fully expanded younger leaves were collocated and analysed for N, P and K contents. Growth and yield parameters of cottonlike plant height, sympodial branches, no. of boll plant-1, seed cotton boll plant-1 and seed cotton yield kg ha-1 were recorded.Soil was analyzed after the harvest of crop for N, P, K and organic matter contents. Data were analysed statistically. Theresults of the experiment indicated that application of recommended dose of NPK produced higher seed cotton yield (2660 kgha-1) and followed by ½ NPK+FM-Fermented (2523 kg ha-1) and differed significantly from other treatments. There waspositive increase in the N, P and K concentration in cotton leaves and in soil due to the combined application of ½ NPK+FMFermented.

Inubushi K., M. A. Ali, M. A. Sattar, M. N. Islam, and Inubushi. 2014. Integrated effects of organic, inorganic and biological amendments on methane emission, soil quality and rice productivity in irrigated paddy ecosystem of Bangladesh: field study of two consecutive rice growing seasons. Plant and Soil, 378:239-252.
Reference ID: 21772
Notes: #21772e
Abstract:
Aims
Effects of different soil amendments were investigated on methane (CH4) emission, soil quality parameters and rice productivity in irrigated paddy field of Bangladesh.
Methods
The experiment was laid out in a randomized complete block design with five treatments and three replications. The experimental treatments were urea (220 kg ha-1) + rice straw compost (2 t ha-1) as a control, urea (170 kg ha-1) + rice straw compost (2 t ha-1) + silicate fertilizer, urea (170 kg ha-1) + sesbania biomass (2 t ha-1) + silicate fertilizer, urea (170 kg ha-1) + azolla biomass (2 t ha-1) + cyanobacterial mixture 15 kg ha-1 silicate fertilizer, urea (170 kg ha-1) + cattle manure compost (2 t ha-1) + silicate fertilizer.
Results
The average of two growing seasons CH4 flux 132 kg ha-1 was recorded from the conventional urea (220 kg ha-1) with rice straw compost incorporated field plot followed by 126.7 (4 % reduction), 130.7 (1.5 % reduction), 116 (12 % reduction) and 126 (5 % reduction) kg CH4 flux ha-1 respectively, with rice straw compost, sesbania biomass, azolla anabaena and cattle manure compost in combination urea and silicate fertilizer applied plots. Rice grain yield was increased by 15 % and 10 % over the control (4.95 Mg ha-1) with silicate plus composted cattle manure and silicate plus azolla anabaena, respectively. Soil quality parameters such as soil organic carbon, total nitrogen, microbial biomass carbon, soil redox status and cations exchange capacity were improved with the added organic materials and azolla biofertilizer amendments with silicate slag and optimum urea application (170 kg ha-1) in paddy field.
Conclusion
Integrated application of silicate fertilizer, well composted organic manures and azolla biofertilizer could be an effective strategy to minimize the use of conventional urea fertilizer, reducing CH4 emissions, improving soil quality parameters and increasing rice productivity in subtropical countries like Bangladesh.

Awale R., A. Chatterjee, and D. Franzen. 2013. Tillage and N-fertilizer influences on selected organic carbon fractions in a North Dakota silty clay soil. Soil and Tillage Research, 134:213-222.
Reference ID: 21773
Notes: #21773e
Abstract: Physical, chemical, and biological fractions of SOC pools, such as coarse particulate organic matter C (CPOM-C), permanganate oxidizable C (KMnO4-C), microbial biomass carbon (MBC), and mineralizable C (Cmin) respond to changes in management practices and provide sensitive indication of changes in the SOC dynamics than commonly reported total soil C alone. We hypothesized that tillage and N-fertilizer managements induced changes in SOC at the surface 0–15 cm soil would predominantly be reflected by parallel changes in different fractions of SOC. Three field experiments (Expt1: 2008–2011, Expt2: 2005–2011, Expt3: 2005–2011) were conducted in a Fargo (Typic Epiaquerts)-Ryan (Typic Natraquerts) silty clay

complex in Fargo, North Dakota, USA. Our objectives were (i) to evaluate the effects of tillage (conventional till [CT], strip till [ST] and no-till [NT] and different N-fertilizer managements on SOC, CPOM-C, KMnO4-C, MBC, and Cmin and (ii) to determine any relationships among these C fractions within corn (Zea mays)-sugarbeet (Beta vulgaris)-soybean (Glycine max) rotation. Compared with CT, ST and NT had significantly higher SOC concentration by 3.8 and 2.7%, SOC stock by 7.2% and 9.2%, CPOM-C by 22 and 25%, and KMnO4-C by 4.8 and 4.1%, respectively in Expt2 and had significantly higher SOC concentration by 3.9 and 6.6%, SOC stock by 11.9 and 8.7%, and CPOM-C by 33 and 45%, respectively in Expt3. The KMnO4-C and 30 d cumulative Cmin were greater under ST than CT by 3.3 and 23%, respectively in Expt3. The amounts of Cmin were consistently higher under ST and NT than CT throughout the incubation period except at 7 d, in Expt3. Across the study, CPOM-C was 16.3–22.1%, MBC was 3.4–4.5%, cumulative Cmin was 0.7–1.4%, and KMnO4-C was 1.6–1.7% of the total SOC. Significant correlations were observed among SOC, CPOM-C and Cmin in all the experiments. CPOM-C was the most sensitive fraction to tillage changes. Tillage influences on SOC fractions followed the order: physical (CPOM-C) > biological (cumulative Cmin) > chemical (KMnO4-C), however, the sequence change with soil type and crop rotation requires further investigation.

Bai J., H. Xu, R. Xiao, H. Gao, K. Zhang, and Q. Ding. 2014. Path analysis for Soil Urease Activities and Nutrient Contents in a Mountain Valley Wetland, China. Clean, 42:324-330.

Reference ID: 21774

Notes: #21774e

Abstract: Soil profiles from 0 to 90?cm depth were collected to investigate temporal dynamics and profile variations in soil urease activities in Carex meyeriana wetland and to capture the direct and indirect effects of soil nutrients on soil urease activities in the Changbai Mountain valley wetland of China during the periods from 2002 to 2003. Our results showed that soil urease activities decreased gradually with increasing depth along soil profiles with higher coefficients of variation in the upper soils, which were positively correlated with microorganism numbers. Soil urease activities during the growing season from May to September were higher than those in April. Path analysis showed that both NO3-–N and dissolved Mg (DMg) had direct positive effects on soil urease activities and they had the highest direct path coefficients and determination coefficients compared to other soil nutrients. Total contents of Cu and Fe showed direct and indirect positive effects on soil urease activities through NO3-–N, whereas they showed negative indirect effects through DMg. Despite that total Mg and dissolved K showed direct adverse effects on soil urease activities, the indirect effects through NO3-–N were much higher. In contrast, total Zn showed both direct and indirect adverse effects on this enzyme. However, the positive indirect effects of soil organic matter, total N, and total P on soil urease activities were more significant than their direct effects. The findings of this work had a potential important role in monitoring soil biological quality in N-limited mountain valley wetland ecosystems.

Bhaduri D., T. J. Purakayastha, A. K. Patra, and D. Chakraborty. 2014. Evaluating soil quality under a long-term integrated tillage-water-nutrient experiment with intensive rice-wheat rotation in a semi-arid Inceptisol, India. Environmental Monitoring and Assessment, 186:2535-2547.
Reference ID: 21775
Notes: #21775e
Abstract: Long-term sustainability and a declining trend in productivity of rice–wheat rotation in the Indo-Gangetic plain, often direct towards the changes in soil quality parameters. Soil quality is decided through few sensitive soil physical, chemical and biological indicators as it cannot be measured directly. The present investigation was carried out to develop a valid soil quality index through some chosen indicators under long-term influences of tillage, water and nutrient-management practices in a rice–wheat cropping system. The experiment consisted of two tillage treatments, three irrigation treatments, and nine nutrient management treatments for both rice and wheat, was continued for 8 years. The index was developed using expert-opinion based conceptual framework model. After harvest of rice, the CFSQI-P (productivity) was higher under puddled situation, whereas CFSQI-EP (environmental protection) was more under non-puddled condition and 3-days of drainage was found promising for all the indices. No-tillage practice always showed higher soil quality index. The treatments either receiving full organics (100 % N) or 25 % substitution of fertilizer N with organics showed higher soil quality indices. Puddling, irrigation after 3 days of drainage and substitution of 25 % recommended fertilizer N dose with FYM in rice could be practiced for maintaining or enhancing soil quality. No-tillage, two irrigations, and domestic sewage sludge in wheat can safely be recommended for achieving higher soil quality.

Bogunovic I., M. Mesic, Z. Zgorelec, A. Jurisic, and D. Bilandzija. 2014. Spatial variation of soil nutrients on sandy-loam soil. Soil & Tillage Research, 144:174-183.
Reference ID: 21776
Notes: #21776e
Abstract: The spatial variability of plant available phosphorus, plant available potassium, soil pH and soil organic matter content in central Croatia was investigated using geostatistical tools and geographical information system to create nutrient maps and provide useful information for the application of inputs that will also be used for the design of an adequate soil sampling scheme. In a regular grid (50 m × 50 m), 330 samples were collected on sandy loam Stagnic Luvisol. Soil available phosphorus and plant available potassium showed relatively high spatial heterogeneity, ranging from 105 mg kg-1 to 310 mg kg-1, and from 115 mg kg-1 to 462 mg kg-1, respectively. Content of soil organic matter and pH had lower variability ranging from 1.26% to 2.66% and from 3.75 to 7.13, respectively. Investigated soil properties did not follow normal distribution. Logarithm and Box–Cox transformation were applied to achieve normality. Directional exponential model for soil available phosphorus, potassium and pH and spherical model for soil organic matter was used to describe spatial autocorrelation. Fourteen different interpolation models for mapping soil properties were tested to compare the prediction accuracy. All models gave similar root mean square error values. Available phosphorus, potassium and pH evaluated by radial basis function models (CRS, IMTQ and CRS, respectively) provide a more realistic picture of the structures of analyzed spatial variables in contrast to kriging and inverse distance weighting models. For soil organic matter datasets the most favorable model was LP1. According to the best model soil nutrient maps were created to provide guidance for site-specific fertilization and

liming. Soil fertility maps showed sufficient concentrations of soil available phosphorus and available potassium. Acidity map showed that the largest part of the investigated area is very acid and acid. For future management it is necessary to provide more liming materials while fertilization rate should be lower.

Gleadow R. M., J. R. Evans, S. McCaffery, and T. R. Cavagnaro. 2009. Growth and nutritive value of cassava (Manihot esculenta Cranz.) are reduced when grown in elevated CO2. Plant Biology, 11:76-82.
Reference ID: 21777
Notes: #21777e
Abstract: Global food security in a changing climate depends on both the nutritive value of staple crops as well as their yields. Here, we examined the direct effect of atmospheric CO2 on cassava (Manihot esculenta Cranz., manioc), a staple for 750 million people worldwide. Cassava is poor in nutrients and contains high levels of cyanogenic glycosides that break down to release toxic hydrogen cyanide when damaged. We grew cassava at three concentrations of CO2 (Ca: 360, 550 and 710 ppm) supplied together with nutrient solution containing either 1 mM or 12 mM nitrogen. We found that total plant biomass and tuber yield (number and mass) decreased linearly with increasing Ca. In the worst-case scenario, tuber mass was reduced by an order of magnitude in plants grown at 710 ppm compared with 360 ppm CO2. Photosynthetic parameters were consistent with the whole plant biomass data. It is proposed that since cassava stomata are highly sensitive to other environmental variables, the decrease in assimilation observed here might, in part, be a direct effect of CO2 on stomata. Total N (used here as a proxy for protein content) and cyanogenic glycoside concentrations of the tubers were not significantly different in the plants grown at elevated CO2. By contrast, the concentration of cyanogenic glycosides in the edible leaves nearly doubled in the highest Ca. If leaves continue to be used as a protein supplement, they will need to be more thoroughly processed in the future. With increasing population density, declining soil fertility, expansion into marginal farmland, together with the predicted increase in extreme climatic events, reliance on robust crops such as cassava will increase. The responses to CO2 shown here point to the possibility that there could be severe food shortages in the coming decades unless CO2 emissions are dramatically reduced, or alternative cultivars or crops are developed.

Malik M. A., K. S. Khan, P. Marschner, and F. Ul-Hassan. 2013. Microbial biomass, nutrient availability and nutrient uptake by wheat in two soils with organic amendments. Journal of Soil Science and Plant Nutrition, 13:955-966.
Reference ID: 21778
Notes: #21778e
Abstract: A 72-day greenhouse pot experiment was conducted with a sandy loam or a silt loam soil to examine the effects of farmyard manure (FYM), poultry litter (PL) and biogenic waste compost (BWC) at 10 g dw kg-1 soil on microbial biomass and activity and growth and nutrient uptake by wheat. Soil samples were collected at days 0, 14, 28, 42, 56 and 72 after planting. Growth and nutrient uptake by wheat were determined on day 72. All three amendments increased microbial biomass C, N and P, dehydrogenase activity, plant growth and nutrient uptake with a greater effect by FYM and PL than by BWC. All amendments increased microbial biomass C, N and P and enzyme activity particularly on day 0. These microbial parameters decreased after day 0 indicating microbial biomass turnover. All amendments increased plant growth and nutrient uptake. It is concluded that organicamendments

can stimulate microbial growth and nutrient uptake as well as plant growth and nutrient uptake. Microbes can increase plant nutrient availability by nutrient mobilisation but also because nutrients taken up by the microbial biomass initially could become available to plants when the microbial biomass turns over as the easily available C is depleted.

Zhang Y., M. Wen, X. Li, and X. Shi. 2014. Long-term fertilisation causes excess supply and loss of phosphorus in purple paddy soil. Journal of the Science of Food and Agriculture, 94:1175-1183.
Reference ID: 21779
Notes: #21779e
Abstract: Phosphorus (P) loss from cropland is accelerating the eutrophication of waters around the world such as the Three Gorges Reservoir (TGR) in China. We investigated whether purple paddy soil under long-term P applications was a major source of P efflux to the TGR.
Substantially surplus P in plow layer (0-20 cm) was evident after 15-year P applications. Available P (Olsen-P) in the plow layer ranged from 1.9 to 42.4 mg kg(-1) and some of which will exceed the threshold of 30 mg kg(-1) for environmental concern within 7 years of P application (inorganic NPK with or without organic fertilizer). Between 30 and 70% of Olsen-P was leached out of the 0-30 cm soil layer. Surplus P resulted in high P concentrations in the surface water during the rice cropping season, and these concentrations exceeded those in most waters of the TGR and exceeded the critical level for eutrophication (0.1 mg L(-1)) during the first 10 days after rice planting. Furthermore, total P in runoff due to rainfall events exceeded the level for eutrophication, with a total loss of 43.2-147.9 g P ha(-1) depending on the fertilization.
Current agronomic P management in purple paddy soil is environmentally unsustainable in terms of the adverse impact on surface water quality. Integrated P management practices are urgently required to optimize crop yield while minimizing P loss so as to protect surface water quality in the TGR region.

Zhao B., J. Chen, J. Zhang, X. Xin, and X. Hao. 2013. How different long-term fertilization strategies influence crop yield and soil properties in a maize field in the North China Plain. Journal of Plant Nutrition and Soil Science, 176:99-109.
Reference ID: 21780
Notes: #21780e
Abstract: The impact of fertilization on maize (Zea mays L.) yield and soil properties was investigated in a long-term (> 18 y) experimental field in N China. A completely randomized block design with seven fertilizer treatments and four replications was used. The seven fertilizer treatments were (1) compost (COMP), (2) half compost plus half chemical fertilizer (COMP1/2), (3) balanced NPK fertilizer (NPK), (4–6) unbalanced chemical fertilizers without one of the major elements (NP, PK, and NK), and (7) an unamended control (CK). In addition to maize yield, soil chemical and biological properties were investigated. Compared to the balanced NPK treatment, maize yield from the COMP treatment was 7.9% higher, from the COMP1/2 was similar, but from the NP, PK, NK, and CK treatment were 12.4%, 59.9%, 78.6%, and 75.7% lower. Across the growing season, microbial biomass C and N contents, basal soil respiration, and fluorescein diacetate hydrolysis, dehydrogenase, urease, and invertase activities in the COMP and COMP1/2 treatments were 7%–203% higher than the NPK treatment. Values from all other treatments were up to 60% lower than the NPK treatment. Maize yield is closely related to the soil organic C (OC) and

biological properties, and the OC is closely related to various biological properties, indicating that OC is a suitable indicator for soil quality. Our results suggest the most limiting nutrient for improving the yield or soil quality was P, followed by N and K, and balanced fertilization is important in maintaining high crop yield and soil quality. Additionally, increases in OC, N, and biological activities in COMP and COMP1/2 treatments imply that organic compost is superior to the chemical fertilizers tested.

Zhou A. and E. Thomson. 2009. The development of biofuels in Asia. Applied Energy, 86:S11-S20.
Reference ID: 21781
Notes: #21781e
Abstract: Asia's largest biofuels producers are currently Indonesia, Malaysia, the Philippines, Thailand, (the) People's Republic of China and India. This paper first examines the current status of biofuels in these countries, including the national development targets, strategies, incentives and policies. It then identifies the fundamental driving forces behind the development and promotion of these industries and considers their economic, social and environmental impacts.

Zhou J., F. Xia, X. Liu, Y. He, J. Xu, and P. C. Brookes. 2014. Effects of nitrogen fertilizer on the acidification of two typical acid soils in South China. Journal of Soils and Sediments, 14:415-422.
Reference ID: 21782
Notes: #21782e
Abstract:
Purpose
A laboratory incubation under constant temperature and humidity was conducted to estimate the impacts of nitrogen (N) fertilizers on the acidification of two acid soils (Plinthudult and Paleudalfs) in south China.
Materials and methods
The experiment had three treatments, i.e., control (CK), addition of urea (U), and addition of ammonium sulfate (AS). We measured soil pH, nitrate (NO_3^-), ammonium (NH_4^+), exchangeable hydrogen ion (H^+), and aluminum ion (Al^{3+}) concentrations at various intervals during the 90 days of incubation. Soil buffering capacity (pHBC) was also measured at the end of the experiment.
Results and discussion
The application of N fertilizers resulted in soil acidification. The U treatment caused greater acidification of the Plinthudult soil than the AS treatment, while there were no differences between U and AS treatments on the acidification of the Paleudalfs. At the end of the trial, the pHBC of Plinthudult in AS treatment was greater than that in CK and U treatments, which may be due to the buffering system of NH_4^+ and NH_4OH. However, the pHBC of Paleudalfs was unchanged between treatments. The dynamics of exchangeable H^+ and Al^{3+} corresponded to that of soil pH. Correlation analysis showed that both soil exchangeable H^+ and soil exchangeable Al^{3+} were significantly related to soil pH.
Conclusions
Application of urea and ammonium sulfate caused acidification in both soils and increased soil exchangeable Al^{3+} and H^+ concentrations in the Paleudalfs. The application of urea increased exchangeable Al^{3+}, and ammonium sulfate increased pHBC in the Plinthudult.

Zorb, C., Senbayram, M., and Peiter, E. Potassium in Agriculture: Status and Perspectives. Better Crops With Plant Food 98[2], 29-31. 2014.
Reference ID: 21783
Notes: #21783e
Abstract: A German research group recently published a review paper taking a fresh look at the behavior of K in soil and in plants. A few of their new findings are summarized here.

Zuiderma P. A., P. A. Leffelaar, W. Gerritsma, L. Mommer, and N. P. R. Anten. 2005. A physiological production model for cocoa (Theobroma cacao): model presentation, validation and application. Agricultural Systems, 84:195-225.
Reference ID: 21784
Notes: #21784e
Abstract: In spite of the economic importance and extensive agronomic literature on cocoa, no physiological production model has been developed for cocoa so far. Such a model would be very useful to compare yields in different climates and cropping systems, and to set the agenda for future agronomic research. Here, we present and apply such a physiological growth and production model for cocoa (SUCROS-Cocoa), based on the SUCROS-family of physiological crop growth models. Our model calculates light interception, photosynthesis, maintenance respiration, evapotranspiration, biomass production and bean yield for cocoa trees grown under shade trees. It can cope with both potential and water-limited situations, and is parameterised using existing information on cocoa physiology and morphology. A validation study showed that the model produces realistic output for bean yield, standing biomass, leaf area and size–age relations. Simulations were carried out using climatic information of 30 locations in 10 cocoa-producing countries, three different soil types and varying shade levels. The model was applied to answer four questions that are currently relevant to cocoa production. (1) Which are the most important yield-determining parameters? Sensitivity analyses revealed that these parameters were chiefly related to the morphology of fruits, photosynthesis and maintenance respiration. (2) To what extent can cocoa yield be predicted by rainfall and irradiance data? Regression analyses showed that over 70% of the variation in simulated bean yield could be explained by a combination of annual radiation and rainfall during the two driest months. (3) How large is the cocoa yield gap due to water limitation? Yield gaps were large – up to 50% – for locations with a strong dry season combined with an unfavourable (clayey or sandy) soil. The calculated yield gaps decreased exponentially with the amount of rain during the two driest months. (4) What are the consequences of shading on cocoa yield? Our simulations showed that moderate shade levels hardly affected bean yield, whereas heavy shading (>60%) reduced yields by more than one-third.

Ayoola O. T. 2010. Yield performance of crops and soil chemical changes under fertilizer treatments in a mixed cropping system. African Journal of Biotechnology, 9:4018-4021.
Reference ID: 21785
Notes: #21785e
Abstract: Yields of maize, melon, cassava and cowpea as well as changes in soil chemical contents were examined under different fertilizer treatments in a mixed cropping system. The results showed that fertilizer treatments had significant effects on the yields of maize, cassava and cowpea but no significant effect on melon yield. Total nitrogen decreased in all the plots after cropping and available phosphorus

reduced from initial value of 4.72 mg/kg to between 3.37 mg/kg where no fertilizer was added and 3.83 mg/kg under inorganic fertilizer. Exchangeable potassium decreased in all the plots irrespective of fertilizer type and the changes ranged between 25% under organic fertilizer and 53% under inorganic fertilizer treatment. The level of organic carbon decreased by about 17% under organic fertilizer but by 59% where inorganic fertilizer was applied. Calcium (Ca) and magnesium (Mg) increased by 21% and 20%, respectively with the application of organic fertilizer. Though yields of crops increased with application of inorganic fertilizer, organic fertilizer and combination of both in this experiment, changes in soil nutrients status after cropping showed that the fertilizer rates used might not be able to sustain soil fertility under the system.

Carsky R. J. and M. A. Toukourou. 2005. Identification of nutrients limiting cassava yield maintenance on a sedimentary soil in Southern Benin, West Africa. Nutrient Cycling in Agroecosystems, 71:151-162.
Reference ID: 21786
Notes: H 8.4.1 #21786
Abstract: Market opportunities will drive intensification of cassava production and fertilizer will play a role in this. A trial was initiated on 15 farmers ' fields (replications) in one village territory in Benin on a relatively fertile sedimentary soil site to identify nutrients limiting cassava yield using nutrient omission plots over three cropping years. There was no response to fertilizer in the first year when fresh root yields in the unamended control averaged 19.1 t ha-1. In the second year, the control yield was 16 t ha-1 and there were significant reductions from withholding P (3.5 t ha-1) and K (2 t ha-1) from a complete fertilizer regime. Nutrient balance after 1 and 2 years (cumulative) showed substantial P and K deficits in unamended plots. In the third year, the control yield was 12.9 t ha-1 and effects of withholding K (5.3 t ha-1), P (5.0 t ha-1) and N (3.0 t ha-1) were statistically significant. Soil K was a significant source of variation in yield in the third year. In the third year of annual nutrient additions soil P and K in the top 0.3 m were increased by 37 and 40%, respectively. Based on the cumulative nutrient balance calculation, the annual application needed to compensate nutrient depletion was 13 kg N, 10 kg P, and 60 kg K ha-1. Partial budget analysis based on these amounts of fertilizer suggested that investment was clearly justified in the third year of continuous cropping at current low cassava prices.

Pypers P., J.-M. Sanginga, B. Kasereka, M. Walangululu, and B. Vanlauwe. 2011. Increased productivity through integrated soil fertility management in cassava–legume intercropping systems in the highlands of Sud-Kivu, DR Congo. Field Crops Research, 120:76-85.
Reference ID: 21787
Notes: #21787e
Abstract: Smallholder farmers in sub-Saharan Africa are confronted by low productivity and limited investment capacity in nutrient inputs. Integrated soil fertility management (ISFM) aims at increased productivity through the combined use of improved germplasm, judicious fertilizer application and organic matter management, adapted to the local farming conditions. We hypothesize that the application of these different ISFM components can result in significant increases in productivity and economic benefits of cassava–legume intercropping systems. Participatory demonstration trials were conducted in the highlands of Sud-Kivu, DR Congo with 12 farmer groups during 3 seasons. Treatments included the farmers' common practice (local common bean and cassava varieties, seed broadcast and

manure addition) and sequentially added ISFM components: improved bean and cassava germplasm, modified crop arrangements, compound NPK fertilizer application and alternative legume species (groundnut or soybean). The use of improved germplasm did not result in yield increases without simultaneous implementation of other ISFM components. Modifying the crop arrangement by planting cassava at 2m between rows and 0.5m within the row, intercropped with four legume lines, increased bean yields during the first season and permits a second bean intercrop, which can increase total legume production by up to 1tha^{-1} and result in an additional revenue of almost 1000USDha^{-1}. Crop arrangement or a second legume intercrop did not affect cassava storage root yields. Fertilizer application increased both legume and cassava yield, and net revenue by 400–700USDha^{-1} with a marginal rate of return of 1.6–2.7. Replacing the common bean intercrop by groundnut increased net revenue by 200–400USDha^{-1} partly because of the higher market value of the grains, but mostly due to a positive effect on cassava storage root yield. Soybean affected cassava yields negatively because of its high biomass production and long maturity period; modifications are needed to integrate a soybean intercrop into the system. The findings demonstrate the large potential of ISFM to increase productivity in cassava–legume systems in the Central-African highlands. Benefits were, however, not observed in all study sites. In poor soils, productivity increases were variable or absent, and soil amendments are required. A better understanding of the conditions under which positive effects occur can enable better targeting and local adaptation of the technologies.

Bull S. E., J. Ndunguru, W. Gruissem, J. R. Beeching, and H. Vanderschuren. 2011. Cassava: constraints to production and the transfer of biotechnology to African laboratories. Plant Cell Reports, 30:779-787.
Reference ID: 21788
Notes: #21788e
Abstract: Knowledge and technology transfer to African institutes is an important objective to help achieve the United Nations Millennium Development Goals. Plant biotechnology in particular enables innovative advances in agriculture and industry, offering new prospects to promote the integration and dissemination of improved crops and their derivatives from developing countries into local markets and the global economy. There is also the need to broaden our knowledge and understanding of cassava as a staple food crop. Cassava (*Manihot esculenta* Crantz) is a vital source of calories for approximately 500 million people living in developing countries. Unfortunately, it is subject to numerous biotic and abiotic stresses that impact on production, consumption, marketability and also local and country economics. To date, improvements to cassava have been led via conventional plant breeding programmes, but with advances in molecular-assisted breeding and plant biotechnology new tools are being developed to hasten the generation of improved farmer-preferred cultivars. In this review, we report on the current constraints to cassava production and knowledge acquisition in Africa, including a case study discussing the opportunities and challenges of a technology transfer programme established between the Mikocheni Agricultural Research Institute in Tanzania and Europe-based researchers. The establishment of cassava biotechnology platform(s) should promote research capabilities in African institutions and allow scientists autonomy to adapt cassava to suit local agro-ecosystems, ultimately serving to develop a sustainable biotechnology infrastructure in African countries.

Bari M. N., M. Z. Alam, S. A. Muyibi, P. Jamal, and Abdullah-Al-Mamum. 2009. Improvement of production of citric acid from oil palm empty fruit bunches: Optimization of media by statistical experimental designs. Biosource Technology, 100:3113-3120.
Reference ID: 21789
Notes: #21789e
Abstract: A sequential optimization based on statistical design and one-factor-at-a-time (OFAT) method was employed to optimize the media constituents for the improvement of citric acid production from oil palm empty fruit bunches (EFB) through solid state bioconversion using Aspergillus niger IBO-103MNB. The results obtained from the Plackett-Burman design indicated that the co-substrate (sucrose), stimulator (methanol) and minerals (Zn, Cu, Mn and Mg) were found to be the major factors for further optimization. Based on the OFAT method, the selected medium constituents and inoculum concentration were optimized by the central composite design (CCD) under the response surface methodology (RSM). The statistical analysis showed that the optimum media containing 6.4% (w/w) of sucrose, 9% (v/w) of minerals and 15.5% (v/w) of inoculum gave the maximum production of citric acid (337.94 g/kg of dry EFB). The analysis showed that sucrose ($p < 0.0011$) and mineral solution ($p < 0.0061$) were more significant compared to inoculum concentration ($p < 0.0127$) for the citric acid production.

ISP. The Planter October 2010. [86], 673-740. 2010. Kuala Lumpur, The Incorporated Society of Planters.
Reference ID: 21790
Notes: S serial #21790 Vol 86 No 1015

ISP. The Planter July 2014. [90], 477-546. 2014. Kuala Lumpur, The Incorporated Society of Planters.
Reference ID: 21791
Notes: S serial #21791 Vol 90 No 1060

ISP. The Planter December 2014. [90], 859-934. 2014. Kuala Lumpur, The Incorporated Society of Planters.
Reference ID: 21792
Notes: S serial #21792 Vol 90 No 1065

Mohd Din A., N. Rajanaidu, A. Kushairi, A. H. Tarmizi, A. Noh, A. Marhalil, Y. Zulkifli, A. Norziha, O. A. Meilina, and S. Ravigadevi. 2014. Performance and Yield Potential of Oil Palm Planting Materials. The Planter, 90:881-904.
Reference ID: 21793
Notes: #21793e > S serial #21792
Abstract: Efforts to improve the oil palm fresh fruit bunch and oil yield in Malaysia continue through various breeding programmes conducted by the Malaysian Palm Oil Board (MPOB) in collaboration with the industry. A total of 10 traits of economic interest have been prioritised and currently being pursued for improvement by oil palm breeders as proposed during a brainstorming session. MPOB also transferred technologies for uptake by the industry in the form of planting materials and breeding populations, better known as 'PS' series. Alternative technologies to the conventional method to produce planting materials took place in the form of semi-clonals, biclonals as well as clones. In addition to that application of molecular technologies is the way to move forward for oil palm breeding to sustain the competitive edge.

ISP. The Planter June 2015. [91], 355-428. 2015. Kuala Lumpur, The Incorporated Society of Planters.
Reference ID: 21794
Notes: S serial #21794

Khairudin H., R. A. Rashyid, and C. S. I. Tan. 2015. Sustainability Certification Standards - Foundation to Finding the Balance in People, Planet and Prosperity. The Planter, 91:367-382.
Reference ID: 21795
Notes: #21795e > S serial #21794
Abstract: Palm oil is an important global commodity with a range of benefits and significant sustainability challenges and opportunities. With the global population expected to increase from the current 7 billion people to 9 billion people in 2050, oil palm has the ability to significantly contribute to the global food security, nutrition and poverty alleviation. In response to the urgent need to address concerns and global demand for sustainably-produced palm oil, there has been increasing numbers of sustainability palm oil standards and producers committing to them, such as the Roundtable on Sustainable Palm Oil (RSPO), Malaysian Sustainable Palm Oil (MSPO), Indonesian Sustainable Palm Oil (ISPO), and International Sustainability Carbon Certification (ISCC). This paper describes the current major challenges facing the palm oil industry such as no deforestation, no planting on peatland, land grabbing and human rights; and illustrates how sustainability standards help provide a reliable framework to implement best practices while continuously improving to address emerging issues, and provide benefits to companies for producing palm oil in a sustainable manner.

Aye T. M. 2015. Field Handbook - 4R Nutrient Management of Mango Tree in Myanmar, IPNI (SEA program).
Reference ID: 21796
Notes: **S 8.6.5 #21796e** e-copy in english

Aye T. M. 2015. Field Handbook - 4R Nutrient Management of Watermelon in Myanmar, IPNI (SEA Program).
Reference ID: 21797
Notes: S 8.6.5 #21797e e-copy in english

Ahenkorah Y., G. S. Akrofi, and A. K. Adri. 1974. The end of the first cocoa shade and manurial experiment at the Cocoa Research Institute of Ghana. Journal of Holticultural Science, 49:43-51.
Reference ID: 21798
Notes: #21798e
Abstract: In an Amelonado cocoa (Theobroma cacao L.) shade and manurial trial, no-shade trees yielded three times as much as shaded trees over 17 years of continuous cropping, but it is inferred that the economic life of an unshaded Amelonado cocoa farm in Ghana may not last for more than 10 years of intensive cropping. No-shade trees require more fertilizer than shaded ones, and lack of fertilizers, especially P, will cause a decline in yield in less than 10 years. A mean loss of over 50 percent of organic carbon within 15 years, with the apparent organic carbon decomposition constant (Kc) = 4.67, was used as a measure of deterioration of the soil productivity. Deterioration of cocoa was rapid under the no-shade conditions partly because of the high loss of exchangeable bases and the greater

stress caused by the higher yield. Trees under stress tended to become more susceptible to insect pests and probably to diseases. Shade conditions affected the distribution of the insect pests of cocoa. The no-shade regime favoured the establishment of mistletoe, Tapinanthus bangwensis and mosses more than on the shaded plots. The intensity of the incident diffuse light and the humidity probably had a greater influence than the age of the tree on the development of mosses on the cocoa trunk and branches.

Amusan O. A., F. O. Amusan, A. Braimoh, and P. Oguntunde. 2005. Management Practices in Cocoa Production in South - Western Nigeria.
Reference ID: 21799
Notes: #21799e
Deutscher Tropentag, Oct 11-13 2005, Stuttgart-Hohenheim
Abstract: The main objective of this study was to investigate quality management practices in the major cocoa production areas of Nigeria. Socio-economic surveys covered resource quality, agronomic practices, and constraints to agricultural production, whereas soil sampling and analyses were carried out to assess contribution of soil to yield. Farm budget analysis was used to determine the profitability of the two major management options of sampled farmers. Linear multiple regression was used to relate biophysical and agronomic data to cocoa yield. Owing to high level of multi-collinearity, independent variables were reduced to six which are organic C, age of farm, plant density, proportion of dormant plants replaced, crop variety and ECEC. Among the variables in the model, two (organic C and age of farm) were negatively related to cocoa yield, whereas other variables were positively related to cocoa yield. However, soil variables were not significant to the model ($p > 0.05$), whereas three management variables (plant density, proportion of dormant plants replaced and crop variety) were significant ($p < 0.1$). All the variables explain 97% of the variability of yield and the model can be used to predict yield at 99% confidence level. Results indicated variability in yield across the three main locations studied. The highest yields were obtained in areas where farmers have access to training in management practices. Soils of the three locations were not significantly different from one another in terms of chemical properties. This probably reflects similarity in the parent materials from which the soils have developed.
Farm budget analysis revealed that minimal management involving fertiliser and pesticide use was less profitable than extensive management. For sustainable cocoa production in the study areas, a high premium should be placed on the quality of cocoa product for export.

Che Man Y. B., T. Haryati, H. M. Ghazali, and B. A. Asbi. 1999. Composition and Thermal Profile of Crude Palm Oil and Its Products. JAOCS, 76:237-242.
Reference ID: 21800
Notes: #21800e
Abstract: Gas-liquid chromatography and high-performance liquid chromatography (HPLC) were used to determine fatty acids and triglyceride (TG) compositions of crude palm oil (CPO), refined, bleached, and deodorized (RBD) palm oil, RBD palm olein, and RBD palm stearin, while their thermal profiles were analyzed by differential scanning calorimeter (DSC). The HPLC chromatograms showed that the TG composition of CPO and RBD palm oil were quite similar. The results showed that CPO, RBD palm oil, RBD olein, and superolein consist mainly of monosaturated and disaturated TG while RBD palm stearin consists mainly of disaturated and

trisaturated TG. In DSC cooling thermograms the peaks of triunsaturated, monosaturated and disaturated TG were found at the range of -48.62 to -60.36, -25.89 to -29.19, and -11.22 to -1.69°C, respectively, while trisaturated TG were found between 13.72 and 27.64°C. The heating thermograms of CPO indicated the presence of polymorphs ß2', a, ß2', and ß1. The peak of CPO was found at 4.78°C. However, after refining, the peak shifted to 6.25°C and became smaller but more apparent as indicated by RBD palm oil thermograms. The heating and cooling thermograms of the RBD palm stearin were characterized by a sharp, high-melting point (high-T) peak temperature and a short and wide low-melting point (low-T) peak temperature, indicating the presence of occluded olein. However, for RBD palm olein, there was only an exothermic low-T peak temperature. The DSC thermograms expressed the thermal behavior of various palm oil and its products quite well, and the profiles can be used as guidelines for fractionation of CPO or RBD palm oil.

Cicatelli A., D. Baldantoni, P. Iovieno, M. Carotenuto, A. Alfani, I. De Feis, and S. Castiglione. 2014. Genetically biodiverse potato cultivars grown on a suitable agricultural soil under compost amendment or mineral fertilization: yield, quality, genetic and epigenetic variations, soil properties. Science of the Total Environment, 493:1025-1035.
Reference ID: 21801
Notes: #21801e
Abstract: The use of compost for soil amendment is a promising agricultural practice environmentally and economically viable. In the framework of a wide research project designed to evaluate the effects of soil amendment with municipal solid waste compost in comparison with traditional mineral fertilization practices, 54 different cultivars (Cvs) of potatoes were AFLP (amplified fragment length polymorphism) molecularly fingerprinted. The seven most genetically biodiverse potato Cvs were used to establish an experimental field in southern Italy. The field area was divided into two portions fertilized with compost (20 Mg ha- 1) or with ammonium sulphate (200 kg ha- 1). No significant differences in productivity, organoleptic characteristics and element concentrations were observed between the potato tubers obtained with both kinds of soil fertilization, while the tubers grown on compost amended soil showed, on average, higher K concentrations with respect to those grown on mineral fertilised soil. cDNA-AFLP (complementary DNA-AFLP) and MSAP (methylation sensitive amplified polymorphism) analyses were carried out on both leaves and tubers of one selected Cv to estimate if any transcriptome alterations or epigenetic modifications were induced by the two kinds of fertilization, however no variations were detected. Chemical and biological soil qualities (i.e., microbial respiration, FDA hydrolysis, alkaline and acid phosphatase) were assessed on soil samples at the start of the experiment and at the end of potato crop cycle. No significant differences in soil pH and limited ones, in the available fraction of some trace elements, were observed; while conductivity was much higher for the compost amended portion of the experimental field. Microbial respiration, FDA hydrolysis and acid phosphatase activities were significantly increased by compost amendment, in comparison with mineral fertilization. Finally, a sensory panel of potato Cvs detected no significant differences among qualitative descriptors and among potatoes coming from the two differently fertilized soils.

Ding X., X. Han, X. Zhang, Y. Qiao, and Y. Liang. 2013. Continuous manuring combined with chemical fertilizer affects soil microbial residues in a Mollisol. Biology and Fertility of Soils, 49:387-393.
Reference ID: 21802
Notes: #21802e
Abstract: In this study, the influence of 10 years' continuous application of organic manure at various rates combined with chemical fertilizer on microbial residues was evaluated in a highly fertile temperate soil. The presence and origin of microbial residues were indicated by amino sugar analysis. The treatments were: (1) CK, unfertilized control; (2) OM0, only chemical fertilizer, no manure added; (3) OM1, organic manure added at 7.5 Mg?ha-1?year-1 plus chemical fertilizer; (4) OM2, organic manure added at 15 Mg?ha-1?year-1 plus chemical fertilizer; and (5) OM3, organic manure added at 22.5 Mg?ha-1?year-1 plus chemical fertilizer. Fertilization significantly increased the total amino sugar concentrations, especially in the plots with higher manure addition rates (OM2 and OM3 plots, P?<?0.05). This suggests a positive effect of organic manure combined with chemical fertilizer on the accumulation of microbial residues in soil. However, the highest manure rate (OM3) did not lead to further increase in the total amino sugar pool as compared with the moderate manure rate (OM2). This suggests manure addition "saturates" in its effect on microbial residue build-up. The different patterns of individual amino sugars suggest a change in the quality of microbial-derived soil organic matter after 10 years.

Fan J., W. Ding, J. Xiang, S. Qin, J. Zhang, and N. Ziadi. 2014. Carbon sequestration in an intensively cultivated sandy loam soil in the North China Plain as affected by compost and inorganic fertilizer application. Geoderma, 230-231:22-28.
Reference ID: 21803
Notes: #21803e
Abstract: Understanding the balance between soil organic carbon (SOC) accumulation and depletion under different fertilization regimes is important for improving soil quality and crop productivity and for mitigating climate change. A long-term field experiment established in 1989 was used to monitor the influence of organic and inorganic fertilizers on the SOC stock in a soil depth of 0–60 cm under an intensive wheat–maize cropping system in the North China Plain. The study involved seven treatments with four replicates: CM, compost; HCM, half compost nitrogen (N) plus half fertilizer N; NPK, fertilizer N, phosphorus (P), and potassium (K); NP, fertilizer N and P; NK, fertilizer N and K; PK, fertilizer P and K; and CK, control without fertilization. Soil samples were collected and analyzed for SOC content in the 0–20 cm layer each year and in the 20–40 cm and 40–60 cm layers every five years. The SOC stock in the 0–60 cm depth displayed a net decrease over 20 years under treatments without fertilizer P or N, and in contrast, increased by proportions ranging from 3.7% to 31.1% under the addition of compost and fertilizer N and P. The stabilization rate of exogenous organic carbon (C) into SOC was only 1.5% in NPK-treated soil but amounted to 8.7% to 14.1% in compost-amended soils (CM and HCM). The total quantities of sequestered SOC were linearly related ($P < 0.01$) to cumulative C inputs to the soil, and a critical input amount of 2.04 Mg C ha- 1 yr- 1 was found to be required to maintain the SOC stock level (zero change due to cropping). However, the organic C sequestration rate in the 0–60 cm depth decreased from 0.41 to 0.29 Mg C ha- 1 yr- 1 for HCM and from 0.90 to 0.29 Mg C ha- 1 yr- 1 for CM from the period of 1989–1994 to the period of 2004–2009, indicating that the SOC stock was getting to saturation after the long-term application

of compost. The estimated SOC saturation level in the 0–60 cm depth for CM was 61.31 Mg C ha- 1, which was 1.52 and 1.14 times the levels for NPK and HCM, respectively. These results show that SOC sequestration in the North China Plain may mainly depend on the application of organic fertilizer. Furthermore, the SOC sequestration potential in the 0–20 cm layer accounted for 40.3% to 44.6% of the total amount in the 0–60 cm depth for NPK, HCM, and CM, indicating that the SOC sequestration potential would be underestimated using topsoil only and that improving the depth distribution may be a practical way to achieve C sequestration.

2015. Towards understanding factors that govern fertilizer response in cassava: lessons from East Africa. Nutrient Cycling in Agroecosystems, 86:133-151.
Reference ID: 21804
Notes: #21804e
Abstract: Information on fertilizer response in cassava in Africa is scarce. We conducted a series of on-farm and on-station trials in two consecutive years to quantify yield responses of cassava to mineral fertilizer in Kenya and Uganda and to evaluate factors governing the responses. Average unfertilized yields ranged from 4.2 to 25.7 t ha-1 between sites and years. Mineral fertilizer use increased yields significantly, but response to fertilizer was highly variable (-0.2 to 15.3 t ha-1). Average yield response per kg applied nutrient was 37, 168 and 45 and 106, 482 and 128 kg fresh yield per kg of applied N, P and K, respectively in 2004 and 2005. Fertilizer response was governed by soil fertility, rainfall and weed management, but was not influenced by variety, pest and disease pressure and harvest age. Relative N and K yields were positively correlated to SOC and exchangeable K, while response to fertilizer decreased on more fertile soils. Still, fertilizer response varied widely on low fertility soils (e.g. on soils with <10 g kg-1 SOC, responses ranged from -8.6 to 24.4 t ha-1), indicating strong interactions between factors governing fertilizer response. Response to fertilizer was reduced if total rainfall <1,500 mm or rainfall from 0 to 3 months after planting <400 mm. Fertilizer application promoted plant growth and resulted in a better soil coverage and reduced weed competition. Yields in fertilized fields were independent of weed management, unless growing conditions were unfavourable.

Araujo Filho J. T., R. A. Paes, P. L. Amorim, F. F. Comassetto, and S. C. Silva. 2013. Morphological and productive characteristics of cassava grown under irrigation and nitrogen levels. Revista Brasileira de Saúde e Produção Animal, 14:609-623.
Reference ID: 21805
Notes: #21805e
Abstract: The objective of this research to evaluate the behavior of cassava cultivated under irrigation and nitrogen levels. The experimental design was a randomized complete block in factorial arrangement (7 x 4), seven water slides (394.28, 333.16, 279.20, 213.00, 209.00, 169.16 and 116.60mm) and four levels of nitrogen (absence, 50, 100 and 150kg/ha) with two replications. Evaluations were performed at 60 and 120 days of regrowth. At 60 and 120 days there was no interaction between water slides and nitrogen for all morphological characteristics. The nitrogen and water slides separately exerted positive linear effect on the variables plant height, number of leaves, number of bifurcations, stem diameter and canopy area at 60 days. Just for the characteristic number of leaves and nitrogen use efficiency were detected significant interactions between factors at 120 days. Nitrogen rates exerted positive linear effect on the morphological characteristics of plant height, number of bifurcations, stem diameter, canopy area, fresh matter yield,

dry matter yield and water use efficiency at 120 days. Similar effect was observed for the factor water slides, however no significant difference was observed for the characteristic canopy area. The morphological characteristics and production of cassava are increased with the use of nitrogen fertilizer and irrigation.

Gillespie A. W., A. Diochon, B. L. Ma, M. J. Morrison, L. Kellman, F. L. Walley, T. Z. Regier, D. Chevrier, J. J. Dynes, and E. G. Gregorich. 2014. Nitrogen input quality changes the biochemical composition of soil organic matter stabilized in the fine fraction: a long-term study. Biogeochemistry, 117:337-350.
Reference ID: 21806
Notes: #21806e
Abstract: The chemical compostion of soil organic matter (SOM) is a key determinant of its biological stability. Our objective in this study was to evaluate the effects of various sources of supplemental N on the chemical composition of SOM in the fine (<5 µm) mineral fraction. Treatments were fallow, maize/soybean in rotation, and continuous maize receiving no fertilizer (maize0N), synthetic fertilizer N (maize + N), or composted manure (maize + manure). The chemical structures in SOM associated with the fine fraction were determined using XANES spectroscopy at the C and N K-edges, which was assessed using multidimensional scaling. Analysis of amino sugar biomarkers were used to evaluate the fungal:bacterial contributions to the SOM. The addition of N to soils (i.e., maize + N, maize + manure, and maize/soybean treatments) resulted in the enrichment of proteinaceous compounds. Soils which did not receive supplemental N (i.e., fallow and maize0N treatments) were enriched in plant-derived compounds (e.g., aromatics, phenolics, carboxylic acids and aliphatic compounds), suggesting that decomposition of plant residues was constrained by N-limitation. Microbial populations assessed by amino sugar biomarker ratios showed that the highest contributions to SOM by bacteria occurred in the maize + manure treatment (high N input), and by fungi in the fallow treatment (low N input). The SOM in the maize + N and maize/soybean treatments was enriched in N-bonded aromatics; we attribute this enrichment to the abiotic reaction of inorganic N with organic C structures. The SOM in the maize + manure treatment was enriched in pyridinic-N, likely as a result of intense microbial processing and high SOM turnover. The presences of signals for ketone and pyrrole compounds in XANES spectra suggest their use as biomarkers for microbially transformed and stabilized SOM. The SOM in the maize + manure treatment was enriched in ketones which are likely microbial by-products of fatty acid catabolism. Pyrrole compounds, which may accumulate over the long term as by-products of protein transformations by an N-limited microbial community, were dominant in the fallow soil. A combination of molecular spectroscopy and biomarker analysis showed that the source of supplemental N to soil influences the stable C- and N-containing compounds of SOM in a long-term field study. Indeed, any increase in N availability allowed the microbial community to transform plant material into microbial by-products which occur as stable SOM compounds in the fine soil fraction.

Gosling P., N. Parsons, and G. D. Bending. 2013. What are the primary factors controlling the light fraction and particulate soil organic matter content of agricultural soils? Biology and Fertility of Soils, 49:1001-1014.
Reference ID: 21807
Notes: #21807e
Abstract: Particulate organic matter (POM) and light fraction organic matter (LFOM) are the fractions of soil organic matter (SOM) considered most active in terms of

nutrient cycling and maintenance of soil structure. They respond quickly to changes in management and may offer insights into the long-term effect of management on SOM. However, the literature provides contradictory evidence regarding the factors which influence the amount of POM and LFOM, and there is little evidence to differentiate the relative importance of factors. Utilising data from over 150 experiments reported in the literature, we employed multiple regression to produce separate models quantifying the effect of management factors and environmental variables on POM, LFOM and total SOM; 29.3 % of the variance in the response variables was explained for POM, 28.3 % for LFOM, and 29.3 % for total SOM. Climate, organic amendments and inclusion of fallow periods were significant terms for all fractions. Climate had a larger influence on total SOM than POM or LFOM, whilst POM and LFOM were more strongly influenced by factors related to the recent history of organic matter addition; organic amendments and inclusion of fallows. Factors that were not significant variables for any of the fractions included tillage and application of N fertiliser, whilst soil texture was only a significant factor for SOM. General agreement between the total SOM, POM and LFOM models on the most important factors supports the idea that both POM and LFOM are good predictors of long-term changes to total SOM.

Guo Z., K. Hua, J. Wang, X. Guo, C. He, and D. Wang. 2014. Effects of different regimes of fertilization on soil organic matter under conventional tillage. Spanish Journal of Agricultural Research, 12:801-808.
Reference ID: 21808
Notes: #21808e
Abstract: To explore the effects of different fertilization regimes on soil organic matter (SOM) sequestration in a winter-soybean/corn rotation, a long-term field experiment was conducted in Anhui, China, from 1982 to 2011. There were six treatments, as follows: (1) no fertilizer input (CK); (2) mineral fertilizers input (NPK); (3) mineral fertilizers + 3,750 kg ha-1 wheat straw (WS/2-NPK); (4) mineral fertilizers + 7,500 kg ha-1 wheat straw (WS-NPK); (5) mineral fertilizers + 15,000 kg ha-1 composted farmyard manure (CNPK); and (6) mineral fertilizers + 30,000 kg ha-1 composted farmyard manure (DNPK). Mineral fertilizer applications combined with organic amendments improved soil physical properties. For the WS/2-NPK, WS-NPK, CNPK and DNPK treatments, the soil bulk density decreased more than 10%, while the air porosity and field water content increased more than 90% and 15%, compared with the values at the start of the experiment in 1982. Our results indicate that about two decades are needed for SOM to reach its saturation point in all treatments. The SOM sequestration rate was related to the fertilization regime. The average SOM sequestration rate in 1982-2005 was 0.27 g kg-1 yr-1 with NPK, 0.45 g kg-1 yr-1 with WS/2-NPK, 0.56 g kg-1 yr-1 with WS-NPK, 0.60 g kg-1 yr-1 with CNPK and 1.02 g kg-1 yr-1 with DNPK. Therefore, both the quantity and the quality of the organic amendment determine the SOM sequestration rate and SOM saturation level.

Gutierrez-Velez V. H., R. DeFries, M. Pinedo-Vasquez, M. Uriarte, C. Padoch, W. Baethgen, K. Fernandes, and Y. Lim. 2011. High-yield oil palm expansion spares land at the expense of forests in the Peruvian Amazon. Environmental Research Letters, 6:1-5.
Reference ID: 21809
Notes: #21809e
Abstract: High-yield agriculture potentially reduces pressure on forests by requiring less land to increase production. Using satellite and field data, we assessed the area

deforested by industrial-scale high-yield oil palm expansion in the Peruvian Amazon from 2000 to 2010, finding that 72% of new plantations expanded into forested areas. In a focus area in the Ucayali region, we assessed deforestation for high- and smallholder low-yield oil palm plantations. Low-yield plantations accounted for most expansion overall (80%), but only 30% of their expansion involved forest conversion, contrasting with 75% for high-yield expansion. High-yield expansion minimized the total area required to achieve production but counter-intuitively at higher expense to forests than low-yield plantations. The results show that high-yield agriculture is an important but insufficient strategy to reduce pressure on forests. We suggest that high-yield agriculture can be effective in sparing forests only if coupled with incentives for agricultural expansion into already cleared lands.

Kering M. K., T. J. Butler, J. T. Biermacher, J. Mosali, and J. A. Guretzky. 2013. Effect of Potassium and Nitrogen Fertilizer on Switchgrass Productivity and Nutrient Removal Rates under Two Harvest Systems on a Low Potassium Soil. BioEnergy Research, 6:329-335.
Reference ID: 21810
Notes: #21810e
Abstract: Biomass demand for energy will lead to utilization of marginal, low fertility soil. Application of fertilizer to such soil may increase switchgrass (Panicum virgatum L.) biomass production. In this three-way factorial field experiment, biomass yield response to potassium (K) fertilizer (0 and 68 kg?K?ha-1) on nitrogen (N)-sufficient and N-deficient switchgrass (0 and 135 kg?N?ha-1) was evaluated under two harvest systems. Harvest system included harvesting once per year after frost (December) and twice per year in summer (July) at boot stage and subsequent regrowth after frost. Under the one-cut system, there was no response to N or K only (13.4 Mg?ha-1) compared to no fertilizer (12.4 Mg?ha-1). Switchgrass receiving both N and K (14.6 Mg?ha-1) produced 18 % greater dry matter (DM) yield compared to no fertilizer check. Under the two-cut harvest system, N only (16.0 Mg?ha-1) or K only (14.1 Mg?ha-1) fertilizer produced similar DM to no fertilizer (15.1 Mg?ha-1). Switchgrass receiving both N and K in the two-cut system (19.2 Mg?ha-1) produced the greatest (P?<?0.05) DM yield, which was 32 % greater than switchgrass receiving both N and K in the one-cut system. Nutrient removal (biomass?×?nutrient concentration) was greatest in plots receiving both N and K, and the two-cut system had greater nutrient removal than the one-cut system. Based on these results, harvesting only once during winter months reduces nutrient removal in harvested biomass and requires less inorganic fertilizer for sustained yields from year to year compared to two-cut system.

Khan S. A., R. L. Mulvaney, T. R. Ellsworth, and C. W. Boast. 2007. The Myth of Nitrogen Fertilization for Soil Carbon Sequestration. Journal of Environmental Quality, 36:1821-1832.
Reference ID: 21811
Notes: #21811e
Abstract: Intensive use of N fertilizers in modern agriculture is motivated by the economic value of high grain yields and is generally perceived to sequester soil organic C by increasing the input of crop residues. This perception is at odds with a century of soil organic C data reported herein for the Morrow Plots, the world's oldest experimental site under continuous corn (Zea mays L.). After 40 to 50 yr of synthetic fertilization that exceeded grain N removal by 60 to 190%, a net decline occurred in soil C despite increasingly massive residue C incorporation, the decline being more

extensive for a corn–soybean (Glycine max L. Merr.) or corn–oats (Avena sativa L.)–hay rotation than for continuous corn and of greater intensity for the profile (0–46 cm) than the surface soil. These findings implicate fertilizer N in promoting the decomposition of crop residues and soil organic matter and are consistent with data from numerous cropping experiments involving synthetic N fertilization in the USA Corn Belt and elsewhere, although not with the interpretation usually provided. There are important implications for soil C sequestration because the yield-based input of fertilizer N has commonly exceeded grain N removal for corn production on fertile soils since the 1960s. To mitigate the ongoing consequences of soil deterioration, atmospheric CO2 enrichment, and NO3 - pollution of ground and surface waters, N fertilization should be managed by site-specific assessment of soil N availability. Current fertilizer N management practices, if combined with corn stover removal for bioenergy production, exacerbate soil C loss.

Khan S. A., R. L. Mulvaney, and T. R. Ellsworth. 2013. The potassium paradox: Implications for soil fertility, crop production and human health. Renewable Agriculture and Food Systems, 29:3-27.
Reference ID: 21812
Notes: #21812e
Abstract: Intensive fertilizer usage of KCl has been inculcated as a prerequisite for maximizing crop yield and quality, and relies on a soil test for exchangeable K in the plow layer to ensure that soil productivity will not be limited by nutrient depletion. The interpretive value of this soil test was rigorously evaluated by: (1) field sampling to quantify biweekly changes and seasonal trends, (2) characterizing the variability induced by air drying and the dynamic nature of soil K reserves and (3) calculating the K balance in numerous cropping experiments. These evaluations leave no alternative but to question the practical utility of soil K testing because test values cannot account for the highly dynamic interchange between exchangeable and non-exchangeable K, exhibit serious temporal instability with or without air drying and do not differentiate soil K buildup from depletion. The need for routine K fertilization should also be questioned, considering the magnitude and inorganic occurrence of profile reserves, the recycling of K in crop residues and the preferential nature of K uptake. An extensive survey of more than 2100 yield response trials confirmed that KCl fertilization is unlikely to increase crop yield. Contrary to the inculcated perception of KCl as a qualitative commodity, more than 1400 field trials predominately documented a detrimental effect of this fertilizer on the quality of major food, feed and fiber crops, with serious implications for soil productivity and human health.

Kisinyo P. O., C. O. Othieno, J. R. Okalebo, P. A. Opala, W. K. Ng'Etich, R. O. Nyambati, E. O. Ouma, J. J. Agalo, S. J. Kebeney, E. J. Too, J. A. Kisinyo, and W. R. Opile. 2014. Immediate and Residual Effects of Lime and Phosphorus Fertilizer on Soil Acidity and Maize Production in Western Kenya. Experimental Agriculture, 50:128-143.
Reference ID: 21813
Notes: #21813e
Abstract: Soil acidity and phosphorus (P) deficiency are some of the major causes of low maize yields in Kenya. This study determined the immediate and residual effects of lime and P fertilizer on soil pH, exchangeable aluminium (Al), available P, maize grain yield, agronomic P use and P fertilizer recovery efficiencies on a western Kenya acid soil. The treatments were: P fertilizer (0, 26 and 52 kg P ha-1 as triple

super phosphate) and lime (0, 2, 4 and 6 tons lime ha-1) applied once at the beginning of the study. A burnt liming material with 92.5% calcium carbonate equivalent was used. Soil samples were analysed prior to and after treatment application. The site had low soil pH–H2O (4.9), available P (2.3 mg kg-1), total N (0.17%), high Al (2.0 cmol kg-1 exchangeable Al and 29% Al saturation). Lime reduced soil pH and exchangeable Al, leading to increased soil available P. Lime at 2, 4 and 6 tons ha-1 maintained soil pH = 5.5 for 2, 3 and 4 years, respectively. The study observed that the recommended P fertilizer rate (26 kg P ha-1) for maize production in Kenya was inadequate to raise soil available P to the critical level (=10 mg P kg-1 soil bicarbonate extractable P) required for healthy maize growth. To maintain soil available P at the critical level where 52 kg P ha-1 and combined 52 kg P ha-1 + 4 tons lime ha-1 were applied, it would be necessary to reapply the same P fertilizer rate after every one and two cropping seasons, respectively. The 4-year mean grain yield increments were 0.17, 0.34, 0.50, 0.58 and 1.17 tons ha-1 due to 2, 4, 6 tons lime ha-1, 26 kg P and 52 kg P ha-1, respectively. Both agronomic P use and P fertilizer recovery efficiencies increased with increasing rates of lime and decreased with increasing rates of P fertilizer. Therefore, combined applications of both lime and P fertilizer are important for enhancing maize production on P-deficient acid soils in western Kenya.

Kumar S., A. K. Patra, D. Singh, and T. J. Purakayastha. 2013. Long-Term Chemical Fertilization Along with Farmyard Manure Enhances Resistance and Resilience of Soil Microbial Activity against Heat Stress. Journal of Agronomy and Crop Science, 200:156-162.
Reference ID: 21814
Notes: #21814e
Abstract: The effect of fertilization on resistance and resilience of soil microbial activity against heat stress in the tropical soils is largely unknown. We investigated the impact of long-term (36 years) application of chemical fertilizers and farmyard manure (FYM) on substrate-induced respiration (SIR) and dehydrogenase activity (DHA) and their resistance and resilience against heat stress in a sandy clay loam soil (Typic Haplustept). Surface soils from five selected treatments (Control, N, NP, NPK, NPK + FYM) under maize (Zea mays) crop were assessed immediately after sampling (0 Day) and at 1, 14, 28 and 56 day(s) after heat stress (48 °C for 24 h). The heat stress significantly decreased soil respiration and dehydrogenase activity by 20–80 %. Recovery after stress was up to 100 % within 56 days. The combined application of NPK (balanced) and FYM was most effective in enhancing resistance and resilience (stability) of soil microbial activity against heat stress. Correlation between resistance of dehydrogenase activity and substrate-induced respiration revealed a significant relationship (R2 = 0.85). However, after stress, this correlation was initially weak but subsequently improved with time (R2 = 0.38–57), indicating different time lags to restore the normalcy of these parameters.

do Nascimento J. M. L., M. R. B. dos Santos, M. A. A. Queiroz, and A. M. Yano-Melo. 2014. Development of cassava plants and its mycorrhizal association in soil supplemented with sugarcane agroindustrial residue. Semina-Ciencias Agrarias, 35:727-734.
Reference ID: 21815
Notes: #21815e
Abstract: Application of organic agroindustrial residues on agriculture can be one way to improve the development and chemical composition of plants, reducing the

cost with chemical fertilizers and impacts generated by the excessive use of them. Sugarcane agroindustrial residue has been generated in high quantity in Brazilian semiarid region and can be applied to cassava crop to improve its growth. The aim of this work was to evaluate the effect of application of sugarcane agroindustrial residue on the vegetative development, chemical composition and mycorrhizal association of cassava plants (Manihot esculenta var. Engana ladrão). It was performed an experiment in greenhouse with completely randomized design with four treatments of addition of sugarcane agroindustrial residue (0, 5, 10 and 15%) with nine replicates. The addition of sugarcane agroindustrial residue increased fresh dry root biomass, leaf area, crude protein and mineral matter, without reducing the mycorrhizal colonization and glomerospores number. This type of residue can be one alternative to improve the nutritional value of these fodder.

Lentendu G., T. Wubet, A. Chatzinotas, C. Wilhelm, F. Buscot, and M. Schlegel. 2014. Effects of long-term differential fertilization on eukaryotic microbial communities in an arable soil: a multiple barcoding approach. Molecular Ecology, 23:3341-3355.
Reference ID: 21816
Notes: #21816e
Abstract: To understand the fine-scale effects of changes in nutrient availability on eukaryotic soil microorganisms communities, a multiple barcoding approach was used to analyse soil samples from four different treatments in a long-term fertilization experiment. We performed PCR amplification on soil DNA with primer pairs specifically targeting the 18S rRNA genes of all eukaryotes and three protist groups (Cercozoa, Chrysophyceae-Synurophyceae and Kinetoplastida) as well as the ITS gene of fungi and the 23S plastid rRNA gene of photoautotrophic microorganisms. Amplicons were pyrosequenced, and a total of 88 706 quality filtered reads were clustered into 1232 operational taxonomic units (OTU) across the six data sets. Comparisons of the taxonomic coverage achieved based on overlapping assignment of OTUs revealed that half of the eukaryotic taxa identified were missed by the universal eukaryotic barcoding marker. There were only little differences in OTU richness observed between organic- (farmyard manure), mineral- and nonfertilized soils. However, the community compositions appeared to be strongly structured by organic fertilization in all data sets other than that generated using the universal eukaryotic 18S rRNA gene primers, whereas mineral fertilization had only a minor effect. In addition, a co-occurrence based network analysis revealed complex potential interaction patterns between OTUs from different trophic levels, for example between fungivorous flagellates and fungi. Our results demonstrate that changes in pH, moisture and organic nutrients availability caused shifts in the composition of eukaryotic microbial communities at multiple trophic levels.

Liu E., C. Yan, X. Mei, Y. Zhang, and T. Fan. 2013. Long-Term Effect of Manure and Fertilizer on Soil Organic Carbon Pools in Dryland Farming in Northwest China. Plos One, 8.
Reference ID: 21817
Notes: #21817e
Abstract: An understanding of the dynamics of soil organic carbon (SOC) as affected by farming practices is imperative for maintaining soil productivity and mitigating global warming. The objectives of this study were to investigate the effects of long-term fertilization on SOC and SOC fractions for the whole soil profile (0–100 cm) in northwest China. The study was initiated in 1979 in Gansu, China and included six

treatments: unfertilized control (CK), nitrogen fertilizer (N), nitrogen and phosphorus (P) fertilizers (NP), straw plus N and P fertilizers (NP+S), farmyard manure (FYM), and farmyard manure plus N and P fertilizers (NP+FYM). Results showed that SOC concentration in the 0–20 cm soil layer increased with time except in the CK and N treatments. Long-term fertilization significantly influenced SOC concentrations and storage to 60 cm depth. Below 60 cm, SOC concentrations and storages were statistically not significant between all treatments. The concentration of SOC at different depths in 0–60 cm soil profile was higher under NP+FYM follow by under NP+S, compared to under CK. The SOC storage in 0–60 cm in NP+FYM, NP+S, FYM and NP treatments were increased by 41.3%, 32.9%, 28.1% and 17.9%, respectively, as compared to the CK treatment. Organic manure plus inorganic fertilizer application also increased labile soil organic carbon pools in 0–60 cm depth. The average concentration of particulate organic carbon (POC), dissolved organic carbon (DOC) and microbial biomass carbon (MBC) in organic manure plus inorganic fertilizer treatments (NP+S and NP+FYM) in 0–60 cm depth were increased by 64.9–91.9%, 42.5–56.9%, and 74.7–99.4%, respectively, over the CK treatment. The POC, MBC and DOC concentrations increased linearly with increasing SOC content. These results indicate that long-term additions of organic manure have the most beneficial effects in building carbon pools among the investigated types of fertilization.

Liu C. A., F. R. Li, C. C. Liu, R. H. Zhang, L. M. Zhou, Y. Jia, W. J. Gao, J. T. Li, Q. F. Ma, K. H. M. Siddique, and F. M. Li. 2013. Yield-increase effects via improving soil phosphorus availability by applying K2SO4 fertilizer in calcareous–alkaline soils in a semi-arid agroecosystem. Field Crop Research, 144:69-76.
Reference ID: 21818
Notes: #21818e
Abstract: Many studies have reported evidence describing the effects of K2SO4 fertilizer on crop productivity, but there is scant information about the yield-increasing mechanisms when influencing soil properties by K2SO4 application in calcareous and alkaline soils. In this study, one field and incubation experiments were conducted to investigate the effects of K2SO4 fertilizer on crop yields and soil properties in calcareous and alkaline soils on the Loess Plateau of Northwestern China. In field experiments, four K2SO4 treatments were applied to potato (Solanum tuberosum L.) in 2007 and spring wheat (Triticum aestivum L.) in 2008: (1) CK: no K2SO4; (2) T1: K2SO4 @ 100 kg ha-1 in 2007 and 50 kg ha-1 in 2008; (3) T2: K2SO4 @ 200 kg ha-1 in 2007 and 100 kg ha-1 in 2008; and (4) T3: K2SO4 @ 300 kg ha-1 in 2007 and 150 kg ha-1 in 2008. In 2007, potato yield increased by 17.4% in T2 and 21.5% in T3 compared with CK, but did not significantly increase in T1. In 2008, spring wheat yields increased by 10.0%, 15.8% and 18.7% in T1, T2 and T3 treatments, respectively, compared with CK. Stepwise regression (P = 0.05) revealed that soil-available K at tuber formation and starch accumulation stage, and available P at starch accumulation stage correlated well with potato yield. Soil available P before sowing and at anthesis correlated well with spring wheat yield. Soil available P content was mostly higher in T1, T2 and T3 than in CK from June 2007 to August 2008 when the same dose P fertilizer was applied in all plots. Applying K2SO4 decreased soil pH. Soil available P was significantly negatively correlated with soil pH (R = –0.5721, P = 0.0015). In an incubation experiment, the four K2SO4 treatments were designed: (1) CK: no K2SO4; (2) S1: K2SO4 @ 0.44 g kg-1 dry soil; (3) S2: K2SO4 @ 0.88 g kg-1 dry soil; (4) S3: K2SO4 @ 1.32 g kg-1 dry soil. The results also showed that addition of K2SO4 significantly decreased soil

pH and increased available P in calcareous and alkaline soils. Our study suggests that K2SO4 is desirable for improving crop productivity by increasing soil P availability via decreasing soil pH in calcareous and alkaline soils besides K effect in a low input dryland agroecosystem.

Durrant-Whyte H., R. Geraghty, F. Pujol, and R. Sellschop. 1115. How digital innovation can improve mining productivity. Metals and Mining, November 2015:1-13.
Reference ID: 21819
Notes: H 16 #21819
Abstract: With profits down, miners are focused on improving their productivity. Digital innovation could provide a breakthrough.

Mintzberg H. 1971. Managerial Work: Analysis from Observation. Management Science, 18:97-110.
Reference ID: 21820
Notes: H 39 #21820
Abstract: The progress of management science is dependent on our understanding of the manager's working processes. A review of the literature indicates that this understanding is superficial at best. Empirical study of the work of five managers (supported by those research findings that are available) led to the following description: Managers perform ten basic roles which fall into three groupings. The interpersonal roles describe the manager as figurehead, external liaison, and leader; the information processing roles describe the manager as the nerve center of his organisation's information system; and the decision-making roles suggest that the manager is at the heart of the system by which organizational resource allocation, improvement, and disturbance decisions are made. Because of the huge burden of responsibility for the operation of these systems, the manager is called upon to perform his work at an unrelenting pace, work that is characterized by variety, discontinuity and brevity. Managers come to prefer issues that are current, specific, and ad hoc, and that are presented in verbal form. Aa a result, there is virtually no science in managerial work. The management scientist has done little to change this. He has been unable to understand work which has never been adequately described, and he has poor access to the manager's information, most of which is never documented. We must describe managerial work more precisely, and we must model the manager as a programmed system. Only then shall we be able to make a science of management.

Fountain, A. C. and Hutz-Adams, F. Cocoa Barometer 2015. 1-54. 2015. Cocoa Barometer.
Reference ID: 21821
Notes: H 8.1.4 #21821e
Abstract: In the last months of 2014 a media scare shocked the world's chocolate lovers, of which there are quite a few; within a few years, there might not be enough cocoa to make one of the worlds most loved and affordable luxury products. Newspaper articles, radio broadcasts and television programs, they were all asking the same questions; 'Is the world running out of chocolate?' Probably not. But the world is running out of cocoa farmers.

ISP. The Planter August 2015. [91], 517-570. 2015. Kuala Lumpur, The Incorporated Society of Planters.
Reference ID: 21822
Notes: S serial #21822 Vol 91 No 1073

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Reference ID: 21823
Notes: S serial #21823 Vol 91 No 1074

Macolino S., L. M. Lauriault, F. Rimi, and U. Ziliotto. 2013. Phosphorus and Potassium Fertilizer Effects on Alfalfa and Soil in a Non-Limited Soil. Agronomy Journal, 105:1613-1618.
Reference ID: 21824
Notes: #21824e
Abstract: Fertilization strategies for high-yielding alfalfa (*Medicago sativa* L.) should take in account the increase in soil nutritional status that occurred during the last decades in areas with intensive agricultural use. A field study was conducted at the University of Padova, northeastern Italy, to determine the response of alfalfa yield and nutritive value to various combinations of P and K rates in a soil lacking nutrient deficiency. Alfalfa cultivar Delta was seeded in March 2005 on a silt loam soil having 38 mg kg-1 available P and 178 mg kg-1 exchangeable K. Nine treatments deriving from the combination of three P fertilization rates (0, 100, and 200 kg ha-1 P2O5) and three K rates (0, 300, and 600 kg ha-1 K2O) were compared in a randomized complete block design. Plots were harvested at bud stage during three growing seasons (2005-2007) and dry matter (DM) yield, forage nutritive value, P and K contents, canopy height, and stem density were measured at each harvest. Soil samples were collected at the end of the research period for determination of available P and exchangeable K. The results demonstrated that P application had no impact on yield and did not interact with K in determining productivity, while K had a positive effect on yield. However, the 300 kg ha-1 K2O rate appeared sufficient to maximize yield, without adverse effects on the forage nutritive value. Data from soil analyses showed that alfalfa has a high K uptake even when it is fertilized at high rates.

Pereira G. A. M., V. T. Lemos, J. B. dos Santos, E. A. Ferreira, D. V. Silva, M. C. de Oliveira, and C. W. G. de Menezes. 2015. Growth of cassava and weed in response to phosphate fertilizer: Crescimento da mandioca e plantas daninhas em resposta à adubação fosfatada. Revista Ceres, 59:716-722.
Reference ID: 21825
Notes: #21825e
Abstract: Fertilizers may be used to change the competitive relations, favoring the crop species, providing the competing species have different responses to the nutrient application. Thus, the aim of this study was to evaluate the growth of Cassava plant, *Bidens pilosa L.* and *Brachiaria decumbens* Stapf, as a function of the amount of P supplied at planting. The experiment was conducted in a greenhouse and the, treatments were arranged in a 3 x 4 factorial, involving the three species studied and four levels of phosphate fertilization (absence of P2O5, 80 kg ha-1, 800 kg ha-1 and 4000 kg ha-1 P2O5, equivalent to 0, 1, 10 and 50 times the phosphorus dose recommended, respectively). A randomized block design was used, with five replications. The application of phosphate fertilizer promoted larger

growth of the species evaluated, and cassava had higher growth of the shoot with the increased availability of phosphorus. In general, weeds showed higher responses to lower doses of phosphorus.

Oluleye A. K. and E. A. Akinrinde. 2010. Phosphorus-use efficiency of cassava/maize/egusi-melon and economics of phosphorus fertilizer application on Alfisols of Ekiti State, South-Western Nigeria. Journal of Food, Agriculture & Environment, 8:594-598.
Reference ID: 21826
Notes: #21826e
Abstract: Potentials of rock phosphate (PR) and PR-fortified organic wastes (OW) as fertilizers are currently being explored. Three-year investigation was conducted on two Alfisols in South-Western Nigeria to evaluate their effects on P-use Efficiency (PUE) and P balance (PB) in cassava/maize/egusi-melon mixtures. Melon/maize were planted @20,000 plants ha-1 and cassava @10,000 plants ha-1 (1st year) but maize was @20,000;25,000 and 35,555 plants ha-1 in 2nd and 3rd years. PUE decreased with increased fertilizer rates while PB was highest in PR plots. Yields with PR were higher than those of other treatments and partial budget analysis indicated higher marginal rate of returns for PR treatment (10.1) than for OW (5.1) relative to SSP. PUE for PR and OMF were higher than for SSP, confirming that these materials could be substituted for SSP in cassava/maize/melon mixtures in the experimental locations.

Omar N. F., S. A. Hassan, U. K. Yusoff, N. A. P. Abdullah, P. E. M. Wahab, and U. R. Sinniah. 2012. Phenolics, Flavonoids, Antioxidant Activity and Cyanogenic Glycosides of Organic and Mineral-base Fertilized Cassava Tubers. Molecules, 17:2378-2387.
Reference ID: 21827
Notes: #21827e
Abstract: A field study was conducted to determine the effect of organic and mineral-based fertilizers on phytochemical contents in the tubers of two cassava varieties. Treatments were arranged in a split plot design with three replicates. The main plot was fertilizer source (vermicompost, empty fruit bunch compost and inorganic fertilizer) and sub-plot was cassava variety (Medan and Sri Pontian). The amount of fertilizer applied was based on 180 kg K2O ha.1. The tubers were harvested and analyzed for total flavonoids, total phenolics, antioxidant activity and cyanogenic glucoside content.Total phenolic and flavonoid compounds were determined using the Folin-Ciocalteu assay and aluminium chloride colorimetric method, respectively. Different sources of fertilizer, varieties and their interactions were found to have a significant effect on phytochemical content. The phenolic and flavonoid content were significantly higher ($p < 0.01$) in the vermicompost treatment compared to mineral fertilizer and EFB compost. The total flavonoids and phenolics content of vermicompost treated plants were 39% and 38% higher, respectively, than those chemically fertilized. The antioxidant activity determined using the DPPH and FRAP assays were high with application of organic fertilizer. Cyanogenic glycoside levels were decreased with the application of organic fertilizer. Among the two types of compost, vermicompost resulted in higher nutritional value of cassava tubers. Medan variety with application of vermicompost showed the most promising nutritional quality. Since the nutritional quality of cassava can be improved by organic fertilization, organic fertilizer should be used in place of chemical fertilizer for environmentally sustainable production of better quality cassava.

Omorusi V. I. and D. K. G. Ayanru. 2011. Effect of NPK Fertilizer on Diseases, Pests and Mycorrhizal Symbiosis on Cassava. International Journal of Agricultural And Biology, 13:391-395.
Reference ID: 21828
Notes: #21828e
Abstract: A screen house study was conducted to evaluate the effects of a compound fertilizer (NPK) on the response of cassava (Manihot esculenta Crantz) to diseases, pests and mycorrhizal symbiosis. Soil drenches of NPK (15 - 15 - 15, N - P2O5- K 2O) were applied at the rates of 0.083 g (10 kg ha-1) and 0.832 g (100 kg ha-1) per 4.2 kg soil. Mycorrhizal spores in rhizosphere soil and root colonization of cassava by arbuscular mycorrhizal (AM) fungi were estimated at 5.5 months. Shoot heights and girths (cm) were assessed at 5.5 months. Incidence of pests-cassava green spider mites (Mononychellus tanajoa Bondar) (CGM), cassava mealybug (Phenaccocus manihoti Matt-Ferr.) (CM), African cassava mosaic disease (ACMD) and cercospora leaf spot disease (CLSD) were rated on varying scales. Mycorrhizal spores and root colonization were significantly higher in the control experiments (P< 0.01) with percentage decreases of 67 and 83% per g/soil of spores and root colonization of 61 and 83%, in the 10 and 100 kg ha-1, respectively. NPK fertilizer significantly increased plant vigour (stem & girth) (P<0.01), with increases by 16.82 to 36.45% for height and 15.20 to 25.45% for girth. Mycorrhizal symbiosis was lowest in plants amended with the highest fertilizer dosage. NPK concentrations diminished CGM, CM (P< 0.01) and ACMD (P< 0.05). However, no significant effects on CLSD infection were obtained.

Pypers P., W. Bimponda, J.-P. Lodi-Lama, B. Lele, R. Mulumba, C. Kachaka, P. Boeckx, R. Merckx, and B. Vanlauwe. 2012. Combining Mineral Fertilizer and Green Manure for Increased, Profitable Cassava Production. Agronomy Journal, 104:178-187.
Reference ID: 21829
Notes: #21829e
Abstract: Due to increasing population pressure and declining soil fertility, there is need for profitable alternatives to the slash-and-burn (SB) practice for cassava (Manihot esculenta Crantz) production in the humid lowlands of sub-Saharan Africa. Integrated Soil Fertility Management (ISFM) has high potential to deliver such options. Two on-farm, researcher-managed trials were installed to compare slash-and-burn with slashing and incorporation of the natural vegetation, and the application of green manure and/or NPK fertilizer at different rates. Root yields were comparable when the natural vegetation was slashed and incorporated, or slashed and burned. Fertilizer application increased yields by 42 to 212%, and had residual effects on a second cassava crop, increasing yields by 40 to 74%. Addition of green manure increased yields by 36 to 158%, without residual effects. Comparison with yields obtained in treatments where both inputs were applied in combination showed that yield increases due to fertilizer and green manure application were additive. Most profitable yield increases were obtained when fertilizer was applied in combination with Tithonia in the more fertile site, and in combination with Chromolaena or incorporation of the natural vegetation in the less fertile site. Net benefits were increased by 30 to 50% with a benefit cost ratio of $5 to $7 $-1 and a marginal rate of return of $4 to $5 $-1 relative to slash-and-burn. While current conditions favor combining fertilizer with green manure, an increase in labor cost or a decrease in fertilizer price would result in superior marginal rates of return for combining fertilizer with the natural fallow vegetation.

Qiu S. L., L. M. Wang, D. F. Huang, and X. J. Lin. 2014. Effects of fertilization regimes on tea yields, soil fertility, and soil microbial diversity. Chilean Journal of Agricultural Research, 74:333-339.
Reference ID: 21830
Notes: #21830e
Abstract: Fertilization is an important agricultural practice for increasing crop yields and influencing soil properties. A field experiment was conducted in the period of 2006-2011 in southeastern China, to investigate the effects of fertilization regimes on tea (Camellia sinensis [L.] Kuntze) yields, soil chemical properties, and soil bacterial and fungal communities. The field experiment included six treatments: (1) unfertilized control (CON); (2) chemical fertilizers (NPK); (3) half-chemical fertilizers plus half-organic manure (1/2NPKOM); (4) organic manure fertilizers (OM); (5) half-chemical fertilizers plus half-organic manure plus legume stover returned (1/2NPKOM+L), and (6) chemical fertilizers plus legume stover returned (NPKL). Results showed that, compared to the control, NPK treatment showed no significant effect on soil organic matter (SOM), total N (TN), total P (TP), total K (TK), available N (AN), available K (AK) and tea yields, but showed the lowest bacterial Shannon index of 1.714 and the lowest value of 2.002 for fungal Shannon index. Organic manure treatment had the richest diversity of soil bacterial community with Shannon index of 2.542, and the highest levels of soil essential nutrients, including SOM (30.03%), TN (2.90 g kg-1), TP (1.35 g kg-1), AN (245.30 mg kg-1), AP (57.00 mg kg-1), and AK (271.80 mg kg-1), followed by 1/2NPKOM+L, which appeared the maximal tea yields of 6772 kg ha-1. Organic manure amendment was a key factor in determining soil properties and productivity. Base on soil quality and tea yields, both OM and 1/2NPKOM+L treatments were recommended as better choices of fertilization practices for tea soils in southeastern China. These findings provided a better understanding of the importance of fertilizations in promoting soil fertility, crop yields, and altering soil microbial diversity, leading to selection of scientific fertilization practices for sustainable development of agroecosystems.

Anh P. T. Q., T. Gomi, L. H. MacDonald, S. Mizugaki, V. K. Phung, and T. Furuichi. 2014. Linkages among land use, macronutrient levels, and soil erosion in northern Vietnam: A plot-scale study. Geoderma, 232-234:352-362.
Reference ID: 21831
Notes: #21831e
Abstract: This study examined the interrelations among vegetative cover and biomass, soil macronutrient levels, and soil erosion in northern Vietnam.We selected ten dominant land-use types in a hilly area of western Hanoi including bare soil, agriculture (cassava or lemon grass), shrub land, five types of plantation forest, and indigenous forest. We measured the understory biomass, litter biomass, canopy openness, soil moisture content, soil pedestal height, soil hardness, soil bulk density, 137 Cs and 210 Pb ex activities, and soil carbon and nitrogen on three 1m 2 plots for each land-use type. Soil erosion was calculated from both pedestal heights and radionuclides. Multivariate statistical analysis was used to identify the key factors controlling soil erosion and nutrient accumulations.Understory biomass ranged from 2 to 375gm -2 , and this tended to be higher in most of the forest types and shrubland than in cassava and lemon grass. In contrast, the amount of ground cover varied more by forest type than between the agricultural land uses and forest lands. The height of soil pedestals indicated that short-term soil erosion was negligible when understory biomass was greater than 130 to 150gm -2 . 137 Cs was only detected in the cassava plots, whereas 210 Pb ex indicated widely different erosion

rates across the land uses, with lower values in the agricultural lands and two types of forest plantations, although this may be due to soil management practices. Both the correlation and principal component analyses showed that soil organic carbon and nitrogen were positively correlated to understory biomass and strongly and inversely influenced by bulk density. Soil erosion as indicated by soil pedestal height was strongly and inversely controlled by ground cover, litter, and understory biomass. Soil erosion was also heavily influential to soil chemical richness and bulk density.Ground vegetation cover and the resultant soil erosion processes altered the production and accumulation of SOC, while forest cover did not always result in high soil fertility or low erosion. A simple characterization of forest or non-forest is not sufficient to calculate carbon and nutrient stocks, or assess erosion risk.Understory biomass of at least 130gm -2 and high ground cover are essential for reducing soil erosion and sustaining short- and long-term soil productivity.Rapidly developing areas in Southeast Asia, including hilly areas in North Vietnam, need to maintain understory biomass and ground cover for soil and nutrient conservation.

Ren T., J. Wang, Q. Chen, F. Zhang, and S. Lu. 2014. The Effects of Manure and Nitrogen Fertilizer Applications on Soil Organic Carbon and Nitrogen in a High-Input Cropping System. Plos One, 9.
Reference ID: 21832
Notes: #21832e
Abstract: With the goal of improving N fertilizer management to maximize soil organic carbon (SOC) storage and minimize N losses in high-intensity cropping system, a 6-years greenhouse vegetable experiment was conducted from 2004 to 2010 in Shouguang, northern China. Treatment tested the effects of organic manure and N fertilizer on SOC, total N (TN) pool and annual apparent N losses. The results demonstrated that SOC and TN concentrations in the 0-10cm soil layer decreased significantly without organic manure and mineral N applications, primarily because of the decomposition of stable C.
Increasing C inputs through wheat straw and chicken manure incorporation couldn't increase SOC pools over the 4 year duration of the experiment. In contrast to the organic manure treatment, the SOC and TN pools were not increased with the combination of organic manure and N fertilizer. However, the soil labile carbon fractions increased significantly when both chicken manure and N fertilizer were applied together. Additionally, lower optimized N fertilizer inputs did not decrease SOC and TN accumulation compared with conventional N applications. Despite the annual apparent N losses for the optimized N treatment were significantly lower than that for the conventional N treatment, the unchanged SOC over the past 6 years might limit N storage in the soil and more surplus N were lost to the environment. Consequently, optimized N fertilizer inputs according to root-zone N management did not influence the accumulation of SOC and TN in soil; but beneficial in reducing apparent N losses. N fertilizer management in a greenhouse cropping system should not only identify how to reduce N fertilizer input but should also be more attentive to improving soil fertility with better management of organic manure.

Ros A. B., A. C. S. H. Hirata, and N. Narita. 2013. Cassava roots yield and soil chemical and physical properties according to chicken manure fertilization: Produção de raízes de mandioca e propriedades química e física do solo em função de adubação com esterco de galinha. Pesquisa Agropecuaria Tropical, 43:247-254.
Reference ID: 21833
Notes: #21833e

Abstract: The cassava crop extracts large amounts of nutrients from the soil and, as a result, nutrients in adequate amounts in the soil favor its yield. Thus, this study aimed at evaluating the influence of laying chicken manure on cassava roots yield and morphological characteristics, as well as on soil chemical and physical properties. The experimental design was randomized blocks, with six replications, and treatments consisted of laying chicken manure doses (0 t ha-1, 6 t ha-1, 12 t ha-1 and 18 t ha-1) incorporated into the soil. It was observed that the crop reacted to the soil fertilization by increasing its yield per area and plant unit. Roots individual fresh matter, diameter and length remained constant with treatments. The soil pH and organic matter were raised with the addition of manure. Concerning soil nutrients, there was an increase in the P, Ca and Mg contents. The soil bulk density decreased, while the total soil porosity increased proportionally to the addition of manure. The addition of chicken manure up to 18 t ha-1 provided a higher cassava yield, due to an increase in the number of roots per plant and improvements in the soil chemical and physical properties.

Sadej W., A. Kosewska, W. Sadej, and M. Nietupski. 2012. Effects of fertilizer and land-use type on soil properties and ground beetle communities. Bulletin of Insectology, 65:239-246.
Reference ID: 21834
Notes: #21834e
Abstract: Among the most important factors influencing the properties of soil are the type of soil management and fertilization. Agronomic technologies, such as undifferentiated fertilization, or fallow and set-aside breaks have a significant, although not always positive effect on soil properties. They can stimulate humus degradation in soil, the leaching of nutrients and accumulation of weed seeds, pathogens and pests in soil. Being a very useful component of biocenoses, carabid fauna is a particularly valuable group of animals.
They are very sensitive to changes in habitat quality and are therefore commonly used as environmental indicators. Because of their predatory polyphagous nutrition, they can be treated as an important component of natural environmental resistance. This paper discusses the species composition of Carabidae communities found on experimental plots maintained under identical, undifferentiated fertilization but managed differently. Relationships between selected physicochemical soil properties under long-term fertilization or soil fallowing and the composition of carabid communities were analyzed. Significantly more carabid individuals were found in the fallows compared to the experimental plots. The Shannon index indicated that treatments with a higher content of organic carbon and total nitrogen had a higher diversity. Carabidae preferred the treatments where the soil had lower pH. The most significant factor affecting assemblages of carabid beetles consisted in agronomic treatments, such as the type of soil management and fertilization. Thus, it can be concluded that the way the land is managed for agricultural purposes has a strong influence on shaping the epigeal fauna of Carabidae. We suggest that in the present experiment carabids preferred fallows, as beetles were not disturbed and could find more places to hide.

Scherer H. W., E. Feils, and P. Beuters. 2014. Ammonium fixation and release by clay minerals as influenced by potassium. Plant Soil Environment, 60:325-331.
Reference ID: 21835
Notes: #21835e

Abstract: It is postulated that stabilized ammonium fertilizers improve fertilizer-N utilization by crops, leading thus to higher yields with the same fertilizer rate, especially on sandy soils. However, it must be taken into consideration that in clayey soil at least a part of the NH4+ ions may be fixed by 2:1 clay minerals, thus delaying the effect of the N fertilizer. Because NH4+ and K+ have similar size and valence properties and therefore compete for the same non-exchangeable sites of 2:1 clay minerals, we investigated the influence of time and K+ application rate on both fixation and release of NH4+. Fixation of NH4+ ions was higher when K+ was applied after NH4+, while the influence of the K+ application rate was less pronounced. Mobilization of non-exchangeable NH4+ was retarded when K+ was applied at the high rate after NH4+. At the first harvest yield formation of ryegrass was neither influenced by the amount as well as the application time of K+, because plant available N was not growth limiting, while yield of the second harvest was significantly higher with the low K+ application rate after NH4+. After the second harvest the blocking effect of K+ on the release of non-exchangeable NH4+ was attenuated and the highest yields of the third cut were reached in the treatments with the high K+ application rate after NH4+. Total dry matter yield was highest when K+ was applied at the low rate after NH4+. Our results show that K+ governs fixation and release of non-exchangeable NH4+, which should be taken into consideration when applying ammonium containing N fertilizers like ammonium sulfate, ammonium sulfate nitrate and ENTEC. Thus K+ can affect N availability when N is applied as NH4+ in both the short and long term.

Shahid M., A. K. Nayak, A. K. Shukla, R. Tripathi, A. Kumar, S. Mohanty, P. Bhattacharyya, R. Raja, and B. B. Panda. 2013. Long-term effects of fertilizer and manure applications on soil quality and yields in a sub-humid tropical rice-rice system. Soil Use and Management, 29:322-332.
Reference ID: 21836
Notes: #21836e
Abstract: Widespread yield stagnation and productivity declines in the rice.rice cropping system have been reported and many of the associated issues are related to soil quality. A long-term experimental study was initiated in 1969 to assess the impact of continuous cultivation of rice as a single crop grown in wet as well as dry seasons using varying levels of chemical fertilizer and manure applications on soil quality indicators (physical, chemical and biological), a sustainable yield index (SYI) and a soil quality index (SQI). The treatments comprised chemical fertilizers and farmyard manure (FYM) either alone or in combination viz. control, N, NP, NK, NPK, FYM, N+FYM, NP+FYM, NK+FYM and NPK+FYM, laid out in a randomized complete block design with three replications. Soil samples were collected after the wet season rice harvest in 2010 and were analysed for physical, chemical and biological indicators of soil quality. A SYI based on long-term yield data and SQI using principal component analysis (PCA) and nonlinear scoring functions were calculated. Application of NPK fertilizers in combination with FYM significantly increased the average grain yield of rice in both wet and dry seasons and enhanced the sustainability of the system compared to the control and plots in receipt of fertilizers. The SYI for the control was higher in the wet season than in the dry one, whereas the reverse was true for NPK+ FYM treatment. The value of the dimensionless SQI varied from 1.46 in the control plot to 3.78 in the NPK+FYM one. A greater SYI and SQI in the NPK+FYM treatment demonstrated the importance of using a chemical fertilizer in combination with FYM. For the six soil quality indicators selected as a minimum data set (MDS), the contribution of DTPA-Zn, available-N

and soil organic carbon to the SQI was substantial ranging from 59.4 to 85.7 per cent in NPK+FYM and control plots, respectively. Thus, these soil parameters could be used to monitor soil quality in a subhumid tropical rice .rice system.

ISP. The Planter June 2012. [88], 375-436. 2012. Kuala Lumpur, The Incorporated Society of Planters.
Reference ID: 21837
Notes: S serial #21837 Vol 88 No 1035

ISP. The Planter October 2012. [88], 691-768. 2012. Kuala Lumpur, The Incorporated Society of Planters.
Reference ID: 21838
Notes: S serial #21838 Vol 88 No 1039

Shang Q., N. Ling, X. Feng, X. Yang, P. Wu, J. Zou, Q. Shen, and S. Guo. 2014. Soil fertility and its significance to crop productivity and sustainability in typical agroecosystem: a summary of long-term fertilizer experiments in China. Plant and Soil, 381:13-23.
Reference ID: 21839
Notes: #21839e
Abstract:
Aims and background
Soil fertility quality index is a useful indicator that helps to improve sustainable land use management and achieve economical yield in agriculture production. The objectives of this study were to evaluate the changes of soil fertility quality between the 1980s and 2000s in different cropping systems and its significance to crop productivity and sustainability.
Methods
We collected all published data on crop yields and soil parameters from 58 long-term experiments in three typical double-cropping systems in China, including maize-wheat (M-W), rice-rice (R-R) and rice-wheat (R-W) cropping systems, and selected seven fertilizer treatments in each experiment, including inorganic fertilizer [nitrogen and phosphorus fertilizer (NP), nitrogen and potassium fertilizer (NK), phosphorus and potassium fertilizer (PK) and balanced mineral fertilizer (NPK)], combined NPK with farmyard manure (NPKM) or crop straw (NPKS), and no fertilizer application (served as control). For comparison, an integrated fertility quality index (IFQI) was used to estimate the variations in soil fertility in different cropping systems. Moreover, the mean production variability index (PVI, %) in each cropping system was calculated to evaluate the stability of crop production.
Results
Over cropping systems, the averaged relative yields of PK, NK and NP ranged from 38.0 to 97.4 %, while the mean yields can be increased by 2.4–5.1 % in NPKM, compared to NPK. The mean yields were similar between NPK and NPKS for maize and wheat crops, but the yield was increased by 4.3–10.0 % in NPKS. Among the different treatments, the highest variability of cereal productivity was obtained in NK, PK or Control, while the lowest value was mostly recorded in NPKM or NPKS in these three cropping systems. Relative to the control, the IFQIs in fertilization treatments were increased by 9.4–150.0 %, 6.2–41.5 % and 1.3–17.5 % in M-W, R-W and R-R systems, respectively (except for PK treatment in R-R system). However, changes of IFQI in topsoil differed among fertilizer treatments, and greater increases existed in the treatments receiving organic residues (NPKM and NPKS).

Conclusions
The increase in crop yield is exponentially correlated with the increased IFQI over treatments in three cropping systems. Over the treatments and systems, production variability among years is shown to be negatively, linearly related to IFQI (P?<?0.001). Therefore, the high grain yield and low production variability can be simultaneously achieved by increasing soil fertility in all three cropping systems.

Simon T. and A. Czako. 2014. Influence of long-term application of organic and inorganic fertilizers on soil properties. Plant Soil Environment, 60:314-319.
Reference ID: 21840
Notes: #21840e
Abstract: This study assesses the effect of long-term (59 years) application of organic and inorganic fertilizers on soil organic matter and enzyme activity. Total organic C, total organic N, hot water soluble C, microbial biomass C and dehydrogenase activity were evaluated in soil from the long-term field experiment in Prague-Ruzyne (Orthic Luvisol, clay loam). Total organic C and N increased significantly in soils treated with organic fertilizers (farmyard manure, compost) and in soils with a combination of organic and mineral NPK fertilizers (manure + NPK, compost + NPK, cattle manure + straw + NPK) compared to soil treated with inorganic fertilizer, cattle slurry + straw and non-fertilized control. Farmyard manure significantly increased hot water soluble C compared to the control. Dehydrogenase activity was significantly increased by all treatments compared to control. The results indicate that additions of organic matter from various sources differ in the effects on soil organic matter and biological activity. The effect of manure was the most favourable; long-term application of cattle slurry + straw is rather similar to mineral fertilization.

Sinha N. K., U. K. Chopra, A. K. Singh, M. Mohanty, J. Somasundaram, and R. S. Chaudhary. 2014. Soil Physical Quality as Affected by Management Practices Under Maize–Wheat System. National Academy Science Letters, 37:13-18.
Reference ID: 21841
Notes: #21841e
Abstract: Soil physical quality is one of the three important aspects of soil quality, besides biological and chemical quality. Decline in soil physical quality can have serious consequences on biological and chemical properties thereby making it relevant to study soil physical quality for maintaining soil health in long run. Changes in this property of soil affect the productivity of crops. In this investigation, Dexter S theory has been applied to evaluate the soil physical quality in maize–wheat system under two tillage/land configurations namely raised bed planting (BP) and conventional tillage (CT) and nine nutrient treatments viz (1) T1—control (crop without fertilizer), (2) T2—100 % recommended dose of nitrogen (N), phosphorous (P) and potassium (K), (3) T3—100 % NPK (25 % N substituted by farmyard manure (FYM)), (4) T4—100 % NPK + green manure (Sesbania), (5) T5—100 % NPK (25 % N substituted by biofertilizer), (6) T6—100 % NPK (25 % N substituted by sewage sludge), (7) T7—100 % NPK + crop residue incorporated (from previous crop), (8) T8—100 % organic source (50 % FYM + 25 % bio-fertilizer + 25 % crop residue), and (9) T9—no crop no fertilizer; were identified for this study. BP significantly improved the soil physical quality compared to CT. Within nutrient treatments, S index was highest in T8 followed by the T5, whereas lowest in T1. There is high and significant correlation between S index and soil physical parameter and crop yield

which shows that S index can be used effectively for quantifying soil physical quality under diverse environments vis-à-vis crop yield.

Sopheap U., A. Patanothai, and T. M. Aye. 2011. Nutrient balances for cassava cultivation in Kampong Cham province in Northeast Cambodia. International Journal of Plant Production, 6:37-58.
Reference ID: 21842
Notes: #21842e
Abstract: In Cambodia, cassava is mostly grown with little or no fertilizer inputs, but the magnitudes of nutrient balances are not known. This study was conducted to assess nutrient balances for cassava cultivation in Kampong Cham province in Northeast Cambodia. Forty five households in four cassava production zones were interviewed in relation to their cultural practices and crop residue management, upon which sources of nutrient inputs and outputs were based. Chemical fertilizer, manure, planting materials and rainfall were the defined inputs, while cassava roots and stumps were the outputs. Crop cutting was undertaken in the cassava fields of the 45 households to obtain weights of roots and other plant parts. Nutrient balances were calculated for the individual fields based on nutrient contents of the component sources obtained from the literatures. The results showed negative balances for all the nutrients evaluated. The imbalances were most serious for N, K and Ca with the averages of -64.45 kg N, -52.83 kg K and -10.83 kg Ca ha-1, but were less serious for P and Mg with the averages of -2.85 kg P and -7.20 kg Mg ha-1. These negative balances were the consequence of low nutrient inputs in current practices where only a few farmers applied low rates of chemical fertilizer or manure. Continued use of current practices will threaten the sustainability of cassava production in Cambodia. For long term productivity of the crop, the application of organic manures together with lime and chemical fertilizers high in N and K is recommended.

Srinivasarao Ch., B. Venkateswarlu, R. Lal, A. K. Singh, S. Kundu, K. P. R. Vittal, J. J. Patel, and M. M. Patel. 2011. Long-term manuring and fertilizer effects on depletion of soil organic carbon stocks under pearl millet-cluster bean-castor rotation in Western India. Land Degradation & Development, 25:173-183.
Reference ID: 21843
Notes: #21843e
Abstract: Soil organic carbon (SOC) pools are important for maintaining soil productivity and reducing the net CO2 loading of the atmosphere. An 18-year old long-term field experiment involving pearl millet-cluster bean-castor sequence was conducted on an Entisol in western India to examine the effects of chemical fertilizers and manuring on carbon pools in relation to crop productivity and C sequestration. The data showed that even the addition of 33.5?Mg?ha-1?C inputs through crop residues as well as farm yard manure could not compensate the SOC depletion by oxidation and resulted in the net loss of 4.4?Mg?C?ha-1 in 18?years. The loss of SOC stock in the control was 12?Mg?C?ha-1. Conjunctive use of chemical fertilizers along with farm yard manure produced higher agronomic yields and reduced the rate of SOC depletion. The higher average seed yields of pearl millet (809?kg?ha-1), cluster bean (576), and castor (827) over six cropping seasons were obtained through integrated use of fertilizers and manure. For every Mg increase in profile SOC stock, there was an overall increase of 0.46?Mg of crop yield, comprising increase in individual yield of pearl millet (0.17?Mg?ha-1?y-1?Mg-1 SOC), cluster bean (0.14) and castor (0.15). The magnitude of SOC build up was proportional to the C inputs. Carbon pools were significantly correlated with SOC,

which increased with application of organic amendments. Threshold C input of 3.3?Mg?C?ha-1?y-1 was needed to maintain the SOC stock even at the low antecedent level.

Sradnick A., M. Oltmanns, J. Raupp, and R. G. Joergensen. 2014. Microbial residue indices down the soil profile after long-term addition of farmyard manure and mineral fertilizer to a sandy soil. Geoderma, 226-227:79-84.
Reference ID: 21844
Notes: #21844e
Abstract: Long-term organic fertilization may control the accumulation of organic matter in subsoil. The objective of this study was to evaluate the effects of long-term farmyard manure application in comparison with mineral fertilization on the accumulation of amino sugars as indices for microbial residues down to 1 m depth at a sandy site that exhibits highly heterogeneous pH conditions. In relation to maximum values in topsoil at 90–100 cm depth, the SOC content decreased to roughly 24% and the total N content to 16% of the maximum values, leading to an increased soil C/N ratio from 11 to values around 16 in all treatments. The relative contribution of microbial residue C to SOC decreased with depth from 68% at 0–25 cm to 24% at 50–100 cm. In the subsoil, the stocks of microbial residue C were increased by manure in comparison with mineral fertilization, but not the stocks of SOC. This suggests that manure-induced priming effects increase the microbial turnover at 50–100 cm depth. Manure fertilization promoted the formation of bacterial residues in the topsoil at 0–25 cm depth, but not in the subsoil. Below the topsoil, the fungal C to bacterial C ratio decreased from 2.6 at 0–25 cm depth to 2.1 at 50–100 cm depth. Below the topsoil, the ratio of fungal to bacterial residues continuously decreased with depth from 2.7 to 1.7 at 90–100 cm depth, without fertilizer effects. Possible reasons for this decrease, such as effects of pH on the subsoil microbial community, a higher sensitivity of fungi to the absence of fresh organic matter or to an unfavourable composition of the subsoil atmosphere, need further investigations.

Subehia S. K., S. Sepehya, S. S. Rana, S. C. Negi, and S. K. Sharma. 2013. Long-term effect of organic and inorganic fertilizers on rice (oryza sativa l.)-wheat (triticum aestivum l.) yield, and chemical properties of an acidic soil in the western himalayas. Experimental Agriculture, 49:382-394.
Reference ID: 21845
Notes: #21845e
Abstract: In a field experiment initiated in 1991 kharif season (April–October) on an acidic soil in the Western Himalayas of India, 25% and 50% of the recommended doses of nitrogen were substituted through different organics, viz. farmyard manure (FYM), wheat cut straw and Sesbania aculeata (as green manure) in rice, followed by use of chemical fertilizers in wheat each year. The aim of this work was to study the long-term integrated effect of organics and chemical fertilizers on grain yield of rice–wheat system and soil quality. Based on five years' moving average values, continuous cropping without fertilization or manuring (control) gave the lowest grain yields of both rice and wheat. Application of 50% N through FYM plus 50% NPK through chemical fertilizers to rice followed by 100% NPK through chemical fertilizers to wheat (T3) maintained the highest productivity of rice and wheat at about 3.4 Mg ha-1 and 3.3 Mg ha-1, respectively, as found from the pooled grain yield over the years. The highest values of organic carbon, cation exchange capacity and available N, P, K were also recorded under this treatment (T3). Soil pH was marginally affected by different treatments, while Diphenyl Triamine Penta Acetic acid

extractable micronutrient cations increased over control when chemical fertilizers were applied in conjunction with different organics.

Umeh S. I. and B. N. Mbah. 2010. Measuring the benefits of biological nitrogen fixation of soybean (Glycine max (l.) Merrill) in cassava (Manihot esculenta crantz) and soybean intercrop. African Journal of Agricultural Research, 5:3354-3359.
Reference ID: 21846
Notes: #21846e
Abstract: The measurement of the benefits of biological nitrogen (N) fixing properties of soybean in cassava and soybean intercrop was conducted at the University of Nigeria, Nsukka between 2000, 2001 and 2002. Changes in soil nutrient concentration were measured at 0 – 30 cm. The effects of N- fertilization on cassava tuber yield and soil-N were monitored for the three seasons using factorial in randomized complete block design. There was no apparent shading effect during the growth of the two crops. Soybean was harvested 110 days after planting, while cassava was harvested at 4, 8 and 12 months after planting in each year. Cassava tuber yield was highest at intercrop X 60 and intercrop X 45 kg N ha-1 (30.0 and 29.9 t. ha-1) x tuber yield of intercrop X 45 kg N ha-1. The result indicates that 60 kg (90 - 30) of applied nitrogen could be spared per hectare by intercropping cassava with soybean due to soybean nitrogen fixation. Grain yield of soybean may not be compromised by intercropping with cassava. Soil - N increased from 0.042 mg kg-1 before the experiment to 0.168 mg kg-1 in sole soybean system and 0.086 mg kg-1 in intercrop system at 8 months after planting and 0.150 mg kg-1 in the sole soybean and 0.085 kg mg-1 in intercrop system in 12 months after planting. The highest land equivalent ratio (LER) of 2.3 and area × time equivalent ratio (ATER) of 1.8 were obtained at 45 kg N ha-1 in the intercrop system.

Uwah D. F., E. B. Effa, L. E. Ekpenyong, and I. E. Akpan. 2013. Cassava (*Manhihot esculenta Crantz)* performance as influenced by nitrogen and potassium fertilizers in Uyo, Nigeria. The Journal of Animal & Plant Sciences, 23:550-555.
Reference ID: 21847
Notes: #21847e
Abstract: Large scale cassava production is today being carried out season after season repeatedly on the same piece of land leading to decline in soil fertility and yield overtime. Research information to guide farmers on appropriate fertilizer management under such continuous cropping are few and poorly documented in south eastern Nigeria. A two-year field experiment was conducted during 2007 - 2009 at Uyo, a humid forest agro-ecology of south eastern Nigeria to assess the growth and yield response of cassava. Treatments included four rates each of nitrogen (N) and potassium (K) (0, 40, 80 and 120 kg/ha) in all possible factorial combination replicated thrice in a randomized complete block design. Application of N at the highest rate significantly (P = 0.05) increased plant height, produced higher number of leaves and branches/plant, stem girth, number and weight of tubers/plant and total fresh tuber yield compared with other treatments. The fresh tuber yield at 120 kg N/ha was however, comparable with that at 80 kg N/ha rate. Cassava growth, fresh tuber yield and all yield attributes peaked at 80 kg K/ha rate. The 120 kg N/ha and 80 kg K/ha rates increased fresh tuber weight by 48 and 45% and total fresh tuber yield by 36 and 27% respectively, compared with the control plots. The application of N between 80 and 120 kg/ha and K at 80 kg/ha appeared appropriate for optimum yield in our study area and are thus recommended.

Wang Q., J. Zhang, B. Zhao, X. Xin, C. Zhang, and H. Zhang. 2014. The influence of long-term fertilization on cadmium (Cd) accumulation in soil and its uptake by crops. Environmental Science And Pollution Research, 21:10377-10385.
Reference ID: 21848
Notes: #21858e
Abstract: Continuous application of organic and inorganic fertilizers can affect soil and food quality with respect to heavy metal concentrations. The risk of cadmium (Cd) contamination in a long-term (over 20 years) experimental field in North China with an annual crop rotation of winter wheat and summer maize was investigated. The long-term experiment had a complete randomized block design with seven fertilizer treatments and four replications. The seven fertilizer treatments were (1) organic compost (OM), (2) half organic compost plus half chemical fertilizer (OM?+?NPK), (3) NPK fertilizer (NPK), (4–6) chemical fertilizers without one of the major nutrients (NP, PK, and NK), and (7) an unamended control (CK). Soil samples from 0 to 20 cm were collected in 1989, 1999, and 2009 to characterize Cd and other soil properties. During the past 20 years, various extents of Cd accumulation were observed in the soil, and the accumulation was mainly affected by atmospheric dry and wet deposition and fertilization. In 2009, the average Cd concentration in the soil was 148?±?15 μg kg-1 and decreased in the order of NPK?˜?OM?+?NKP?˜?PK?>?NP?˜?NK?>?OM?˜?CK. Sequential extraction of Cd showed that the acid-soluble fraction (F1, 32?±?7 %) and the residual fraction (F4, 31?±?5 %) were the dominant fractions of Cd in the soil, followed by the reducible fraction (F2, 22?±?5 %) and oxidizable fraction (F3, 15?±?6 %). The acid-soluble Cd fraction in the soil and Cd accumulation in the crops increased with soil plant available K. Fraction F3 was increased by soil organic C (SOC) and crop yields, but SOC reduced the uptake of soil Cd by crops. The long-term P fertilization resulted in more Cd buildup in the soil than other treatments, but the uptake of Cd by crops was inhibited by the precipitation of Cd with phosphate in the soil. Although soil Cd was slightly increased over the 20 years of intensive crop production, both soil and grain/kernel Cd concentrations were still below the national standards for environmental and food safety.

Whitmore A. P., K. W. T. Goulding, M. J. Glendining, A. G. Dailey, K. Coleman, and D. S. Powlson. 2012. Nutrient Management in Support of Environmental and Agricultural Sustainability. Sustainability, 4:2513-2524.
Reference ID: 21849
Notes: #21849e
Abstract: Given that we must farm land in order to eat, the total environmental burden imposed by farming a crop, such as winter wheat in the UK, appears to be close to the minimum given current production techniques. The value of the services other than food production, such as flood water buffering, pollination, carbon storage and so on, that land can provide is relatively large compared with the value in reducing environmental burdens from pesticide use, nutrient pollution and greenhouse gas emissions that might arise by farming less intensively. More land will need to be brought into cultivation in order to provide the same amount of food if the intensity of farming is reduced and the resultant loss of ecosystem services (ES) outweighs the reduction in other burdens. Nevertheless, losses of nutrients, especially nitrogen (N), from agriculture are a serious concern and the current cost of the environmental footprint of agriculture is significant compared with the value of the food it produces. This article examines nutrient burdens and analyses the means by which the total environmental burden might be reduced relative to productivity.

These include increasing the efficiency of farming, removing constraints to yield, and establishing multiple uses for land at the same time as farming. It concludes that agronomic measures which improve nutrient capture and which obtain more yield per unit area are valuable means to avoid degradation of environmental quality because both nutrient pollution and land consumption can be avoided.

Millard E. 2011. Incorporating Agroforestry Approaches into Commodity Value Chains. Environmental Management, 48:365-377.
Reference ID: 21850
Notes: #21850e
Abstract: The productivity of tropical agricultural commodities is affected by the health of the ecosystem. Shade tolerant crops such as coffee and cocoa benefit from environmental services provided by forested landscapes, enabling landscape design that meets biodiversity conservation and economic needs. What can motivate farmers to apply and maintain such landscape approaches? Rather than rely on a proliferation of externally funded projects new opportunities are emerging through the international market that buys these commodities. As part of their growing commitment to sustainable supply chains, major companies are supporting agroforestry approaches and requiring producers and traders to demonstrate that the source of their commodities complies with a set of principles that conserves forested landscapes and improves local livelihoods. The paper presents examples of international companies that are moving in this direction, analyzes why and how they are doing it and discusses the impact that has been measured in coffee and cocoa communities in Latin America and Africa. It particularly considers the role of standards and certification systems as a driver of this commitment to promote profitable operations, environmental conservation and social responsibility throughout the coffee and cocoa value chains. Such approaches are already being taken to scale and are no longer operating only in small niches of the market but the paper also considers the limitations to growth in this market-based approach.

Sambuichi R. H. R., D. B. Vidal, F. B. Piasentin, J. G. Jardim, T. G. Viana, A. A. Menezes, D. L. N. Mello, D. Ahnert, and V. C. Baligar. 2012. Cabruca agroforests in southern Bahia, Brazil: tree component, management practices and tree species conservation. Biodiversity and Conservation, 21:1055-1077.
Reference ID: 21851
Notes: #21851e
Abstract: In southern Bahia, Brazil, cabrucas are the traditional agroforests in which cacao trees are planted under thinned-out native forests. To analyze the role of cabrucas in tree species conservation, we inventoried the non-cocoa trees in 1.0 ha plots of cabruca in 16 cocoa farms and compared our results with a similar survey undertaken in the early 1960s in the same region to analyze the long term changes. We also interviewed 160 cocoa farmers to investigate their preferences for species and the main practices used in managing shade trees. The cabrucas showed high levels of tree diversity for an agroforestry system (Shannon index ranging from 2.21 to 3.52) and also high variation in structure and composition among the different farms. Forest specialist trees accounted for most species (63.9%) in the survey and were among the species most preferred by the farmers, although we found evidence that some of these trees are gradually being replaced by other species. Our results indicate that cabrucas are poor substitutes for undisturbed forests in terms of tree species richness, but their presence in human-altered landscapes is of utmost importance to the conservation of forest tree species as they increase overall

heterogeneity and may serve as ecological corridors, additional habitats, and buffer zones.

Tscharntke T., Y. Clough, S. A. Bhagwat, D. Buchori, H. Faust, D. Hertel, D. Holscher, J. Juhrbandt, M. Kessler, I. Perfecto, C. Scherber, G. Schroth, E. Veldkamp, and T. C. Wanger. 2011. Multifunctional shade-tree management in tropical agroforestry landscapes – a review. Journal of Applied Ecology, 48:619-629.
Reference ID: 21852
Notes: #21852e
Abstract:
Summary
1. Agricultural intensification reduces ecological resilience of land-use systems, whereas paradoxically, environmental change and climate extremes require a higher response capacity than ever. Adaptation strategies to environmental change include maintenance of shade trees in tropical agroforestry, but conversion of shaded to unshaded systems is common practice to increase short-term yield.
2. In this paper, we review the short-term and long-term ecological benefits of shade trees in coffee Coffea arabica, C. canephora and cacao Theobroma cacao agroforestry and emphasize the poorly understood, multifunctional role of shade trees for farmers and conservation alike.
3. Both coffee and cacao are tropical understorey plants. Shade trees in agroforestry enhance functional biodiversity, carbon sequestration, soil fertility, drought resistance as well as weed and biological pest control. However, shade is needed for young cacao trees only and is less important in older cacao plantations. This changing response to shade regime with cacao plantation age often results in a transient role for shade and associated biodiversity in agroforestry.
4. Abandonment of old, unshaded cacao in favour of planting young cacao in new, thinned forest sites can be named 'short-term cacao boom-and-bust cycle', which counteracts tropical forest conservation. In a 'long-term cacao boom-and-bust cycle', cacao boom can be followed by cacao bust due to unmanageable pest and pathogen levels (e.g. in Brazil and Malaysia). Higher pest densities can result from physiological stress in unshaded cacao and from the larger cacao area planted. Risk-averse farmers avoid long-term vulnerability of their agroforestry systems by keeping shade as an insurance against insect pest outbreaks, whereas yield-maximizing farmers reduce shade and aim at short-term monetary benefits.
5. Synthesis and applications. Sustainable agroforestry management needs to conserve or create a diverse layer of multi-purpose shade trees that can be pruned rather than removed when crops mature. Incentives from payment-for-ecosystem services and certification schemes encourage farmers to keep high to medium shade tree cover. Reducing pesticide spraying protects functional agrobiodiversity such as antagonists of pests and diseases, pollinating midges determining cacao yields and pollinating bees enhancing coffee yield. In a landscape perspective, natural forest alongside agroforestry allows noncrop-crop spillover of a diversity of functionally important organisms. Knowledge transfer between farmers, agronomists and ecologists in a participatory approach helps to encourage a shade management regime that balances economic and ecological needs and provides a 'diversified food-and-cash crop' livelihood strategy.

Ojeniyi S. O., N. E. Egbe, and T. I. Omotoso. 1982. Effects of nitrogen and phosphorus fertilizers on unshaded Amazon cocoa in Nigeria. Fertilizer Research, 3:13-16.
Reference ID: 21853
Notes: #21853e
Abstract: No extensive investigation on the effect of fertilizers on Amazon cocoa variety (Theobroma cacao L.) has been performed in Nigeria. Therefore eight fertilizer treatments involving nitrogen and phosphorus, replicated six times at four locations across southern Nigeria, were established in 1973. The four N levels (N0, N1, N2, N3) involved were 0, 80, 160 and 240 kg ha-1 y-1, and the two P levels (P0, P1) were 0 and 67 kg ha-1 y-1. Results of the first 5 years of fertilizer application are reported. Response to P was observed at all locations, and the response was statistically significant at 2 of the locations. There was no response to the application of nitrogen. The data suggest, however, that there is only a response to phosphorus when nitrogen is applied.

Stichnothe H. and F. Schuchardt. 2010. Comparison of different treatment options for palm oil production waste on a life cycle basis. The International Journal of Life Cycle Assessment, 15:907-915.
Reference ID: 21854
Notes: #21854e
Abstract:
Background, aim, and scope
Globally, 45 million metric tonnes of palm oil has been produced in 2009. The production of 1 t crude palm oil requires 5 t of fresh fruit bunches (FFB). On average, processing of 1 t FFB in palm oil mills generates 230 kg empty fruit bunches (EFB) and 650 kg palm oil mill effluent (POME) as residues. These residues cause considerable environmental burdens, particularly greenhouse gas emissions. In order to reduce those emissions, four waste management options are compared in the present study using 1,000 kg of FFB as functional unit.
Methods
A detailed life cycle model has been used to calculate the environmental impacts of POME and EFB treatment. The options under investigation are: (1) dumping EFB and storing POME and ponds, (2) returning EFB to the plantation and POME as before, (3) using EFB and POME for co-composting and returning the produced compost to the plantation, (4) generating biogas from POME and thereafter as in (3). The CML 2001 method included in the GABI 4.3 software package has been used for the impact calculations. Sensitivity analysis has been carried out in order to estimate the influence of good and poor management practice on the environmental performance.
Results and discussion
The main contributor to the GWP is methane from POME and EFB dumping. The GWP of palm oil mill waste treatment can be reduced from 245 kg CO2eq per ton FFB to up to 5 kg CO2eq per ton FFB due to reduced methane emissions and nutrient recycling. Co-composting of POME and EFB leads to considerable nutrient recovery, in addition to GWP reduction. Thus, the composting process reduces not only environmental burdens; it also leads to net environmental benefit regarding most environmental impact categories, e.g., acidification potential, eutrophication potential, ozone layer depletion potential, etc. due to the avoided emissions from inorganic fertilizer production. The recovery of nutrients in EFB can be achieved by solely returning it to the plantation, but only the combined treatment of EFB and

POME allows nutrient recovery from POME while methane emissions from pond systems are avoided simultaneously. The fermentation of POME to produce biogas reduces environmental burdens when operating under best practice conditions. However, fugitive biogas emissions of more than 2% reverse that beneficial effect.

Conclusion and recommendation

A life-cycle-based comparison of conventional and advanced treatment systems for EFB and POME can support decision makers regarding waste treatment options and provide information on technology risks involved. The results of this study may be used as basic calculation data for clean development mechanism for palm oil mills. LCA is shown to be a powerful tool to estimate and compare environmental impacts of different options. Unfortunately, it is rarely used in the palm oil industry in order to improve or optimize palm oil production systems. This study has shown that nutrient recovery from POME and EFB offers considerable environmental and economic benefits to palm oil production systems. However, using EFB for energy production, as it is discussed and realized by some palm oil mills, prohibits environmental beneficial POME utilization. Best waste management practice reduces emissions at palm oil mills and consequently the carbon footprint of palm oil products. Co-composting of EFB and POME, with or without prefermentation of POME in a biogas plant, is a profitable way to use the nutrients from both POME and EFB.