

New Entries to IPNI Library as References

MOSTA. Malaysian Oil Science and Technology, Vol 23 No 2. Malaysian Oil Science and Technology 23[2], 55-129. 2014. Malaysia.

Reference ID: 20829

Notes: S 8.1.1 #20829

Mielke T. 2014. The vegetable oils market in 2015 and beyond. Malaysian Oil Science and Technology, 23:55-64.

Reference ID: 20830

Notes: S 8.1.1 #20830e < #20829

Parish F. 2014. Best management practices to minimise CO2 emissions from oil palms on peat. Malaysian Society of Soil Science, 23:69-76.

Reference ID: 20831

Notes: S 8.1.1 #20831e < #20829

Basiron Y. 2014. 2015 outlook for the Malaysian palm oil industry. Malaysian Oil Science and Technology, 23:79-89.

Reference ID: 20832

Notes: S 8.1.1 #20832e < #20829

Donnelly P. 2014. Global oils and fats: Addressing major challenges. Malaysian Oil Science and Technology, 23:90-102.

Reference ID: 20833

Notes: S 8.1.1 #20833e < #20829

MOSTA. 2013. Malaysian Oil Science and Technology, Vol 22 No 2. Malaysian Oil Science and Technology, 22:48-74.

Reference ID: 20834

Notes: S 8.1.1 #20834

MOSTA. 2014. Malaysian Oil Science and Technology, Vol 23 No 1. Malaysian Oil Science and Technology, 23:1-54.

Reference ID: 20835

Notes: S 8.1.1 #20835

Rice R. A. and R. Greenberg. 2000. Cacao cultivation and the conservation of biological diversity. Ambio, 29:167-173.

Reference ID: 20836

Notes: H 8.1.4.1 #20836e

Abstract: Cacao (*Theobroma cacao*) is a crop of the humid lowland tropics produced largely by small-scale producers and often on farms with a canopy of shade trees. Where a diverse shaded canopy is used, cacao farms support higher levels of biological diversity than most other tropical crops. A host of viral and fungal diseases, loss of soil fertility, and numerous socioeconomic problems facing producers, often makes cacao production locally unsustainable. Continued clearing

of new lands threatens biodiversity. Moreover, new frontiers for cacao expansion are rapidly disappearing. Such problems can be addressed by increasing the long-term productivity of existing cacao farms and restoring abandoned lands. Improved shade management offers guidance along this path. Institutions involved with cocoa should establish collaborations with groups concerned with development, environmental protection, and most importantly producers themselves to pursue a program of research, extension and policy initiatives focused on the ecologically and economically sustainable cacao production on farms with a diverse shade canopy.

Nelson P. N., C. Fidelis, M. J. Webb, S. Berthelsen, and D. Yinil. 2010. Nutrient status of cocoa (*Theobromae cacao*) in Papua New Guinea: results from a survey. Pages 71-74.

Reference ID: 20837

Notes: H 8.1.4.1 #20837

Abstract: Cocoa is the primary cash crop in most coastal areas of Papua New Guinea (PNG), supporting an estimated 150,000 households. Smallholders produce most of the crop, but their yields are low, at about 10% of the maximum. Low yields have been attributed to many factors, but the possibility of nutrition-related limitations to productivity has not been examined in detail. Here we report on a survey of 63 cocoa blocks across the country. Based on leaf analyses, N and Fe deficiencies appear to be very widespread, with 95 % of sampled blocks falling below the critical level for N and 89 % for Fe. P deficiencies were encountered in ~25% of the blocks sampled. Leaf Mg concentrations were adequate in most blocks in most provinces, except East New Britain, where 64 % of the blocks sampled were deficient. Deficiencies of K, Ca, Mn, B, Cu and Zn were encountered in 2 -15 % of sampled blocks. There were significant relationships between leaf and soil contents of K, Ca, Mg and P. There is a clear need to further examine nutrition-related limitations to productivity in PNG, including establishment of more reliable critical levels for leaf nutrient concentrations.

Ng S. K. and K. C. Thong. 2003. Nutrient requirements for exploiting yield potentials of major plantation tree crops in the tropics. Pages 81-95 *in* RHV Corley and PBH Tinker, editors. The oil palm. Blackwell Publishing, Inc.

Reference ID: 20838

Notes: S 8.1.1 #20838e < #7474

van der Velde M., L. See, L. You, J. Balkovic, S. Fritz, N. Khabarov, M. Obersteiner, and S. Wood. 2013. Affordable nutrient solutions for improved food security as evidenced by crop trials. *Plos One*, 8:1-8.

Reference ID: 20839

Notes: H 2.8 #20839

Abstract: The continuing depletion of nutrients from agricultural soils in Sub-Saharan African is accompanied by a lack of substantial progress in crop yield improvement. In this paper we investigate yield gaps for corn under two scenarios: a micro-dosing scenario with marginal increases in nitrogen (N) and phosphorus (P) of 10 kg ha⁻¹ and a larger yet still conservative scenario with proposed N and P applications of 80 and 20 kg ha⁻¹ respectively. The yield gaps are calculated from a database of historical FAO crop fertilizer trials at 1358 locations for Sub-Saharan Africa and South America. Our approach allows connecting experimental field scale data with continental policy recommendations. Two critical findings emerged from the analysis. The first is the degree to which P limits increases in corn yields. For example, under

a micro-dosing scenario, in Africa, the addition of small amounts of N alone resulted in mean yield increases of 8% while the addition of only P increased mean yields by 26%, with implications for designing better balanced fertilizer distribution schemes. The second finding was the relatively large amount of yield increase possible for a small, yet affordable amount of fertilizer application. Using African and South American fertilizer prices we show that the level of investment needed to achieve these results is considerably less than 1% of Agricultural GDP for both a micro-dosing scenario and for the scenario involving higher yet still conservative fertilizer application rates. In the latter scenario realistic mean yield increases ranged between 28 to 85% in South America and 71 to 190% in Africa (mean plus one standard deviation). External investment in this low technology solution has the potential to kick start development and could complement other interventions such as better crop varieties and improved economic instruments to support farmers.

Jones D. L., P. Cross, P. J. A. Withers, T. H. DeLuca, D. A. Robinson, R. S. Quilliam, I. M. Harris, D. R. Chadwick, and G. Edwards-Jones. 2013. Nutrient stripping: the global disparity between food security and soil nutrient stocks. *Journal of Applied Ecology*, 50:851-862.

Reference ID: 20840

Notes: H 2.8 #20840

Abstract: 1. The Green Revolution successfully increased food production but in doing so created a legacy of inherently leaky and unsustainable agricultural systems. Central to this are the problems of excessive nutrient mining. If agriculture is to balance the needs of food security with the delivery of other ecosystem services, then current rates of soil nutrient stripping must be reduced and the use of synthetic fertilisers made more efficient.

2. We explore the global extent of the problem, with specific emphasis on the failure of macronutrient management (e.g. nitrogen, phosphorus) to deliver continued improvements in yield and the failure of agriculture to recognise the seriousness of micronutrient depletion (e.g. copper, zinc, selenium).

3. Nutrient removals associated with the relatively immature, nutrient-rich soils of the UK are contrasted with the mature, nutrient-poor soils of India gaining insight into the emerging issue of nutrient stripping and the long-term implications for human health and soil quality. Whilst nutrient deficiencies are rare in developed countries, micronutrient deficiencies are commonly increasing in less-developed countries. Increasing rates of micronutrient depletion are being inadvertently accomplished through increasing crop yield potential and nitrogen fertiliser applications.

4. Amongst other factors, the spatial disconnects caused by the segregation and industrialisation of livestock systems, between rural areas (where food is produced) and urban areas (where food is consumed and human waste treated) are identified as a major constraint to sustainable nutrient recycling.

5. Synthesis and applications. This study advocates that agricultural sustainability can only be accomplished using a whole-systems approach that thoroughly considers nutrient stocks, removals, exports and recycling. Society needs to socially and environmentally re-engineer agricultural systems at all scales. It is suggested that this will be best realised by national-scale initiatives. Failure to do so will lead to an inevitable and rapid decline in the delivery of provisioning services within agricultural systems.

Kearney S., S. J. Fonte, A. Salomon, J. Six, and K. M. Scow. 2012. Forty percent revenue increase by combining organic and mineral nutrient amendments in Ugandan smallholder market. *AGRON SUSTAIN.DEV.*, 32:831-839.

Reference ID: 20841

Notes: H 2.8 #20841

Abstract: Linkages between poverty and soil fertility decline in sub-Saharan Africa indicate the need for effective strategies to restore soils, while improving smallholder incomes. Combining organic and inorganic nutrient resources offers a promising means to address this issue, via improvements to nutrient cycling and key soil properties. Yet few studies have examined this practice from an economic perspective and none have explored its potential in intensively managed, market vegetable crops. We address this issue through a demonstrative, on-farm research trial examining the agronomic and economic benefits of mixing manure and inorganic fertilizer for smallholder cabbage production in rural Uganda. Cabbage was grown on eight replicate farms in close association with a farmer field school on vegetable production. Inorganic fertilizer, urea and NPK, and cattle manure were applied alone and in combination, based on equivalent monetary inputs, yielding six treatments: (1) 100 % fertilizer, (2) 75 % fertilizer and 25 % manure, (3) 50 % fertilizer and 50 % manure, (4) 25 % fertilizer and 75 % manure, (5) 100 % manure, and (6) a control without nutrient inputs. Initial soil fertility was evaluated prior to planting and cabbage biomass, nutrient content, and market value were assessed at harvest. Our findings demonstrate that combining manure and inorganic fertilizers produced up to 26 % higher biomass and 40 % higher market value on average than fertilizer or manure alone treatments. Incomes could be increased by 114.68 USD per growing season based on the current area of land that farmers dedicate to cabbage production, compared to using manure or inorganic fertilizer alone. Furthermore, the input ratio of manure to fertilizer appears to be flexible and thus easily adjusted to price fluctuations. This research provides a clear means for smallholder farmers to better allocate soil fertility investments and enhance incomes from market vegetable production. This research also highlights the importance of involving farmers in agricultural research for efficient evaluation of new technologies, building local capacity and yielding rapid impacts.

Ryan J., A. Rashid, J. Torrent, S. K. Yau, H. Ibrikci, R. Sommer, and E. B. Erenoglu. 2013. Micronutrient constraints to crop production in the Middle East-West Asia region: Significance, research and management. *Advances in Agronomy*, 122:1-84.

Reference ID: 20842

Notes: H 2.8.3 #20842

Abstract: In addition to nine major nutrients, eight micronutrients [i.e., boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), and zinc (Zn)] are also essential for healthy growth and reproduction of higher plants. Globally, crop production is largely dependent on chemical fertilizer use, especially in developed countries. While fertilizer use, particularly nitrogen (N) and phosphorus (P), has increased substantially in the past four decades in developing countries, such as Pakistan and India, fertilizer use is limited in many areas of the world where agriculture is constrained by harsh climatic conditions, especially low rainfall. The disparity between developed and developing countries is particularly acute with respect to micronutrient awareness and use.

One area of the world that is characterized by major climatic and soil constraints, often exacerbated by unfavorable socioeconomic conditions, is the Middle East-West

Asia region. This review provides a current perspective on that region of the world where crop yields are invariably low due to drought, with limited inputs and inherent soil nutrient deficiencies. With a high population, there is an urgent need to sustainably expand output. However, there is generally limited awareness of the potential significance of micronutrients in agriculture as factors in crop production, as well as limited research on micronutrients in most countries of the region. The long history of cultivated agriculture in the Middle East-West Asia region and the peculiar characteristics of its soils and climate predispose it toward problems of micronutrient deficiencies.

Over three decades ago, a global study on micronutrients indicated widespread deficiencies of iron (Fe) and zinc (Zn), in contrast to copper (Cu) and manganese (Mn), but suggested the likelihood of excess levels of boron (B) in some countries of the region. This overview primarily addresses three focal points in the region, Pakistan in the east, Syria/Lebanon/Turkey in the center, and Spain on the western fringes, reflecting the zones of activity of the respective authors; the latter focal point is a developed region, where, because of soil and climatic similarities, the research is relevant to the whole Middle East-West Asia region.

While providing some international context, this article brings together and summarizes published work in the areas of crop and soil micronutrient availability, their behavior in soils in relation to crop growth, and strategies to deal with either deficiency or toxicity, including crop selection for tolerance and subsequent genetic manipulation. Considerable strides have been made in elucidating the significance of both Zn and Fe in the region's mainly calcareous soils, through soil and plant analysis, with the resulting knowledge providing a sound basis for management interventions through validated field research. While B deficiency is common in some countries such as Pakistan, the problem of B toxicity (BT), where it exists, is only handled by crop adaptation.

The review also highlights the implications of micronutrient constraints in the soil-plant-human-animal continuum. Intensification of agricultural production as a result of overall macronutrient use, expansion of irrigation, and introduction of new or "niche" crops is likely to accentuate micronutrient deficiencies in the region, but developments such as conservation agriculture may counteract this trend. As the trend for land-use intensification increases because of higher yields due to fertilizer use and irrigation and the introduction of new crops, and as other nutrient constraints are eliminated, micronutrients will inevitably assume greater significance in the future agriculture of the Middle East-West Asia region together with improvements in plant breeding and crop management.

Hoffmann M. P., C. Donough, T. Oberthür, A. Castaneda Vera, M. T. van Wijk, C. H. Lim, D. Asmono, Y. M. S. Samosir, A. P. Lubis, D. S. Moses, and A. M. Whitbread. 2015. Benchmarking Yield for Sustainable Intensification of Oil Palm Production in Indonesia using PALMSIM. *The Planter*, 91:81-96.

Reference ID: 20843

Notes: #20843e

Abstract: The physiological oil palm growth model PALMSIM can be used to estimate yield ceilings that provide benchmarks for sustainable intensification of oil palm production, either by expansion of cultivation to degraded sites or by increasing production from areas under cultivation. This is demonstrated using two case

studies. In the first case study, PALMSIM estimates of water-limited yield for Kalimantan was overlaid onto a recently published map showing degraded sites potentially suitable for oil palm cultivation. A large proportion (35.6%; or 115,300 km²) of the identified areas fell into the potential productivity range of 35 to 40 tonnes FFB per hectare. In the second case study, PALMSIM was used to estimate potential yield for six plantation sites in Indonesia where best management practices (BMP) were assessed for yield intensification by the International Plant Nutrition Institute (IPNI) Southeast Asia Program (SEAP) and its collaborating plantation partners. Potential yields are generally higher in Sumatra than in Kalimantan due to higher solar radiation. Water deficit was a problem at two sites. The gap between water-limited yield and actual yield differs from location to location, and therefore requires a site-specific analysis. In these two case studies, the scope for sustainable intensification at regional and at plantation level was explored in a quantitative manner - a novel approach to oil palm production.

Pinitpaitoon S., R. W. Bell, and A. Suwanarit. 2011. The significance of available nutrient fluxes in N and P budgets for maize cropping on a Rhodic Kandistox: a study with compost, NP fertilizer and stubble removal. *Nutr Cycl Agroecosyst*, 89:199-217.

Reference ID: 20844

Notes: H 8.2.2.1 #20844

Abstract: Nutrient budgets may be useful tools for nutrient management of crops especially if they estimate the nutrient fluxes available from a variety of sources including organic and inorganic fertilizer, crop residues and soil organic matter. The aim of the present study was to develop a budget of available nutrients by determining the contribution of mineralized nutrient fluxes and fertilizer input relative to nutrient losses and removal in harvested products in the overall N and P balances. N and P inputs and outputs and available N and P fluxes in the soil were estimated for 3 consecutive maize crops where inputs and outputs were altered by NP fertilizer, compost and stubble removal on a Rhodic Kandistox. A sensitivity analysis of calculated and measured nutrient budget items was conducted to identify the main factors affecting the accuracy of the nutrient balance calculations. Mineral fertilizer rate was the major factor for maize nutrient budgets as shown by its contribution to N and P balances. Without mineral fertilizer application, soil organic matter (SOM) mineralization was the most important within-season nutrient input. In the case of N, shoot uptake was the main output followed by denitrification. Phosphorus adsorption by the soil was the major P output from the available pools followed by shoot uptake. SOM mineralization maintained the pools of available N and P if stubble of the previous crop was returned. Mineral fertilizer application, which produced surplus balances of N and P, would however, be needed to attain high yield, even with stubble return. The available N and P from compost were not significant inputs in the nutrient balances until year 3. Total N and resin extractable P in soil after five crops supported the calculated nutrient balances indicating the importance of available nutrient fluxes in calculating N and P balances.

Morris M., V. A. Kelly, R. J. Kopicki, and D. Byerlee 2007. Fertilizer use in African agriculture: Lessons learned and good practice guidelines, The International Bank for Reconstruction and Development / The World Bank.

Reference ID: 20845

Notes: H 21.6 #20845e

Kawano K. 1990. Harvest index and evolution of major food crop cultivars in the tropics. *Euphytica*, 46:195-202.

Reference ID: 20846

Notes: #20846e

Abstract: Relative importance of harvest index (I) and total biomass yield (B) to economic yield (Y) was assessed in several food crops at different levels of environmental productivity. Importance of B is generally higher in low than high yielding environments, while that of I is higher in high than low yielding environments. In some crops B is important throughout different yield levels while in others I is important even in low yielding environments. Past efforts by anonymous farmers have consummated a good part of genetic improvement of crop yields through improvement in B. Many venerable land cultivars of grain crops, adapted to unimproved, limited input cultural conditions, evolved through this process. The same process may not have thoroughly exhausted the yield improvement opportunity through improving I. Success in yield improvement by modern breeding has been limited mainly to high-input cultural conditions characterized by higher soil fertility and irrigation mainly through improvement in I. Varietal improvement possibility for less productive environments is discussed.

Horst W. J., M. K. Schenk, A. Burkert et al. 2001. *Plant Nutrition: Food security and sustainability of agro-ecosystems through basic and applied research*, Kluwer Academic Publishers, The Netherlands.

Reference ID: 20847

Notes: S 2.8 #20847

ESA. 2010. *Proceedings of Agro2010 the XI ESA Congress*. Pages 1-1048 Agropolis International Editions, Montpellier, France.

Reference ID: 20848

Notes: S 8 #20848

Banta S. J. 2007. *Rice, Water and Forests*. Pages 1-158 The Asia Rice Foundation, Manila, Philippines.

Reference ID: 20849

Notes: S 8.2.1.3 #20849

Yoshida S., D. A. Forno, J. H. Cock, and K. A. Gomez 1976. *Laboratory manual for physiological studies of rice*, The International Rice Research Institute, Laguna. Philippines.

Reference ID: 20850

Notes: S 8.2.1 #20850

ten Berge, H. F. M., Aggarwal, P. K., and Kropff, M. J. *Applications of Rice Modelling*. *Field Crops Research* 51[1,2], 1-164. 1997. The Netherlands.

Reference ID: 20851

Notes: S 8.2.1 #20851

IPNI. *Mission With Metrics*. 1-95. 2014. IPNI.

Reference ID: 20852

Notes: S 35 #20852

van der Ent A. 2013. Kinabalu, Natural History Publications (Borneo) Sdn Bhd, Sabah, Malaysia.

Reference ID: 20853

Notes: S 26.1.5 #20853

Coelho E. F., T. M. D. Neto, and D. L. Barros. 2014. Concentration of Injection Solution and its Effects on Soil and yield of Fertirrigated Banana cv Terra Maranhao. *Engenharia Agricola*, 34:1104-1113.

Reference ID: 20854

Notes: #20854e

Abstract: The Fertigation is the combined application of water and nutrients to a crop. It can be adapted to all types of agricultural crops. The objective of this study was to evaluate the effect of urea concentration in irrigation water on electrical conductivity of the soil solution and saturation extract along the first cycle of banana cv. Terra Maranhao. The experiment followed a completely randomized design with six treatments and ten replications. Treatments regarded for using three urea concentrations (1.0; 2.5 and 4.0 g L⁻¹) in irrigation water applied by two micro irrigation systems (microsprinkler and drip). Results showed that there was a linear elevation of electrical conductivity of saturation extract and soil solution with the increase on concentration of urea in the injection solution. Urea should be used under concentrations up to 2.5 g L⁻¹ in irrigation water without causing increase on electric conductivity of soil solution and saturation extract, considering 1.1 dS m⁻¹) as the tolerated value for the crop. Nitrate in the soil solution increased significantly with the increase of urea concentration in the injection solution. The maximum concentration of nitrate in the soil occurred for 4,0 g L⁻¹ concentration of the injection solution.

Roque R. D., T. B. do Amorim, C. F. Fereira, C. A. D. Ledo, and E. P. Amorim. 2014. Agronomic Performance Of Banana Genotypes In The Reconcavo Of Bahia: Desempenho Agronômico De Genótipos De Bananeira No Recôncavo Da Bahia. *Revista Brasileira De Fruticultura*, 36:598-609.

Reference ID: 20855

Notes: #20855e

Abstract: The objective of the present study was to evaluate the agronomic performance of tri-and tetraploid bananas in two production cycles aiming to select the most promising for recommendation for planting in the Reconcavo Region of Bahia. The experimental design was in randomized blocks with 11 genotypes and three replicates with four plants per plot in 3 m x 2 m spacing. The following agronomic characteristics were evaluated: plant height (m); pseudostem diameter (cm); number of live leaves at flowering; number of live leaves at harvest; stem length (cm); stem diameter (cm); bunch weight (kg); hand weight (kg); single hand weight (g); number of hands; number of fruits per bunch; pedicel length (cm); pedicel diameter (mm); finger drop susceptibility (Lb); firmness of pulp with peel; fruit weight (g); fruit length (cm); fruit diameter (mm); elongation index; pulp weight (g); pulp/ peel ratio; pulp yield (%); pulp diameter (mm), peel thickness (mm); pulp thickness (Lb), titratable acidity-TA (%), soluble solids-SS (degrees Brix), SS/TA ratio and pH. Of the thirty variables evaluated, 12 were significant for the source of variation 'cycles'. As to the 'genotype x cycles' interaction it is possible to assert that there was no differentiated behavior in the genotypes from the first to the second production cycle, except for 'plant height', 'number of live leaves at flowering', 'fruit diameter' and 'peel thickness'. Results for the effect of 'genotypes' were significant for all characteristics,

except for fruit 'finger drop susceptibility'. Considering the agronomic data, genotypes from the YB series and the cultivars BRS Princesa and BRS Garantida showed to be promising for cultivation in the Reconcavo region of Bahia for presenting good agronomic performance.

Niere B., C. S. Gold, D. Coyne, T. Dubois, and R. Sikora. 2014. Performance of tissue-cultured versus sucker-derived East African highland banana (*Musa* AAA-EA) under high and low input systems in Uganda. *Field Crops Research*, 156:313-321.

Reference ID: 20856

Notes: #20856e

Abstract: Banana (*Musa* spp.) is a vegetatively propagated crop and the type of planting material is of great importance for the productivity of banana plantations. Traditionally, sucker derived planting materials have been used to establish banana plantations but there is a risk of transmitting pests such as plant-parasitic nematodes with untreated suckers. Tissue cultured banana plants are pest-free and widely grown in commercial dessert banana plantations but are not common agricultural practice under East African conditions. This study aimed at evaluating the agronomic performance and nematode infestation levels of sucker-derived and tissue cultured planting material of the East African highland cooking banana cultivar Nabusa (*Musa* spp., genome group AAA-EA) over five crop cycles. A field trial was conducted in Central Uganda using tissue culture plants, untreated suckers, pared suckers or pared and hot water treated suckers.

All plants were cultivated under mulched or non-mulched conditions to represent high or low input systems, respectively. Mulch in general improved agronomic performance of banana. Type of planting material also influenced plant growth and yield. Tissue culture plants developed faster and yielded higher during the first crop cycle than sucker-derived material but not thereafter. Plant height and bunch weight of untreated suckers was inferior to all other planting material from the third crop cycle onwards. All mulched plants flowered earlier in all crop cycles. Duration from planting to the first harvest was less for tissue-cultured plants, but planting material had no influence on days to harvest from the third crop cycle onwards. Nematode densities were higher in roots from plants grown from untreated suckers than all other planting material, with *Radopholus similis* consistently recovered in greater densities than *Helicotylenchus multicinctus* across treatments. Mulching had no influence on nematode densities, root necrosis, number of root base lesions or number of dead roots. Nematode associated damage was higher in plants from untreated suckers but did not differ among tissue-cultured and pared and hot water treated or pared sucker plants. This study demonstrates the benefits of using clean planting material for cooking banana over five consecutive crop cycles and confirms the beneficial effects of mulching. In order to achieve high banana yields over several crop cycles, clean planting material needs to be supported by the application of mulch. However, this study shows that the application of mulch will not offset the detrimental effects of plant parasitic nematode-infected sucker planting material.

Zhong S., Y. Mo, G. Guo, H. Zeng, and Z. Jin. 2014. Effect of Continuous Cropping on Soil Chemical Properties and Crop Yield in Banana Plantation. *Journal of Agricultural Science And Technology*, 16:239-250.

Reference ID: 20857

Notes: #20857e

Abstract: The effects of banana continuous cropping on soil quality and chemical properties and crop yield were investigated under continuous cropping for 1, 3, 5, 7, 10, and 15 years in Hainan province, China. The results indicated that the contents of total N, total K, available K, NH₄-N, exchangeable Ca, and available Cu tended to increase, while total organic C (TOC), available S, and available Zn tended to decrease with the increase of continuous cropping years at the four sampling stages. The contents of exchangeable Mg and available Fe and Mn were higher in the 3, 5, 7, and 10 years than in the 1 and 15 years at the four sampling stages. The values of pH, the contents of total P and available P decreased from 1 to 5 years and increased from 7 to 15 years at most of the sampling stages. Overall, average banana yield increased from 1 to 3 years and decreased afterwards. In conclusion, banana continuous cropping deteriorated soil quality as evidenced by increase of soil acidity, decrease of total organic C, accumulation of N, P, K, Ca and Cu, deficiency of Mg, S, Fe, Mn, and Zn and accompanying decline in banana yield. In order to improve the soil environment and sustain higher productivity under continuous-banana cropping system, application of balanced rate of fertilizers is of considerable importance.

Surendar K., D. Devi, I. Ravi, P. Jeyakumar, and K. Velayudham. 2013. Influence of water stress on antioxidative enzymes and yield of banana cultivars and hybrids. *Pakistan Journal of Biological Sciences*, 16:1997-2002.

Reference ID: 20858

Notes: #20858e

Abstract: The main aim for this field experimental study is to screening of various banana cultivars and hybrids for water deficit tolerance through antioxidative enzymes and yield. The field experiment was conducted at National Research Centre for Banana to screen the banana cultivars and hybrids for water deficit tolerance and to elucidate information on antioxidative enzymes mechanism correlated with yield of banana cultivars and hybrids. The methodology of this experimental were analyzed by split plot design and has two treatments considered as main plot (M) viz., control plot taken as M1 and water deficit plot taken as M2 and also the cultivars and hybrids were considered as sup plots (S). The stress was imposed according to the Available Soil Moisture (ASM) and this ASM was measured by using pressure plate membrane apparatus. The experimental data were significantly varied between the treatments and also cultivars and hybrids. The antioxidative enzymes of catalase, super oxide dismutase and ascorbate peroxidase were significantly enhanced during water deficit conditions. Among the twelve cultivars and hybrids, Karpuravalli, Karpuravalli x Pisang Jajee, Saba and Sannachenkathali was identified as tolerant to water stress with highly accelerated by water stress treatment in the range of 23 to 32% over Control in Catalase (CAT), Super Oxide Dismutase (SOD) and Ascorbate Peroxidase (APX) leads to reduced the cellular membrane damaged by reactive oxygen species and get higher yield; whereas, Matti, Pisang Jajee x Matti, Matti x Anaikomban and Anaikomban x Pisang Jajee were notified as sensitive cultivars and hybrids with lesser increase in antioxidative enzyme activity of 15% than control which is leads to get very low yield.

Barbosa F. E. L., C. F. de Lacerda, H. D. Feitosa, I. Soares, F. L. de Andrade, and A. V. Amorim. 2013. Growth, nutrition and yield of banana associated with cover crops and irrigation depths Crescimento, nutrição e produção da bananeira associados a plantas de cobertura e lâminas de irrigação. *Revista Brasileira De Engenharia Agricola e Ambiental*, 17:1271-1277.

Reference ID: 20859

Notes: #20859e

Abstract: The objective of this study was to evaluate the growth, nutrition and production of Prata Ana banana (*Musa* spp), intercropped with legumes and subjected to different irrigation depths. The experimental design was a randomized block split plot with five replications. The plots were formed by four irrigation depths: 50, 75, 100 and 125% of crop evapotranspiration (ET_c) and the control subplots (conventional management without cover crops) and three types of cover crops intercropped with banana: spontaneous vegetation (VE), tropical cudzu in succession to crotalaria (CK) and calopogonio in succession to jack beans (FC). In banana crop, the height, pseudostem circumference, foliar concentrations of macro and micronutrients, production and crop cycle duration were evaluated. The use of legumes in the pre-planting and as a cover crop exerted positive influences on growth, nitrogen nutrition and yield of banana, partially replacing the N applied as mineral fertilizer. The use of legumes intercropped with banana represents an adequate alternative to provide N for banana.

Chopin P. and J. M. Blazy. 2013. Assessment of regional variability in crop yields with spatial autocorrelation: Banana farms and policy implications in Martinique. *Agriculture, Ecosystems & Environment*, 181:12-21.

Reference ID: 20860

Notes: #20860e

Abstract: Agricultural research can support farmers and policy makers' decisions by identifying the causes of spatial variability in crop yield at a regional level. In this paper, we propose a method that combines spatial autocorrelation measures and a farm network survey. This method is intended to describe the causes of spatial variability in crop yields, along with key crop management practices for reaching the best yields and the physical and socio-economic constraints of adopting these practices. This causal and hierarchical analysis of cropping system performance has the advantage of (1) preventing bias in the correlation between variables from the yield gap analysis and (2) formulating spatially targeted policies that are aimed at relaxing adoption constraints at the territorial level. After introducing the method and its different steps, we present the results of the assessment of the spatial variability in banana yields in Martinique (Caribbean). Our study has clearly shown that the planting stage is one of the most important aspects of banana production: allowing a long fallow period, plowing for soil preparation and using seedlings that are produced by tissue culture were associated with the best yields. However, several constraints limit their adoption by farmers at the regional level. The limiting factors were steep slopes, small farm size and low cash flow. We observed no relationship between pesticide use and yields. These study results finally permit the elaboration of spatially targeted policy recommendations to improve crop yields in a sustainable manner. It mainly consists in promoting and facilitating the adoption of good plantation practices for smallholders.

Coelho E. F., R. C. de Oliveira, and A. J. M. Pamponet. 2013. Water requirements of Terra-type banana under coastal tableland conditions Necessidades hídricas de bananeira tipo Terra em condições de tabuleiros costeiros. *Pesquisa Agropecuária Brasileira*, 48:1260-1268.

Reference ID: 20861

Notes: #20861e

Abstract: The objective of this work was to evaluate the effects of different water depths on the morphophysiological and yield variables of three Terra-type banana cultivars. A randomized complete block design was used, in a factorial arrangement with 12 treatments and three replicates. Treatments consisted of water depths correspondent to 33, 66, 99, and 120% of crop evapotranspiration (ETc), besides the control without irrigation, and of the cultivars Terra Maranhao, Terrinha, and D'Angola. The morphophysiological variables evaluated were: plant height, pseudostem diameter, leaf area, stomatal conductance, and, during harvest, the number of fingers and hands, and hand weight per bunch. Crop coefficients of the Terra-type banana cultivars were obtained from the best combination of yield and water use efficiency. The consumptive water-use depths of 1,599 mm (1.20 ETc), 922 mm (0.84 ETc), and 940 mm (1.06 ETc) correspond to the maximum yields and water use efficiencies of the cultivars Terra Maranhao, Terrinha, and D'Angola, respectively.

Ndabamenye T., P. J. A. van Asten, G. Blomme, and B. Vanlauwe. 2013. Nutrient imbalance and yield limiting factors of low input East African highland banana (*Musa* spp. AAA-EA) cropping systems. *Field Crops Research*, 147:68-78.

Reference ID: 20862

Notes: #20862e

Abstract: Low yields of East African highland bananas (*Musa* spp. AAA-EA) are often attributed to poor and declining soil fertility, which outweighs other biophysical factors and management practices. We investigated the influence of planting density on nutrient mass fractions and nutrient imbalance indices in bananas under small-scale, low-input systems using the compositional nutrient diagnosis (CND) approach. Boundary line functions were developed to identify yield limiting factors and quantify their contribution to the yield gap. Soil, plant, yield and water data were collected in plant density experiments conducted in three contrasting agro-ecological sites of Rwanda (i.e. Kibungo low rainfall with medium soil fertility, Rubona high rainfall but low soil fertility and Ruhengeri high rainfall with high soil fertility). Effects of site x cultivar and site x density on bunch yield were significant ($p < 0.05$). Annual yields ($t\ ha^{-1}\ yr^{-1}$) ranged from 6.1 to 9.2 at Kibungo, 9.5 to 21.5 at Rubona and 7.0 to 25.0 at Ruhengeri. Similar trends were registered for the above ground dry matter yield. CND indices showed that K, Mg and P were the most deficient elements in areas with low inherent soil fertility (Kibungo and Rubona). The yield gap analysis also confirmed that K was the most limiting factor, contributing to a predicted yield gap of 55.3% at Kibungo while P and Mg collectively contributed to a 35% yield gap at Rubona. An increase in plant density resulted in an increase in average yield gap from 45.6 to 70.2% at Kibungo, whilst the average yield gap decreased significantly with increases in plant density from 47.5 to 30.2% at Rubona and 76.6 to 53.7% at Ruhengeri. The study confirmed that soil fertility is a more limiting factor than water, but both CND norms and boundary line analysis showed that predicted yield gaps seem to be higher for plant density than soil fertility. Therefore, plant density management is an entry point to optimize yield of East African highland bananas.

Bellamy A. S. 2013. Banana Production Systems: Identification of Alternative Systems for More Sustainable Production. *Ambio*, 42:334-343.

Reference ID: 20863

Notes: #20863e

Abstract: Large-scale, monoculture production systems dependent on synthetic fertilizers and pesticides, increase yields, but are costly and have deleterious impacts on human health and the environment. This research investigates variations in banana production practices in Costa Rica, to identify alternative systems that combine high productivity and profitability, with reduced reliance on agrochemicals. Farm workers were observed during daily production activities; 39 banana producers and 8 extension workers/researchers were interviewed; and a review of field experiments conducted by the National Banana Corporation between 1997 and 2002 was made. Correspondence analysis showed that there is no structured variation in large-scale banana producers' practices, but two other banana production systems were identified: a small-scale organic system and a small-scale conventional coffee-banana intercropped system. Field-scale research may reveal ways that these practices can be scaled up to achieve a productive and profitable system producing high-quality export bananas with fewer or no pesticides.

da Silva M. J. R., I. S. Gomes, E. A. de Souza, E. S. Rios, A. R. E. de Souza, and V. G. Ribeiro. 2013. Growth and yield of banana 'Thap Maeo' (AAB) during two production cycles in São Francisco Valley, Brazil: Crescimento e produção da bananeira 'Thap Maeo' (AAB) durante dois ciclos de produção no Vale do São Francisco. *Revista Ceres*, 60:528-534.

Reference ID: 20864

Notes: #20864e

Abstract: The evaluation of banana genotypes performance during successive cycles of production in different ecosystems is not only essential for a breeding program, but also to indicate promising cultivars for local cropping system. The aim of this study was to evaluate the growth and yield of banana 'Thap Maeo' (AAB) cultivated in São Francisco Valley, during the first and second production cycle (from the harvest of the mother-plant to the harvest of the daughter-plant) and quality attributes of fruits. Seedlings of banana 'Thap Maeo' were produced by the method of plant tissue culture and transplanted to the field with six months old in the spacing of 3 m x 3 m. The characteristics evaluated were: crop cycles and, in each cycle (in days), plant height, pseudo stem perimeter, number of leaves per plant, number of days from planting to harvest, bunch weight, number of bunches and fruits per bunch; weight of the second bunch, number, length and diameter of the fruits of the second bunch; pulp/peel ratio, firmness, pH, soluble solids (SS), titratable acidity (TA) and SS/TA ratio. The banana 'Thap Maeo' showed, in the second cycle, greater growth, better performance of characters that express production and fruit quality in post-harvest.

da Silva I. P., J. T. A. da Silva, P. J. de Pinho, C. L. Rodas, and J. G. de Carvalho. 2013. Vegetative development and yield of the banana cv. 'Prata Anã' as a function of magnesium and potassium fertilization: Desarrollo y producción del banano 'Prata Anã' bajo fertilización con magnesio y potasio. *Idesia(Arica)*, 31:83-88.

Reference ID: 20865

Notes: #20865e

Abstract: To apply high amounts of K to the soil there must be adequate quantities of Mg, thus avoiding the rise of physiological disorders in the banana plant which

appear as Mg-induced deficiency symptoms. The purpose of this study was to evaluate the effects of application of K and Mg on the vegetative development and yield of the banana cv. "Prata Anã". Treatments were distributed in a randomized block design in a 3 x 5 factorial arrangement, corresponding to three doses of potassium (0, 800 and 1200 kg ha⁻¹ year⁻¹) and five doses of magnesium (0, 60, 120, 240 and 480 kg ha⁻¹ year⁻¹), with three replicates. The sources of potassium and magnesium were potassium chloride and magnesium sulfate, respectively. Application of K, regardless of the cycle, increased the bunch weight, the number of banana fruits per bunch, the number of hands per bunch, and the weight and diameter of the middle fruit of the banana plant. Increasing doses of Mg applied to the soil reduced the weight of the bunch in the first cycle; and with increasing doses of K there was an increase in the leaf content of K and Ca, with a decrease in the leaf content of Mg and B in the banana cv. 'Prata Anã'.

IPNI 2013. 4R de la Nutricion de Plantas, IPNI, Norcross, GA, USA.

Reference ID: 20867

Notes: S 2.8 #20867

Tolescu C., I. Fierascu, C. Neamtu, I. Anton, and R. C. Fierascu. 2014. Microencapsulated Fertilizers for Improvement of Plant Nutrition. Journal of the Serbian Chemical Society, 79:659-668.

Reference ID: 20868

Notes: H 22.2 #20868

Abstract: Given the need to reduce the impact of the use of chemical fertilizers on the quality of food crop production, it is necessary to develop fertilizer formulations enabling the gradual and controlled release of the active substance, which could be achieved by encapsulation, thereby allowing its almost complete metabolization by plants. The study reported herein was intended to test such fertilizer compositions with controlled release, achieved by encapsulation in polymeric structures, by monitoring the biological activity of the new products, using maize and sunflower crops as the target plants, i.e., crops having a major impact in the agricultural sector. To achieve this objective, solid microstructures were obtained, which allowed, on one hand, the incorporation of the fertilizing composition and, on the other, the controlled release of the active components over a period of time chosen so that advanced absorption in the plants could occur. Based on the presented findings, the tested fertilizers could ensure high quality fertilization in terms of a greater degree of nutrient recovery, lower doses without reducing plant productivity and reduced chemical pollution of soil.

Boyfield K. 2011. Dispelling the Myths: Palm Oil and the Environmental Lobby. Adam Smith Institute, 1-4.

Reference ID: 20869

Notes: H 15 #20869

Konam J., Y. Namallu, R. Daniel, and D. Guest 2008. Integrated Pest and Disease Management for Sustainable Cocoa Production, Australian Centre for International Agricultural Research (ACIAR), Canberra, Australia.

Reference ID: 20870

Notes: H 8.1.4.2 #20870

Bladyka, E. Coffee Staling Report. 1-15. 2013. Long Beach, CA, USA, SCAA.
Reference ID: 20872

Notes: H 8.1.5 #20872

Abstract: Maintaining the freshness of coffee is critical to preserving taste, especially as coffee is often sent home with customers. This fact led the SCAA to acknowledge a need for sensory testing within the coffee industry as with customers. This work was conducted as a joint effort between the SCAA and the Roasters Guild due to interest expressed by the membership. Together, the groups focused on answering some fundamental, taste-based questions. The industry has many assumptions about what happens to the taste of roasted coffee over time. A group of Roasters Guild-based project leaders set out to validate some of those assumptions and learn more about how production choices can influence the taste of coffee.

Wheeler T. and J. von Braun. 2013. Climate Change Impacts on Global Food Security. *Science*, 341:508-513.

Reference ID: 20875

Notes: H 15 #20875

Abstract: Climate change could potentially interrupt progress toward a world without hunger. A robust and coherent global pattern is discernible of the impacts of climate change on crop productivity that could have consequences for food availability. The stability of whole food systems may be at risk under climate change because of short-term variability in supply. However, the potential impact is less clear at regional scales, but it is likely that climate variability and change will exacerbate food insecurity in areas currently vulnerable to hunger and undernutrition. Likewise, it can be anticipated that food access and utilization will be affected indirectly via collateral effects on household and individual incomes, and food utilization could be impaired by loss of access to drinking water and damage to health. The evidence supports the need for considerable investment in adaptation and mitigation actions toward a "climate-smart food system" that is more resilient to climate change influences on food security.

Sim C. C., C. B. Teo, and S. H. Tey. 2008. Replanting for Sustainable High Yield. *The Planter*, 84:739-751.

Reference ID: 20876

Notes: H 8.1.1.6 #20876

Abstract: The average crude palm oil (CPO) yield in Malaysia has been stagnating at around 4 tonnes per hectare per year. Production and hence profit of most plantation companies had been increased and temporarily sustained largely by expanding the areas of planting. However, due to shortage of suitable agriculture land, we will have no other option but to increase and sustain the productivity of the existing cultivated land. Other than implementing good agro-management practices to achieve high yield of existing palms, one of the most promising ways by which the productivity of existing land can be significantly improved is to replant i.e. replacing existing old palms with higher yielding materials. This can be supported by the fact that 16 per cent of improvement in fresh fruit bunch (FFB) yield and 35 per cent of improvement in oil yield has been achieved over the past 10 to 15 years through breeding efforts. With the advancement of technologies and knowledge, we can also take the rare opportunity in replanting to optimise the planting density and planting pattern under different environment conditions in ways that have not been possible before to enhance the yield and productivity of the improved planting materials. With the introduction of useful spatial data and geo-spatial analysis tools, efficient road

system should be planned to reduce the long-term maintenance cost in hilly areas while effective drainage scheme can be designed to enhance the yield productivity of low-lying areas. In addition to these, large amount of nutrients, equivalent to about 1500 kg per hectare of ammonium sulphate, 220 kg per hectare of rock phosphate, 1330 kg per hectare of muriate of potash and 360 kg per hectare of kieserite that are 'stored' in the palm biomass can also be reutilised by young palms. At the same time, 'free' nitrogen from the air, equivalent to 1190 kg per hectare of ammonium sulphate can possibly be fixed and incorporated into the soil by hbvjljhboleguminous cover plants during the immature period.

Donough C. R. 2002. Best Management Practices for Oil Palm Nurseries: A review of current knowledge & areas for further improvements. Pages 1-15.

Reference ID: 20877

Notes: H 8.1.1.6 #20877

Kissinger G., A. Brasser, and L. Gross 2013. Reducing Risk: Landscape Approaches to Sustainable Sourcing, Landscapes for People, Food and Nature, Washington, DC.

Reference ID: 20878

Notes: H 15 #20878

Abstract: Climate change, ecosystem degradation, and and increasing competition over limited resources pose significant risks to agrifood businesses. In this report, LPFN looks at what agribusinesses stand to gain from a landscape approach, and examines the benefits and trade-offs faced by early adopters.

The Economic Benefit of Palm Oil to Indonesia. 1-26. 2011. Arlington, VA, World Growth.

Reference ID: 20879

Notes: H 8.1.1.5 #20879

Albani, M. and Henderson, K. Creating Partnerships for Sustainability. 1-6. 2014. McKinsey&Company.

Reference ID: 20880

Notes: H 13.1 #20880

Abstract: Business is being asked to do more than ever to solve social and environmental problems.¹ As a result, a growing number of leading companies are taking the challenge of sustainability seriously, not only to reduce their environmental footprint and bolster their reputations but also to improve operations and financial performance.²

Many ecosystem challenges cross jurisdictional boundaries and require systemic changes beyond the capabilities of individual companies or even of an industry. In these cases, the best approach for business can be to partner up-with governments, investors, local communities, nongovernmental organizations (NGOs), and other companies. Think of these partnerships as distinctive and complicated joint ventures, often with multiple parties.

Such collaborations often go through phases-good, bad, and sometimes ugly, particularly in the early days. The Marine Stewardship Council (MSC), a partnership that sets standards for the fishing industry, struggled in its first few years with high staff turnover and unstable funding. In the past decade, however, it has become a force. Its certification standards cover 10 percent of the global seafood harvest, and

almost a quarter of global shoppers recognize the MSC label. This covers more than 20,000 products sold in over 100 countries.

To understand how to make these collaborations work, we interviewed dozens of business, government, and NGO leaders. From this research, we identified seven essential principles of success.

Wessel M. 1985. Shade and Nutrition. Pages 166-193 *in* GAR Wood and RA Lass, editors. Cocoa. Longman Scientific and Technical, Harlow.

Reference ID: 20881

Notes: S 8.1.4 #6381 > H 8.1.4.1 #20881

Abstract: Research and experience have shown that the effects of light and nutrition are interrelated. This means in practical terms that the shade requirements for cocoa and the response to fertilisers cannot be considered separately. Therefore the two factors, shade and nutrition, are grouped together in this chapter.

de Miranda E. R. and A. C. da Costa Pinto Dias. 1971. Efeito da saturacao de aluminio no crescimento de plantas de cacau. *Revista Theobroma*, 1:33-42.

Reference ID: 20882

Notes: H 8.1.4.1 #20882

de Santana C. J. L., C. P. Pereira, and F. P. C. Rosand. 1975. Amostragem de solos em cacauais do sul da bahia. *Revista Theobroma*, 5:3-11.

Reference ID: 20883

Notes: H 8.1.4.1 #20883

Tilman, D., Fargione, J., Wolff, B., D'Antonio, C., Dobson, A., Howarth, R., Schindler, D., Schlesinger, W. H., Simberloff, D., and Swackhamer, D. Forecasting Agriculturally Driven Global Environmental Change. *Science* 292, 281-292. 2001. Washington DC, AAAS.

Reference ID: 20884

Notes: H 15 #20884

Abstract: During the next 50 years, which is likely to be the final period of rapid agricultural expansion, demand for food by a wealthier and 50% larger global population will be a major driver of global environmental change. Should past dependences of the global environmental impacts of agriculture on human population and consumption continue, 109 hectares of natural ecosystems would be converted to agriculture by 2050. This would be accompanied by 2.4- to 2.7-fold increases in nitrogen- and phosphorus-driven eutrophication of terrestrial, freshwater, and near-shore marine ecosystems, and comparable increases in pesticide use. This eutrophication and habitat destruction would cause unprecedented ecosystem simplification, loss of ecosystem services, and species extinctions. Significant scientific advances and regulatory, technological, and policy changes are needed to control the environmental impacts of agricultural expansion.

Goh K. J., P. S. Chew, and K. C. Teoh. 2004. Vegetative Growth, Resource Optimisation and N productivity of Oil Palm (*Elaeis guineensis* Jacq.) as Influenced by Soil and Fertilization. *Crop Science*, 1-6.

Reference ID: 20885

Notes: H 8.1.1.8 #20885

Abstract: Oil palm is mainly grown on infertile soils in Southeast Asia with large amount of fertilizer input to sustain growth and production. The objectives of this paper are to examine the effects of soil and fertilization on the growth and biomass allocation of oil palm in relation to its N productivity, and to determine the critical plant N concentration for optimal growth of oil palm. Results from five long-term oil palm fertilizer response trials on Oxisols and Inceptisols indicated that vegetative growth and biomass allocation were consistent with the concepts of N productivity and resource optimisation, respectively. Plant N productivity at 0.08 kg dry weight/g N/year was higher on the more fertile Inceptisols due to better N uptake and larger storage of excess N in the stem. Their critical plant N concentration was also higher at 8.3 g N/kg dry weight compared with 7.1 g N/kg dry weight in Oxisols. Oil palm under N limiting conditions tended to allocate less biomass to the stem resulting in higher relative growth rate. Higher leaf N concentration reduced root:shoot ratio in Oxisols but had no effect in Inceptisols. The roots seemed insensitive to external soil N availability and maintained their internal N concentrations fairly well. These results could be included in future models of growth and N nutrition of oil palm to better predict its N requirement and N-use efficiency for sustainable production.

Anonymous. Palm Oil Industry: Indonesia Industry Research. 1-24. 2010. Emerging Markets Direct.

Reference ID: 20886

Notes: H 8.1.1.5 #20886

Ataga, C. D. and van der Vossen, H. A. M. *Elaeis guineensis* Jacq. 1-15. 1763. PROTA.

Reference ID: 20887

Notes: H 8.1.1 #20887

Snoeck, J. and Jadin, P. Cacao (*theobroma cacao* L.). 1-4. 2015.

Reference ID: 20888

Notes: H 8.1.4.1 #20888

Morais F. I. O. and F. P. C. Rosand. 1971. Efeitos dos equilíbrios entre cálcio, magnésio e potássio no crescimento do cacau. *Revista Theobroma*, 1:21-32.

Reference ID: 20889

Notes: H 8.1.4.1 #20889

Morais F. I., E. P. Prado, F. P. R. Cabala, and M. B. M. Santana. 1975. Efeito da mistura de carbonatos de cálcio e magnésio no desenvolvimento de plântulas de cacau. *Revista Theobroma*, 5:21-30.

Reference ID: 20890

Notes: H 8.1.4.1 #20890

Anonymous. From Reformasi to Institutional Transformation: A Strategic Assessment of Indonesia's Prospects for Growth, Equity and Democratic Governance. 1-111. 2010. Rajawati Foundation Institute for Asia.

Reference ID: 20891

Notes: H 26.1.3 #20891

Anonymous. Palm Oil Industry: Malaysia Industry Research. 1-26. 2015. Emerging Market Direct.

Reference ID: 20892

Notes: H 8.1.1.5 #20892

Heffer, P. and Prud'homme, M. Short Term Fertilizer Outlook 2011-2012. 1-7. 2011. IFA.

Reference ID: 20893

Notes: H 20 #20893

37th IFA Enlarged Council Meeting Mayakoba, Riviera Maya (Mexico) 29 Nov - 1 Dec 2011

Khalajabadi S. S. 2008. Fertilidad del suelo y nutricion del cafe en colombia Soil Fertility and Coffee Nutrition in Colombia, Cenicafe, Colombia.

Reference ID: 20895

Notes: S 8.1.5.1/H 8.1.5.1 #20895e

English translated copy available in hanging

Leng T., M. Shukri, K. P. Ong, and A. Zainuriah. 2010. Alternative Oil Palm Fertilizer Sources and Management. Oil Palm Bulletin, 61:11-32.

Reference ID: 20896

Notes: H 8.1.1.8 #20896

Abstract: The euphoric sentiment of the oil palm industry in 2007 till first half of 2008, generated by the historic high prices of crude palm oil (CPO) as influenced by the price escalation of fossil fuel and biofuel, has very quickly vaporized and been replaced by an awakening call for prudence. Inorganic fertilizer prices soared concurrently to historic high levels as well. Notwithstanding the problem of uncertainty that led to non-timely supply and delivery, the cost of fertilizer inputs in oil palm plantations has doubled to 50%-60% of the cost of fresh fruit bunch (FFB) production. Profitability of the oil palm plantation business is consequently squeezed as the business remains as a price taker for its produce and the purchase of inorganic fertilizers. The Malaysian oil palm industry's dependence on inorganic fertilizer imports can only be partially mitigated by the use of organic fertilizers produced within the country. Recycling of solid and liquid wastes from palm oil mills is the logical alternative, and accepted as a standard good agricultural practice in the industry. There are, however, some obvious limitations in their utilization which must not be overlooked, particularly when the industry is moving toward sustainable development. The industry in Malaysia is poised to adopt a wholesome green technology approach with several options that can achieve multiple objectives. Cocomposting of empty fruit bunches (EFB) and palm oil mill effluent (POME) has the highest attractiveness while at the same time the compost/organic fertilizer produced can be applied over a much bigger area, especially in those areas of poorer growing conditions, that can benefit significantly in growth/yield as compared to what may be expected from the current EFB mulching and irrigation with treated POME. Concurrently, biogas capture with and without generation of renewable energy enhances CO₂ emission reduction above the criterion of 35% as set by the EU Commission on Renewable Energy. Thus, palm oil will qualify as a feedstock for biofuel in the European market. The continuation of the clean development mechanism (CDM) beyond 2012 with the carbon credit incentive is critical for more ready adoption by the industry members. Composting systems and usage of compost for substitution of inorganic fertilizer, and the impact of compost on yield

enhancement are described in the article. The 4 Rs approach to fertilizer management is also discussed in relation to compost usage. The oil palm industry is strongly urged to adopt the good agricultural practice of establishing leguminous cover crops for N fixation without fail in all new plantings/replantings. The choice of *Mucuna bracteata* over other conventional leguminous cover crops is strongly emphasized for reasons discussed. The potential usage of biochar, derivable from the oil palm biomass, is also highlighted as an area of research that can lead to its future exploitation for soil fertility improvement and long-term sequestration of CO₂ in the soil.

Khor Y. L. 2012. FELDA Settlers & the FELDA Global IPO - a socio-political perspective. *Malaysia Analysis*, 1-10.

Reference ID: 20897

Notes: H 19.5 #20897

MPOB. 2008. 2008 National Seminar on Biofertilizer, Biogas & Effluent Treatment in the oil palm industry: Waste to Wealth 14-15 August 2008 Palace Beach&Spa, Mines Resort City, Seri Kembangan, Selangor. Pages 1-33 *Malaysian Palm Oil Board*.

Reference ID: 20898

Notes: H 8.1.1 #20898

Lim C. H., G. Singh, K. H. Lim, and L. Teo. 2009. Production of Organic Fertilizer and Soil Conditioners. Pages 317-336 *in* G Singh, KH Lim, L Teo, and KW Chan, editors. *Sustainable Production of Palm Oil-A Malaysian Perspective*. Malaysian Palm Oil Association, KL, Malaysia.

Reference ID: 20899

Notes: H 8.1.1.8 #20899 > S 8.1.1 #20106

Singh G., D. L. Kow, K. H. Lee, K. C. Lim, and S. G. Loong. 2009. Empty Fruit Bunches as Mulch. Pages 301-313 *in* G Singh, KH Lim, L Teo, and KW Chan, editors. *Sustainable Production of Palm Oil*. Malaysian Palm Oil Association, KL, Malaysia.

Reference ID: 20900

Notes: H 8.1.1.8 #20900 > S 8.1.1 # 20106

Sattari S. Z., A. F. Bouwman, K. E. Giller, and M. K. van Ittersum. 2012. Residual Soil Phosphorus As The Missing Piece In The Global Phosphorus Crisis Puzzle. *PNAS*, 109:6348-6353.

Reference ID: 20901

Notes: H 3.1 #20901

Abstract: Phosphorus (P) is a finite and dwindling resource. Debate focuses on current production and use of phosphate rock rather than on the amounts of P required in the future to feed the world. We applied a two-pool soil P model to reproduce historical continental crop P uptake as a function of P inputs from fertilizer and manure and to estimate P requirements for crop production in 2050. The key feature is the consideration of the role of residual soil P in crop production. Model simulations closely fit historical P uptake for all continents. Cumulative inputs of P fertilizer and manure for the period 1965-2007 in Europe (1,115 kg·ha⁻¹ of cropland) grossly exceeded the cumulative P uptake by crops (360 kg·ha⁻¹). Since the 1980s in much of Europe, P application rates have been reduced, and uptake continues to

increase due to the supply of plant-available P from residual soil P pool. We estimate that between 2008 and 2050 a global cumulative P application of 700-790 kg-ha⁻¹ of cropland (in total 1,070-1,200 teragrams P) is required to achieve crop production according to the various Millennium Ecosystem Assessment scenarios [Alcamo J, Van Vuuren D, Cramer W (2006) *Ecosystems and Human Well-Being: Scenarios*, Vol 2, pp 279-354]. We estimate that average global P fertilizer use must change from the current 17.8 to 16.8-20.8 teragrams per year in 2050, which is up to 50% less than other estimates in the literature that ignore the role of residual soil P.

Shean, M. Indonesia: Rising Global Demand Fuels Palm Oil Expansion. 1-7. 2010. United States Department of Agriculture.

Reference ID: 20902

Notes: H 8.1.1.5 #20902

IFA. Preliminary Annual Potash Statistics 2011. 1-7. 2011. Paris France, IFA.

Reference ID: 20903

Notes: H 20.3.2 #20903

Koning N. B. J., M. K. van Ittersum, G. A. Becx, M. A. J. S. van Boekel, W. A. Brandenburg, J. A. van den Broek, J. Goudriaan, G. van Hofwegen, R. A. Jongeneel, J. B. Schiere, and M. Smies. 2008. Long-Term Global Availability of Food: Continued Abundance or New Scarcity. *Netherlands Journal of Agricultural Science*, 55:229-292.

Reference ID: 20904

Notes: H 19.3 #20904

Abstract: During the 20th century hunger has become a problem of poverty amidst plenty rather than absolute food scarcity. The question is whether this will remain so or whether the hunger of the poor will once more be exacerbated by the rising food prices. In this paper we discuss biophysical conditions, social forces and non-linear interactions that may critically influence the global availability of food in the long term. Until 2050, the global demand for primary phytomass for food will more than double, while competing claims to natural resources for other purposes (including biobased non-foods) will increase. A sober assessment of the earth's biophysical potential for biomass production, which recognizes competing claims and unavoidable losses, suggests that this is in itself still large enough for accommodating this rising demand. However, the exploitation of this biophysical potential proceeds through technical paradigms that set a relative maximum to food production. In addition, socio-economic mechanisms make the food economy run up against a ceiling even before this maximum is reached. As a consequence, current developments may well entail a new trend change in international markets. These developments include the depletion of land and water reserves, the stagnation of the potential yields of major crops, the rise in energy prices, and the way in which systemic socio-economic factors lead to a strong underutilization of production possibilities in the developing world. Given these conditions, the avoidance of steep rises in food prices may depend on the timely relaxation of socio-economic constraints in developing countries and on timely breakthroughs in sustainable yield increases, biorefinement and non-farm production systems. Myopic expectations make it doubtful whether spontaneous market forces will provide the necessary incentives for this, which may be reason for societal actors to consider the need for more active policies.

Koning N. and M. K. van Ittersum. 2009. Will the world have enough to eat? Current Opinion in Environmental Sustainability, 1:77-82.

Reference ID: 20905

Notes: H 19.3 #20905

Abstract: The food price spike in the first half of 2008 has increased concerns about the global supply of food in the future. Technically it seems possible to feed the nine billion people who are expected two or three times over by mid-century. However, diminishing returns, rising input prices and handicaps of less-favored areas will make the world food economy run up against a ceiling long before the technical potential has been realized. On the basis of an analysis of the literature we argue that if the long-term price decline of food in the 20th century were to change, short time horizons of private and public actors pose special risk because these may prevent timely investment in increasing the world's capacity for food production. Governments have a number of options to mitigate this risk by influencing the supply and demand for farm products, investing in research and infrastructure, and reducing the price instability in agricultural markets.

Mathews J. and L. C. Foong. 2010. Yield and Harvesting Potentials. The Planter, 86:699-709.

Reference ID: 20906

Notes: H 8.1.1.6 #20906

Abstract: Palm oil yield is the product of the amount of fresh fruit bunches produced in the estate and its oil extracted in the oil mill. Yield of fresh fruit bunches are determined by the oil palm site yield potential and the field agronomic management practices are targeted towards achieving such potential yields. An increase in the oil extraction rates in the oil mill can be achieved by planting or replanting new high oil yielding planting material and by improving the harvesting ripeness standards.

Doheny, M., Nagali, V., and Weig, F. Agile operations for volatile times. 1-7. 2012. McKinsey&Company.

Reference ID: 20907

Notes: H 19 #20907

Abstract: The specter of a catastrophic failure in one or more links of a company's global supply chain haunts senior executives in many industries: for example, the overnight flood or fire that disrupts a key supplier and quickly grinds production to a halt half a world away. Well founded as such worries are, given the increasingly globalized and interconnected operations of large organizations, they are hardly the only risks facing supply chains. No less significant are subtler, and more persistent, sources of disruption, such as fluctuating demand, labor rates, or commodity prices that together chip away at profits, increase costs, and force organizations to miss market opportunities.

All of these issues have become more acute in recent years as rising volatility, uncertainty, and business complexity have made reacting to—and planning for—changing market conditions more difficult than ever. The addition of some three billion consumers to the global middle class over the coming two decades, and the strains they will place on global resource supplies, all but guarantee that such pressures will continue.

Against this backdrop, some companies in industries as varied as automotive, building products, chemicals, high tech, and pharmaceuticals are refocusing global

operations to make them more agile. Notably, these companies aren't just spotting and mitigating supply chain risks. They are also seeking ways to use volatility to gain advantages over rivals.

In this article, we'll examine three companies that are seeking advantages from greater operational agility. While each is benefiting in different ways, all are developing similar skills that should position their organizations well for years to come.

Ng, M. C. C. Contributing Factors to Improvements In Oil Extraction Ratios-A Review Unilever Plantations Group Research Meeting 16-17th Sept 1991 Kluang, Johore, Malaysia. 1-14. 1991.

Reference ID: 20908

Notes: H 8.1.1.9 #20908

Kushairi A. and E. A. Ghani. 2007. Proceedings of the Roundtable Discussion on 'Oil Palm: Narrowing the Yield Gap towards Vision 35:25' 26-27 November 2007 Sheraton Hotel, Labuan, Malaysia. Pages 1-99 Malaysian Palm Oil Board, Malaysia.

Reference ID: 20909

Notes: H 8.1.1 #20909

McCarthy J. F., P. Gillespie, and Z. Zen. 2011. Swimming Upstream: Local Indonesian Production Networks in 'Globalized' Palm Oil Production. World Development, 40:555-569.

Reference ID: 20910

Notes: H 8.1.1.5 #20910

Abstract: When agricultural commodities in developing countries experience an economic boom, they offer potential pathways out of poverty while creating environmental and social problems. While recent research provides insights into the governance of international supply chains, it provides less analysis of the local production networks creating critical problems. Indonesia is now the world's largest exporter of crude palm oil. This paper analyses processes of oil palm development in three oil palm districts. It considers how policy models, regime interests, and agribusiness strategies shape local production networks, generate local outcomes, and affect the possibilities of tackling issues associated with this boom.

Gan L. T., C. Y. Ho, J. S. Chiew, and K. S. Lam. 1993. Effects of Harvesting Practices on Oil Extraction Ratios. Pages 68-75 Palm Oil Research Institute of Malaysia.

Reference ID: 20911

Notes: H 8.1.1.10 #20911

Mosquera M., C. A. Fontanilla, R. Martinez, A. C. Sanchez, and W. Alarcon. 2009. Identifying oil palms with ripe bunches before harvesting, IRBBH: a strategy for increasing labor productivity. Pages 1-14 MPOB, Malaysia.

Reference ID: 20912

Notes: H 8.1.1 #20912

PIPOC 2009 November 9-12 Kuala Lumpur

Abstract: In Colombia the increase of oil palm planted area has not been supported with an oil palm worker training policy. It has caused an increase in the demand for experienced workers and has pushed wages up in a way that threatens Colombian

oil palm competitiveness. This increase on wages does not result in an increase on labor productivity. Colombian Centro de Investigaciones en Palma de Aceite (Cenipalma) has explored alternatives for increasing oil palm worker labor productivity focusing on the harvest, which is the activity that concentrates most of the oil palm agro industry workers. The harvest method Identifying Oil Palms with Ripe Bunches before Harvesting (IRBBH) has been one of them. It implies that the day before harvesting a worker walks or rides an area following the paths that are to be followed by the harvesters, identifying with colorful laces the oil palms that must be harvested in accordance with the plantations criteria. This work compared IRBBH with traditional harvesting methods finding that IRBBH increases labor productivity, simplifies harvest planning, diminishes the fixed cost and the total cost of the harvest, increases the area harvested and the oil extraction rate by decreasing the unripe, overripe and rotten bunches harvested.

Tahir A. M. 2002. Keynote Paper - Elevating the National Oil Palm Productivity: Government's Perspective. Page 3 MPOB, Kuala Lumpur.

Reference ID: 20913

Notes: S 8.1.1.6 #19110 > H 8.1.1.5 #20913 (abstract only)

Sukaimi J., Y. Basiron, A. Darus, K. W. Chan, and N. Rajanaidu. 2002. Elevating the National Oil Palm Productivity: General Perspective. Pages 20-36 MPOB, Kuala Lumpur.

Reference ID: 20914

Notes: S 8.1.1.6 #19110 > H 8.1.1.6 #20914

Sok A. C. and K. J. Goh. 2002. Elevating the National Oil Palm Productivity - Breeding and Agronomic R&D Aspects. Pages 53-75 MPOB, Kuala Lumpur.

Reference ID: 20915

Notes: S 8.1.1.6 #19110 > H 8.1.1.6 #20915

Jelani A. R., A. R. Shuib, R. Kamisan, M. N. A. Wahab, S. Saar, S. Ismail, O. Ariffin, A. Ismail, A. T. Mohammed, and A. K. Din. 2010. Cantas - Greared for Mechanised Harvesting. Page 91 MPOB, Kuala Lumpur.

Reference ID: 20916

Notes: S 8.1.1.5 #18968 > H 8.1.1.5 #20916 (Abstract only)

Khalid M. R. M., M. S. Deraman, and A. R. Shuib. 2010. Small Machinery in Oil Palm Plantation. Page 116 MPOB, Kuala Lumpur.

Reference ID: 20917

Notes: S 8.1.1.5 #18968 > H 8.1.1.5 #20917 (Abstract only)

Walat O. and M. Pudin. 2010. Mechanised In-field FFB Evacuation System in Oil Palm Plantation, SKB's Experiences. Pages 128-142 MPOB, Kuala Lumpur.

Reference ID: 20918

Notes: S 8.1.1.5 #18968 > H 8.1.1.5 #20918

Selamat P., R. Veloo, and J. Haron. 2010. Mechanization of FFB Evacuation with Special Reference to Shallow Bin System - Tradewinds Experience. Page 143 MPOB, Kuala Lumpur.

Reference ID: 20919

Notes: S 8.1.1.5 #18968 > H 8.1.1.5 #20919 (Abstract only)

Menon N. R. 2000. Factors Affecting Oil and Kernel Extraction Rates. Pages 697-743 *in* Y Basiron, BS Jalani, and KW Chan, editors. Advances in Oil Palm Research Vol 1. MPOB, Kuala Lumpur.

Reference ID: 20920

Notes: S 8.1.1 #8627 > H 8.1.1.9 #20920

Sellan G. 2007. Arguments for Separate Oil Palm Loose Fruit Collection - With Special Reference to a High Yielding Estate in Sabah. *The Planter*, 83:181-191.

Reference ID: 20921

Notes: H 8.1.1.5 #20921

Phan, T. C. and Moody, P. W. Development of a Core Set of Soil Analyses for Diagnosing Potassium Status of Tropical Soils. 1-16. 2003.

Reference ID: 20922

Notes: H 1.4 #20922

Wilson R. H., A. A. Charry, and D. R. Kemp. 2005. Performance Indicators and Benchmarking in Australian Agriculture: Synthesis and Perspectives. *Extension Farming Systems Journal*, 1:45-57.

Reference ID: 20923

Notes: H 11 #20923

Abstract: Performance indicators and benchmarking for Australian Agriculture are disperse methods in the hands of professional farm business consultants and farm business related researchers. Integration and common grounds to standardise the techniques have not been attempted so far. This paper provides an overview of the most common whole farm physical and financial performance indicators and benchmarking practices used in Eastern Australia. The review is organised using a whole-farm family centred approach rather than an enterprise oriented approach. Available information from leading farm business consultants and related researchers has been brought together and the most commonly used physical and financial performance indicators are highlighted. Complementary comments are inserted aiming for an in-depth review of this issue; and the setting of new development proposals to strengthen farm business education, research, consultancy and extension.

Jack L. and J. Boone. 2009. Sustainable Change and Benchmarking in the Food Supply Chain. Pages 1-8 *in* L Jack, editor. *Benchmarking in Food and Farming*. Gower.

Reference ID: 20924

Notes: H 11 #20924

Abstract: Those outside agriculture are usually very surprised to find that benchmarking is a longstanding and highly developed practice in the agricultural industry. Certainly, in reading about the development of benchmark setting and benchmarking for best practice, there is very rarely any mention of farming and food. Yet benchmarking practices can be traced back to the late nineteenth century and new, innovative practices are being developed today. A review of benchmarking in agriculture and a discussion of its future potential is overdue, particularly at a time when food producers have to make significant changes to their business practices in order to survive.

What is equally surprising is the evidence that relatively very little benchmarking

takes place downstream from producers in the food supply chain, among the processors, manufacturers, distributors and retailers of the food and drinks industry.

The discussions and case studies in this book should be of interest to anyone involved in benchmarking as a practice, as well as to those involved in the food and farming industry. These are stories of innovation and collaboration among producers and their advisors. What sets benchmarking in agriculture above the usual explorations of benchmarking for best practice in major corporations is that benchmarking here is among large numbers of small, often family owned, businesses working in a global industry. This is about accounting practice as sharing, trust and a sociable activity, driven by a thirst for information. It is also about sustaining farming and food in individual businesses and for everyone: as the slogan (attributed to American farmer and philosopher Wendell Berry) has it 'if you eat, you're in agriculture'.

Dros, J. M. Accomodating Growth: Two Scenarios for Oil Palm Production Growth. 1-9. 2003. AIDEnvironment.

Reference ID: 20925

Notes: H 8.1.1.5 #20925

Abstract: This quick scan elaborates two scenario's for increasing oil palm production to meet the growing world demand: Business as Usual and Better Policies and Practices. The scenario's have been applied to Indonesia and Malaysia.¹

The Business as Usual scenario extrapolates recent (1996-2003) growth trends in productive area, per hectare Crude Palm Oil (CPO) yields and CPO production up to 2020 and calculates the resulting forest loss. The Better Policies and Practices scenario assumes that through planning, law enforcement and implementation of better management practices, existing areas planted can be made more productive and expansion can be preferentially accommodated on existing idle lands. Future production of palm oil is based on the production levels as calculated under the Business as Usual scenario. For the Better Policies and Practices scenario future planted areas are determined by dividing the production by assumed improved yields resulting from implementation of these better policies and practices. Before comparing the scenario's, a brief outline of the global market for palm oil and description of production trends in the two major producer countries Indonesia and Malaysia is given.

Tan, J. Helping Brands Green Supply Chains. Green Purchasing Asia [4], 25-27. 2011. Kuala Lumpur, Briomedia Green Sdn Bhd.

Reference ID: 20926

Notes: H 8.1.1.5 #20926

Tan, J. Fronds of a dilemma. Green Purchasing Asia [4], 22-24. 2011. Kuala Lumpur, Briomedia Green Sdn Bhd.

Reference ID: 20927

Notes: H 8.1.1.5 #20927

Tan, J. The Tough Route to Green Palm Oil. Green Purchasing Asia [4], 20-22. 2011. Kuala Lumpur, Briomedia Green Sdn Bhd.

Reference ID: 20928

Notes: H 8.1.1.5 #20928

Tan, S. M. Tribes of the Roundtable. Green Purchasing Asia [4], 16-19. 2011. Kuala Lumpur, Briomedia Green Sdn Bhd.

Reference ID: 20929

Notes: H 8.1.1.5 #20929

Snyder, C, Bruulsema, T., Casarin, V., Chen, F., Jaramillo, R., Jensen, T., Mikkelsen, R., Norton, R., Satyanarayana, T., and Tu, S. Global Crop Intensification Lessens Greenhouse Gas Emissions. Better Crops With Plant Food 94[4], 14-15. 2010. Canada, IPNI.

Reference ID: 20930

Notes: H 15 # 20930

Burney J. A., S. J. Davis, and D. B. Lobell. 2010. Greenhouse Gas Mitigation by Agricultural Intensification. PNAS, 1-6.

Reference ID: 20931

Notes: H 15 #20931

Abstract: As efforts to mitigate climate change increase, there is a need to identify cost-effective ways to avoid emissions of greenhouse gases (GHGs). Agriculture is rightly recognized as a source of considerable emissions, with concomitant opportunities for mitigation. Although future agricultural productivity is critical, as it will shape emissions from conversion of native landscapes to food and biofuel crops, investment in agricultural research is rarely mentioned as a mitigation strategy. Here we estimate the net effect on GHG emissions of historical agricultural intensification between 1961 and 2005. We find that while emissions from factors such as fertilizer production and application have increased, the net effect of higher yields has avoided emissions of up to 161 gigatons of carbon (GtC) (590 GtCO₂e) since 1961. We estimate that each dollar invested in agricultural yields has resulted in 68 fewer kgC (249 kgCO₂e) emissions relative to 1961 technology (\$14.74/tC, or ~\$4/tCO₂e), avoiding 3.6 GtC (13.1 GtCO₂e) per year. Our analysis indicates that investment in yield improvements compares favorably with other commonly proposed mitigation strategies. Further yield improvements should therefore be prominent among efforts to reduce future GHG emissions.

Hooijer, A., Silvius, M., Wosten, H., and Page, S. Peat CO₂: Assessment of CO₂ Emissions from Drained Peatlands in SEAsia. 1-36. 2006. Delft Hydraulics.

Reference ID: 20932

Notes: H 15 #20932

OXFAM. Think Big. Go Small.: Adapting business models to incorporate smallholders into supply chains. 1-18. 2010. Oxford, UK, Oxfam International.

Reference ID: 20933

Notes: H 18 #20933

Abstract: Food and beverage companies are facing a rapidly changing world. Global demand is rising as the world's population grows. Yet the planet's ability to meet this demand is threatened by factors such as droughts and other expected consequences of climate change, together with land degradation and biofuel

production. At the same time consumers everywhere are growing more knowledgeable and concerned about the ethics of where and how their food and drink are produced.

This paper tries to show the advantages – both in productivity and consumer appeal – of domestic and global companies connecting with smallholder suppliers. The Fair Trade movement grew out of the recognition that most large-scale food supply chains were bypassing smallholders.

Daviron B. and I. Vagneron. 2010. From Commoditisation to De-commoditisation... and Back Again: Discussing the Role of Sustainability Standards for Agricultural Products. *Development Policy Review*, 29:91-113.

Reference ID: 20934

Notes: H 11.5 #20934

Abstract: Sustainability standards are flooding global agricultural markets. Standards, however, are not new. This article analyses, from a historical perspective, the implications of the transition from traditional to sustainability standards in the commoditisation/de-commoditisation process. It shows how early standards contributed to the construction of the category of primary commodities and how, after a short attempt at de-commoditisation (with the early fair-trade and organic standards), sustainability standards are tending towards re-commoditisation.

Morris K. S., V. E. Mendez, and M. B. Olson. 2013. 'Los Meses Flacos': Seasonal Food Insecurity in a Salvadoran Organic Coffee Cooperative. *Journal of Peasant Studies*, 40:457-480.

Reference ID: 20935

Notes: H 13.1 #20935

Abstract: Central American coffee farmers commonly refer to annual periods of food insecurity as 'los meses flacos' – the thin months – indicating a recurring season in which they are unable to meet household food needs. Although this is a common phenomenon, little empirical research has documented the seasonal food insecurity that many small-scale coffee farmers face. Household surveys and focus groups were conducted with 29 members of an organic coffee cooperative in western El Salvador to determine the causes of, and responses to, seasonal food insecurity. Ninety-seven percent of households faced food shortages during some period of the year. The two most common proximate causes of food shortages were lack of income-generating opportunities to buy food and running out of staple food crops. Families coped with seasonal food shortages by borrowing money and food, seeking work outside of the community, changing diet, and selling livestock. It is clear that small-scale coffee farmers seek to maintain a balance between coffee, which provides income, and food crops, which provide staple food. Livelihood and income diversification are important coping strategies that should be supported; however, we conclude that efforts to address food insecurity in coffee regions require deeper structural changes to support peasant farmers.

Spielman, D. J. and Birner, R. How Innovative is Your Agriculture? Using Innovation Indicators and Benchmarks to Strengthen National Agricultural Innovation Systems. 1-47. 2008. Washington DC, USA, Agricultural & Rural Development Dept, World Bank.

Reference ID: 20936

Notes: H 13.1 #20936

Abstract: This paper explores the application of the innovation systems framework to the design and construction of national agricultural innovation indicators. Optimally, these indicators could be used to gauge and benchmark national performance in developing more responsive, dynamic, and innovative agricultural sectors in developing countries. The paper develops a conceptual framework that ties the innovation systems framework to the agricultural sector; reviews how the framework has been used to develop innovation indicators in other fields; discusses a set of potential innovation indicators for developing-country agriculture; and identifies potential data sources and methods for constructing different types of indicators. Ultimately, the paper aims to inform national and regional stakeholders, policymakers, development partners and researchers who are interested in developing or using indicators as a tool for designing evidence-based agricultural innovation policies.

Zapata R. and J. Espinosa. 2010. Agronomic Education and Credit for Purchasing Fertilizer Bring Environmental and Social Benefits for Coffee Growers-An Update. *Better Crops With Plant Food*, 94:12-15.

Reference ID: 20937

Notes: H 8.1.5 #20937

Abstract: An article in this publication in 2007 reported on a successful, privately funded program in Peru which enables farm families to improve their standard of living and better manage land in coffee production. IPNI staff have assisted this program by providing agronomic education. Following is a recap of the story and an update on continued progress of the "Family Program".

Chien S. H., L. I. Prochnow, and R. Mikkelsen. 2010. Agronomic Use of Phosphate Rock for Direct Application. *Better Crops With Plant Food*, 94:21-23.

Reference ID: 20938

Notes: H 21.1 #20938

Abstract: In many acid soils in the world, especially in the tropics, soil fertility limitations constrain successful crop production. These soils usually are low in plant available P and often have a high P-fixing capacity that results in low efficiency of water-soluble P (WSP) fertilizers such as triple superphosphate (TSP) or diammonium phosphate (DAP) by crops. Application of unprocessed PR to soil can be an attractive alternative to WSP fertilizers in such cases.

Leal L., A. Salamanca, and S. Sadeghian. 2010. Urea Volatilization Losses from Coffee Plantations. *Better Crops With Plant Food*, 94:18-20.

Reference ID: 20939

Notes: H 8.1.5.1 #20939

Abstract: Responses to N are common in the coffee growing areas of the world. In Colombia, N recommendations vary from 120 to 300 kg N/ha/year, according to soil organic matter content, shade level, and plant density. Yield reductions of 30 to 50% are expected when N is not applied to the crop. Urea is the most common source of N used in coffee production in Colombia due to its high N content and relatively low price per unit. High N losses via volatilization from broadcast-applied urea are expected under the climate and soil conditions prevalent in the coffee production areas in Colombia. However, field research in the country to quantify the magnitude of these losses has been lacking.

Nake S. 2010. Potassium Fixation and Release in Alluvial Clay Soils of Milne Bay, Papua New Guinea: Effects of Management under Oil Palm. James Cook University, Australia.

Reference ID: 20940

Notes: H 8.1.1.8 #20940

Abstract: Potassium deficiency is pronounced in oil palm and other crops on alluvial clay soils of Milne Bay Province in Papua New Guinea. These clay soils contain clay minerals that can fix K. This, coupled with large amounts of exchangeable Mg and Ca, triggers the K deficiency problem in oil palm growing in this area. Oil palm yield and other growth parameters had responded positively to K fertiliser application for the last 12-13 years in long-term factorial fertiliser trials. However, a K use efficiency study showed that 40% of the added K was taken up by the oil palm while more than 50% had accumulated in the top 60 cm of the soil. There is currently limited information to explain why K accumulated in the soil and the implications for management. Fixation of K could be one of the factors contributing to K accumulation. Therefore, this study was carried out to determine fixation and release characteristics of K in alluvial clay soils under oil palm cultivation in relation to soil and management factors.

All the work was carried out using soil samples collected in 2007 from plots with different K fertiliser history in two long-term fertiliser trials, trial 502b and 504, which had been operating since 1995 and 1994, respectively. Soil mineralogy was predominantly smectite in trial 502b and vermiculite in trial 504. In Experiment 1 (Chapter 3), the effects of management (K fertiliser history and surface management) on the amounts and forms of K in the soil was examined by measuring exchangeable (ammonium acetate extractable) and non-exchangeable (sodium tetraphenyl borate extractable minus ammonium acetate extractable) K. The results showed that in both trial sites, the management zones receiving K fertilizer (frond pile [FP], frond tip [FT] and between other zones [BZ]) had significantly ($p < 0.001$) higher concentration of both exchangeable and non-exchangeable K than the other zones (weeded circle [WC] and harvest path [HP]). The exchangeable and non-exchangeable K concentrations differed significantly between sites, and there was a significant interaction between sites and K fertiliser history. In the plots and zones that had received fertiliser, exchangeable and non-exchangeable K contents were higher in trial 502b than 504, whereas in the plots that had received no fertiliser they were higher in trial 504 than 502b. In the plots that had received no K fertiliser, contents of exchangeable and non-exchangeable K were very low and could be considered deficient at both sites. The difference between the two sites was related to the mineralogy of the soils.

In Experiment 2 (Chapter 4), the effects of site and previous management on K fixation were determined. Solutions with nine different concentrations of KCl (equivalent to 0, 3.2, 9.6, 12.8, 16.0, 19.2, 22.4 and 25.6 mmol K kg⁻¹ soil) were added to the soil, centrifuged and decanted. Exchangeable K was then extracted from the soil with 1 M ammonium acetate. The decanted equilibrium solutions and ammonium acetate extracts were analysed for K using an atomic absorption spectrophotometer. Fixed K was determined using the formula: Fixed K = added K minus decanted equilibrium solution K minus ammonium acetate extractable K. Potassium fixation was significantly ($p < 0.001$) affected by the K fertiliser history and surface management. In soils and zones that had received no K fertiliser, an average of 27% of added K was fixed in both trials, whereas in the plots with a history of K

fertiliser, there was little net fixation or release in the WC zone and a considerable release of non-exchangeable K in the BZ and FP zones.

In Experiment 3 (Chapter 5), the release of K from non-exchangeable form into solution was studied. Firstly, the exchangeable K in the soil was removed by rinsing the soil three times with 0.25 M CaCl₂. Then the soil was equilibrated with 0.01 M CaCl₂ for 480 hours. At various intervals during that period, the supernatant was removed, analysed for K, and replaced with fresh 0.01 M CaCl₂. In the plots that had received no K fertiliser, more K was released from the native non-exchangeable pool in trial 504 than trial 502b. In the plots that had received K fertiliser, a substantial amount of K was released. In those plots more K was released in trial 502b than 504. In both trials, more K was released from the FP zones than the other zones, and K release in both trials increased in the order; HP<WC<BZ<FT<FP. The kinetics of K release from non-exchangeable K pool was described well by the Elovich function in all samples ($r^2 = 0.957-0.989$; $se = 0.002-0.179$). Over all samples, the parameters a and $1/\beta$ were linearly related to the amount of non-exchangeable initially present; i.e. the rate of release of non-exchangeable K was positively related to the amount present. The rate of release was greater for trial 502b than trial 504. This study showed that management has a large effect on the fixation and release of K in alluvial soils of PNG under oil palm cultivation. Soil behaviour differed considerably between management zones, suggesting that K fertiliser placement might have a considerable effect on uptake efficiency.

Mohan S. 2010. Fair Trade Without The Froth, The Institute of Economic Affairs, London, UK.

Reference ID: 20941

Notes: H 19 #20941

Chien S. H., L. I. Prochnow, S. Tu, and C. S. Snyder. 2010. Agronomic and Environmental Aspects of Phosphate Fertilizers Varying in Source and Solubility: An Update Review. *Nutr Cycl Agroecosyst*, 89:229-255.

Reference ID: 20942

Notes: H 23 #20942

Abstract: This review discusses and summarizes the latest reports regarding the agronomic utilization and potential environmental effects of different types of phosphate (P) fertilizers that vary in solubility. The agronomic effectiveness of P fertilizer can be influenced by the following factors: (1) water and citrate solubility; (2) chemical composition of solid water-soluble P (WSP) fertilizers; (3) fluid and solid forms of WSP fertilizers; and (4) chemical reactions of P fertilizers in soils. Non-conventional P fertilizers are compared with WSP fertilizers in terms of P use efficiency in crop production. Non-conventional P fertilizers include directly applied phosphate rock (PR), partially acidulated PR (PAPR), and compacted mixtures of PR and WSP. The potential impacts of the use of P fertilizers from both conventional (fully acidulated) and non-conventional sources are discussed in terms of (1) contamination of soils and plants with toxic heavy metals, such as cadmium (Cd), and (2) the contribution of P runoff to eutrophication. Best practices of integrated nutrient management should be implemented when applying P fertilizers to different cropping systems. The ideal management system will use appropriate sources, application rates, timing, and placement in consideration of soil properties. The goal of P fertilizer use should be to optimize crop production without causing environmental problems.

Lendle, A. and Schaus, M. Sustainability Criteria in the EU Renewable Energy Directive: Consistent with WTO Rules? 1-15. 2010. California, US, International Centre for Trade and Sustainable Development.

Reference ID: 20943

Notes: H 15.1 #20943

Abstract: The European Union has adopted a very ambitious plan to increase the share of renewables in their energy consumption to 20% by 2020, including a 10% goal for the use of renewables in transport alone. Renewable energy could come from a variety of sources, but for transport the main source is biofuel.¹The Renewable Energy Directive 2009/28/EC, which sets these goals, will therefore trigger a large increase in the consumption of biofuel in the EU.

The debate around biofuels is well known. Critics argue that biofuels could have negative social implications because they could lead to an increase in food prices. This is particularly relevant for today's first generation biofuels, which are based on biomass that could otherwise be used for food purposes, or on biomass produced on land otherwise suitable for food production. The environmental effects of biofuels are also controversial.

Although in principle CO₂-neutral, the use of biofuel never leads to a 100% reduction in greenhouse gas (GHG) emissions compared to the use of fossil fuels and could, in extreme cases, even lead to an increase in emissions. To address the possible negative environmental concerns, the Directive lays out sustainability criteria that biofuels have to fulfil. These relate to overall efficiency in terms of emission reductions, but also specify which type of land can be used to produce the feedstock. Some critics have argued that making a distinction between biofuels based on such criteria is incompatible with WTO disciplines. This paper examines the Directive's biofuel sustainability criteria and their WTO-consistency within the framework of specific WTO Articles, with a particular emphasis on the general exemption clause (Article XX of the GATT).

Pampolino M., C. Witt, J. M. Pasuquin, and P. J. Sinohin 2009. Nutrient Manager for Hybrid Maize, IPNI.

Reference ID: 20944

Notes: H 8.2.2.1 #20944

Beddoes, Z. M. For Richer, For Poorer. The Economist , 1-8. 2012.
Ref Type: Magazine Article

Reference ID: 20945

Notes: H 19 #20945

Abstract: Growing inequality is one of the biggest social, economic and political challenges of our time. But it is not inevitable.

Pandin, M. R. L. Portrait of Indonesian Fertilizer Industry. Economic Review 214, 1. 2008.

Reference ID: 20946

Notes: H 21 #20946

Anonymous. Indonesian Agriculture Ministry: Indonesia has Succeeded in Achieving Self-Sufficiency in Corn. Indonesian Agroindustries, 2-5. 2010.

Reference ID: 20947

Notes: H 8.2.2 #20947

Anonymous. Indonesia: Rice and Corn Update. 1-9. 2010. US, Global Agricultural Information Network, USDA Foreign Agricultural Service.

Reference ID: 20948

Notes: H 26.1.3 #20948

Abstract: Assuming that there will be no extreme weather event and significant pest outbreak, Post forecast that Indonesian rice and corn production to slightly increase to 39 million tons of milled rice equivalent and 8.4 million tons of corn. Due to sufficient supply from domestic production, GOI only allows imports of specific rice of around 250,000 tons per annum. In line with marginal increase in production, imports of corn in MY 2010/11 are forecast to decrease to 500,000 tons.

Blanco-Macias F., R. Magallanes-Quintanar, R. D. Valdez-Cepeda, R. Vazquez-Alvarado, E. Olivares-Saenz, E. Gutierrez-Ornelas, J. A. Vidales-Contreras, and B. Murillo-Amador. 2010. Nutritional Reference Values for Opuntia Ficus-Indica Determined by Means of the Boundary-Line Approach. Journal of Plant Nutrition and Soil Science, 173:927-934.

Reference ID: 20949

Notes: H 8.11 #20949

Abstract: Optimum concentrations and/or sufficiency ranges of nutrients are useful for a correct diagnosis and improvement of nutrient status of cultivated plants. To develop boundary-line approach (BLA) standards for Opuntia ficus-indica L., a database of N, P, K, Ca, and Mg concentrations in 1-year-old cladodes and cladodes fresh-matter yield was used. The BLA optimum concentrations (associated with estimated maximum yield) for O. ficus-indica were: N = 13.1 g/kg-1, P = 3.2 g/kg-1, K = 44.4 g/kg-1, Ca = 38.1 g/kg-1, and Mg = 17.3 g/kg-1. The BLA sufficiency ranges at 95% yield were 8.4-20.3 g/kg-1 for N, 2.4-4.2 g/kg-1 for P, 38.2-50.8 g/kg-1 K, 31.8-45.2 g/kg-1 for Ca, and 14.3-20.9 g/kg-1 for Mg. The BLA standards are comparable to those obtained in a previous study using compositional-nutrient-diagnosis (CND) approach.

Nelson P. N., S. Berthelsen, M. J. Webb, and M. Banabas. 2010. Acidification of Volcanic Ash Soils under Oil Palm in Papua New Guinea: effects of fertiliser type and placement. Pages 8-11.

Reference ID: 20950

Notes: H 8.1.1.8 #20950

Abstract: Soil acidification is a widespread degradation problem, but little information is available for oil palm production systems. The aim of this work was to determine the effect of fertiliser type and placement on acidification of volcanic ash soils under oil palm in Papua New Guinea. A field trial, which had various combinations of N (114-120 kg N/(ha.year)) and K (329 kg K/(ha.year)) fertilisers applied over 13 years, was examined. Over that period, pH_{water} of the 0-0.2m layer declined by 0.38 units in the control treatment and 0.52-0.96 units in the fertilised treatments. Application of fertiliser and plant residues are not uniform in oil palm plantations, so the effect of placement was measured in another trial, which had been operating for 6 years. In the 0-0.05 m layer, the decrease in pH_{water} due to fertiliser addition (ammonium chloride plus kieserite) was least (0.52 units) when fertiliser was applied in the

weeded circle and greatest (1.03 units) when it was applied in the frond pile. Soil pH buffer capacity was different between zones and fertilizer treatments, but the difference in acidification effect of fertiliser between zones was attributed primarily to differences in the water balance and N cycling rather than pH buffer capacity.

Berthelsen S., M. J. Webb, and P. N. Nelson. 2010. Limited Movement of Fertiliser-Derived Mg and K through Volcanic Ash and Alluvial Clay Soils in Papua New Guinea. Pages 140-143.

Reference ID: 20951

Notes: H 1.8 #20951

Abstract: Crop symptoms of K and Mg deficiency are common on the coastal plains of Papua New Guinea. It was hypothesised that fertiliser uptake efficiency in oil palm is limited in these environments due to leaching loss resulting from high rainfall and high soil exchangeable Ca contents. Two field experiments were carried out on volcanic ash soils to determine the effect of fertiliser type (MgSO₄, MgO or MgCO₃) on movement of Mg. In one trial the fertilisers were applied to 36-palm plots over a period of 3 years before soil sampling. In the other trial the fertilisers were applied evenly over 4 m² plots and the soil was sampled after 42 days and 1 year. A third field experiment, in which various rates of K fertiliser had been applied to an alluvial clay soil over a period of 13 years (36-palm plots), was sampled to determine the depth to which K had moved. Concentration profiles and mass balances showed that neither Mg nor K moved deeper than 0.6 m depth in any of the trials. In the K trial, approximately half of the fertiliser-derived K was fixed in non-exchangeable form. Results suggest that loss of K or Mg by leaching is not of concern in these environments.

The World Bank. 4 Degrees: Turn Down The Heat: Why a 4 degrees celcius warmer world must be avoided. 1-83. 2012. Washington DC, US, The World Bank.

Reference ID: 20952

Notes: S 15 #20952

Setiyono, T. D., Walters, D. T., Cassman, K. G., Witt, C., and Dobermann, A. Modelling Nutrient Requirements for Irrigated Maize: I. Internal Nutrient Efficiencies and Nutrient Uptakes. 2006. IPNI.

Reference ID: 20953

Notes: H 8.2.2.1 #20953

Dobermann, A., Ping, J., Adamchuk, V. I., Simbahan, G. C., and Ferguson, R. B. Classification of Yield Variability for Site-Specific Management. 2015.

Reference ID: 20954

Notes: H 16 #20954

Prud'homme, M. Fertilizers and Raw Materials Supply: Global Supply/Demand Balances 2011-2015. 79th IFA Annual Conference Montreal (Canada), 23-25 May 2011 , 1-62. 2011. Paris France, IFA.

Reference ID: 20955

Notes: H 20.1 #20955 power point version available with report copy

Heffer P. 2011. Medium-Term Outlook for World Agriculture and Fertilizer Demand 2010/11-2015/16. Pages 1-37.

Reference ID: 20956

Notes: H 20.1 #20956

Campanha M. M., R. H. S. Santos, G. B. de Freitas, H. E. P. Martinez, S. L. R. Garcia, and F. L. Finger. 2004. Growth and Yield of Coffee Plants in Agroforestry and Monoculture Systems in Minas Gerais, Brazil. *Agroforestry Systems*, 63:75-82.

Reference ID: 20957

Notes: H 8.1.5 #20957

Gutierrez, G. E. La Caficultura Organica en Colombia. 1-49. 2001. Federacion Nacional de Cafeteros.

Reference ID: 20958

Notes: H 8.1.5 #20958

Hockerts K. and R. Wustenhagen. 2010. Greening Goliaths versus Emerging Davids-Theorizing about the role of incumbents and new entrants in sustainable entrepreneurship. *Journal of Business Venturing*, 25:481-492.

Reference ID: 20959

Notes: H 13.5 # 20959

Abstract: This paper proposes a model of how incumbents and new entrants engage in sustainable entrepreneurship. We suggest that in the early stages of an industry's sustainability transformation, new entrants ('Emerging Davids') are more likely than incumbents to pursue sustainability-related opportunities. Incumbents react to the activities of new entrants by engaging in corporate sustainable entrepreneurship activities. While these 'Greening Goliaths' are often less ambitious in their environmental and social goals, they may have a broader reach due to their established market presence. This paper analyses the interplay between 'Greening Goliaths' and 'Emerging Davids' and theorizes about how it is their compounded impact that promotes the sustainable transformation of industries.

Giovannucci D. and S. Ponte. 2005. Standards as a new form of social contract? Sustainability initiatives in the coffee industry. *Food Policy*, 30:284-301.

Reference ID: 20960

Notes: H 8.1.5 #20960

Anonymous. Risk Management in Agriculture-A Holistic Conceptual Framework. 1-59. 2009. Trade and Agriculture Directorate:Committee for Agriculture.

Reference ID: 20961

Notes: H 13.2 #20961

Bitzer V., M. Francken, and P. Glasbergen. 2008. Intersectoral Partnerships for sustainable coffee chain: Really addressing sustainability or just picking (coffee) cherries? *Global Environmental Change*, 18:271-284.

Reference ID: 20962

Notes: H 8.1.5 #20962

Keating B. A., P. S. Carberry, P. S. Bindraban, S. Asseng, H. Meinke, and J. Dixon. 2010. Eco-efficient Agriculture: Concepts, Challenges, and Opportunities. *Crop Science*, 50:1-11.

Reference ID: 20963

Notes: H 13.3 #20963

Abstract: Eco-efficiency in the simplest of terms is about achieving more with less—more agricultural outputs, in terms of quantity and quality, for less input of land, water, nutrients, energy, labor, or capital. The concept of eco-efficiency encompasses both the ecological and economic dimensions of sustainable agriculture. Social and institutional dimensions of sustainability, while not explicitly captured in eco-efficiency measures, remain critical barriers and opportunities on the pathway toward more eco-efficient agriculture. This paper explores the multidimensionality of the eco-efficiency concept as it applies to agriculture across diverse spatial and temporal scales, from cellular metabolisms through to crops, farms, regions, and ecosystems. These dimensions of eco-efficiency are integrated through the presentation and exploration of a framework that explores an efficiency frontier between agricultural outputs and inputs, investment, or risk. The challenge for agriculture in the coming decades will be to increase productivity of agricultural lands in line with the increasing demands for food and fiber. Achieving such eco-efficiency, while addressing risk and variability, will be a major challenge for future agriculture. Often, risk will be a critical issue influencing adoption; it needs explicit attention in the diagnosis and intervention steps toward enhancing eco-efficiency. To ensure food security, systems analysis and modeling approaches, combined with farmer-focused experimentation and resource assessment, will provide the necessary robust approaches to raise the eco-efficiency of agricultural systems.

Kaplinsky R. 2004. Competitions Policy and the Global Coffee and Cocoa Value Chains. Pages 1-31.

Reference ID: 20964

Notes: H 13.1 #20964

Abstract: It is a historical fact that, considered over a long period of time, the prices of traded commodities have fallen, both in real terms (that is, taking account of inflation), and particularly in relation to the price of manufactures (UNCTAD - please put in most appropriate reference). The incomes provided to the growers of these commodities have fallen, but so too often have those of other actors in these chains who are located in the producing countries, such as buyers and exporters. Yet, at the same time, incomes in those links in the chain which are located in the main consuming countries in high-income economies have either been sustained, or more generally have increased. The experience of the 1990s has seen an exacerbation of these trends, particularly for commodities and primary products which are not integrated into production chains which produce complex manufactures.¹ The historical context in which this divergent income growth has played out, has been one characterised by two notable, and contrasting developments in the producing and consuming countries. These trends have been particularly apparent in food-based chains such as coffee and cocoa which are not subject to inherent scale economies at the growing and primary processing stage. Both developments began to emerge during the late 1980s, and gathered pace during the 1990s and early 21st century. At the growing stage, countries had previously regulated production and marketing using various forms of marketing boards. The Structural Adjustment Programmes of the

1990s involved a process of deregulation and liberalisation. The consequence has been that the private sector has played a growing role in increasingly deregulated production systems. Thus, "aggregated producer power" which had been reflected in these marketing boards has weakened, and small and medium scale producers, who previously linked to final markets through the various forms of marketing boards, increasingly found themselves selling directly into volatile global markets. At the consuming end of these chains, there has been a growing tendency towards the concentration of economic power into a decreasing number of increasingly transnational firms. Thus, there has been a growing asymmetry in many commodity value chains - between the fragmentation at the producing end of these chains, and the concentration at the buying and retail ends. This asymmetry raises the possibility that part of the explanation for these divergent income trends has been the abuse of dominant market position which often occurs in markets characterised by such inequalities in power. In this report we examine the nature of this concentration in the food industry in general, and the coffee and cocoa value chains in particular. Although, as will be shown below, we are not able to document the existence of the abuse of dominant market power, we are able to show the extent of market concentration in these two chains, and to identify the key actors which drive these two value chains. We have chosen the coffee and cocoa value chains because of their size and significance. In

The very rapid growth of China and India in recent years has seen a sharp spike in the price of metallic commodities, with the possibility of a reversal of the historic trend in the terms of trade of these primary products compared with manufactures (Kaplinsky, forthcoming, Chapter 7).

In particular, the absence of scale economies at the growing stage of these chains and their agronomic characteristics means that these two crops are particularly important to poor people in the poorest economies in Africa and Central America, as well as to more robust economies such as Brazil, India, Indonesia and Malaysia.

Before exploring the emerging patterns of concentration in the food chain in general and in these two chains in particular, we begin with a preparatory discussion laying out the bare bones of the value chain framework. This analytical framework has become increasingly important as a tool for explaining the underlying dynamics of global production networks - identifying the key actors who drive these chains (Gereffi, 1994; Gereffi, Humphrey and Sturgeon, 2004), and the impact which globalisation has on income distribution (Kaplinsky, 2000). An identification of these key actors is of course a necessary step in the exploration of the existence of anti-competitive practices.

Portmann F. T., S. Siebert, and P. Doll. 2010. MIRCA 2000-Global monthly irrigated and rainfed crop areas around the year 2000: A new high-resolution data set for agricultural and hydrological modeling. *Global Biogeochemical Cycles*, 24:1-24.

Reference ID: 20965

Notes: H 13.3 #20965

Abstract: To support global-scale assessments that are sensitive to agricultural land use, we developed the global data set of monthly irrigated and rainfed crop areas

around the year 2000 (MIRCA2000). With a spatial resolution of 5 arc min (about 9.2 km at the equator), MIRCA2000 provides both irrigated and rainfed crop areas of 26 crop classes for each month of the year. The data set covers all major food crops as well as cotton. Other crops are grouped into categories (perennial, annual, and fodder grasses). It represents multicropping systems and maximizes consistency with census-based national and subnational statistics. According to MIRCA2000, 25% of the global harvested areas are irrigated, with a cropping intensity (including fallow land) of 1.12, as compared to 0.84 for the sum of rainfed and irrigated harvested crops. For the dominant crops (rice (1.7 million km² harvested area), wheat (2.1 million km²), and maize (1.5 million km²), roughly 60%, 30%, and 20% of the harvested areas are irrigated, respectively, and half of the citrus, sugar cane, and cotton areas. While wheat and maize are the crops with the largest rainfed harvested areas (1.5 million km² and 1.2 million km², respectively), rice is clearly the crop with the largest irrigated harvested area (1.0 million km²), followed by wheat (0.7 million km²) and maize (0.3 million km²). Using MIRCA2000, 33% of global crop production and 44% of total cereal production were determined to come from irrigated agriculture

Dobermann, A., Buresh, R., Dixon, J., and Atlin, G. Rice-Maize Systems for Improving the Quality of Life of Asia's Poor. 1-5. 2006. IRRI-CIMMYT Alliance Research Program on Intensive Production Systems in Asia (IPSA).

Reference ID: 20966

Notes: H 8.2 #20966

Fairhurst, T. Review of Proposed Moratorium on Oil Palm Expansion on Forest Land. 1-9. 2008.

Reference ID: 20967

Notes: H 8.1.1.5 #20967

Heffer P. and M. Prud'homme. 2008. World Agriculture and Fertilizer Demand, Global Fertilizer Supply and Trade 2008-2009: Summary Report. Pages 1-7.

Reference ID: 20968

Notes: H 20 #20968

DaMatta F. M. and J. D. C. Ramalho. 2006. Impacts of drought and temperature stress on coffee physiology and production: a review. Brazilian Journal of Plant Physiology, 18:55-81.

Reference ID: 20969

Notes: H 8.1.5 #20969

Abstract: Overall, drought and unfavourable temperatures are the major climatic limitations for coffee production. These limitations are expected to become increasingly important in several coffee growing regions due to the recognized changes in global climate, and also because coffee cultivation has spread towards marginal lands, where water shortage and unfavourable temperatures constitute major constraints to coffee yield. In this review, we examine the impacts of such limitations on the physiology, and consequently on the production of mainly *Coffea arabica* and *C. canephora*, which account for about 99 % of the world coffee bean production. The first section deals with climatic factors and the coffee plant's requirements. The importance of controlling oxidative stress for the expression of drought and cold tolerance abilities is emphasized in the second section. In the third section, we examine the impacts of drought on cell-water relations, stomatal

behaviour and water use, photosynthesis and crop yield, carbon and nitrogen metabolism, root growth and characteristics, and on drought tolerance. In the fourth section, the impacts of low positive and high temperatures on coffee physiology are discussed; some insights about effects of negative temperatures are also presented. Finally, the last section deals with shading in harsh environments as a mean of buffering climatic fluctuations, as well as of increasing environmental sustainability in coffee exploitation.

Cassman K. G. 2004. Opportunities for Aligning the Interests of Agriculture and Environmentalists. Pages 1-12.

Reference ID: 20970

Notes: H 13.2 #20970

Crimp, S., Gaydon, D., DeVoil, Peter, and Howden, M. On-farm management in a changing climate: A participatory approach to adaptation. 1-10. 2007. Australia, Birchin Cropping Group.

Reference ID: 20971

Notes: H 11 #20971

Abstract: There is firm evidence that, in addition to climate variability, there are also changes (trends) in key climate indices (i.e. rainfall and temperature) resulting from human activity, which will have important consequences on agricultural production in Australia.

- Good risk managers need to consider both climate variability and change in their on-farm plans in order to ensure future sustainability.
- Under changed climate conditions (up to 1.1o C warmer and up to 6% drier) expected around 2030 simulation studies show that in the Wimmera Mallee region yield losses can be offset through improved residue management and longer fallows.
- Under the same set of climate changes, but with no change in management, simulated median yields may be 15% lower than present long term yields. By changing current management practices to include longer fallows these losses can be ameliorated (i.e. only 6% lower). Your management can have a positive impact.
- Local crop management adaptations are likely to play a significant role in maintaining or increasing current productivity under variable and changing climate conditions.
- Climate variability and change are likely to continue to have different impacts in different regions and will require locally specific adaptation strategies.

Starbucks Coffee Company. Cocoa Practices: Generic Scorecard. 1-18. 2007. Starbucks Coffee Company.

Reference ID: 20972

Notes: H 8.1.4 #20972

Anonymous. Simulating potential yield of maize in Southeast Asia using temperature-derived solar radiation. 1-16. 2004.

Reference ID: 20973

Notes: H 8.2.2.3 #20973

CARDI. Balanced fertilizer application to maintain or improve soil fertility: The Cassava Crop. 2015. Cambodia, Cambodian Agricultural Research and Development Institute (CARDI).

Reference ID: 20974

Notes: H 8.4.1.1 #20974

Rangga, I. Cokelat. Cokelat [mac-may 2014], 1-32. 2014. Indonesia, Cocoa Sustainability Partnership.

Reference ID: 20975

Notes: H 8.1.4 #20975

IPNI. Agristats: User Manual. 2009. IPNI.

Reference ID: 20976

Notes: General IT #20976

Nakayama, L. H. I., Santana, C. J. L., and Pinto, L. R. M. Response of Young Cacao Plants to Liming. *Revista Theobroma* 18[4], 229-240. 1988.

Reference ID: 20977

Notes: #20977e

Abstract: The effect of liming on the correction of soil acidity, the supplying of calcium and magnesium and the absorption of nutrients by cacao seedlings in pots was evaluated by experimental doses. Two Ultisols (var. dystrophic Vargito and Itabuna Modal) and one Oxisol (var. Colonia) were incubated for 45 days with CaCO_3 and MgCO_3 in a 3:1 ratio respectively of Ca and Mg. The doses were calculated from titration curves for pH 5.0, 5.5, 6.0 and 6.5 including a control (without lime). Calcium and magnesium were used both as liming and as a source of nutrients using 70 and 140 mg/pot of a mixture of calcium and magnesium sulphates besides basic fertilization. The experimental design was entirely randomized with four repetitions. Cacao seedlings were grown in plastic pots for 190 days. Liming increased the biomass production of the cacao trees, the maximum production being obtained with a bases saturation of about 50 percent. Liming caused a reduction of Mn and Zn concentration in the leaves and an increase of N, P, K, Ca and Mg absorption in both Ultisols. The mixture of calcium and magnesium sulphates did not change the soil pH but increased the available manganese of the soils of average acidity, besides serving as a source of calcium, magnesium and sulphur. Correlations between manganese in the plant and soil and biomass production established the ranges of 360 - 762 ppm and 7 - 28 ppm, respectively, as appropriate for cacao development.

Santana, C. J. L. and Cabala-Rosand, P. Soil Acidity and Cacao Responses to Lime in Southern Bahia, Brazil. *Revista Theobroma* 14[4], 141-251. 1984.

Reference ID: 20978

Notes: #20978e

Abstract: Soil acidity has been considered as a criterion for selecting soil suitable for cacao as most of the plantations in either the West Africa or Brazil are of soils having neutral or a slightly acid pH value. This criterion however has been questioned, as well as the necessity of time for acid, poor soils (Oxisols and Utisols) even in order to build up a better soil. In Southern Bahia the effect of lime additions and the tolerance of cacao to Al toxicity had been investigated in pot and field experiments. Although in nutrient solutions the cacao showed some degrees of tolerance to Al, in a pot

experiment using soils presenting high absolute levels of Al (Udisols distroficicos) a negative correlation between growth and Al saturation was found.

Ng S. K. 1989. Compilation of Research and Scientific Papers.

Reference ID: 20979

Notes: S 8.1.1 #20979e

CIAT. CIAT Strategy 2014-2020: Building an Eco-Efficient Future. 1-48. 2014. Cali, Colombia, CIAT.

Reference ID: 20980

Notes: H 13.3 #20980

GPNM and INI. Our Nutrient World: The challenge to produce more food and energy with less pollution. 1-115. 2013. Edinburgh, UK, Centre of Ecology and Hydrology.

Reference ID: 20981

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IPNI. Finding Balance Through Science. 1-41. 2011. Norcross USA, IPNI.

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Notes: S 35 #20982

Fisher M. and S. Cook 2012. Water, Food and Poverty in River Basins: Defining the Limits, Routledge, Abingdon, UK.

Reference ID: 20983

Notes: S 17 #20983

Abstract: Conventional wisdom says that the world is heading for a major water crisis. By 2050, global population will increase from 7 billion to a staggering 9.5 billion and the demands this will place on food and water systems will inevitably push river basins over the edge.

The findings from this book present a different picture. While it is convenient to visualize an inevitable global water and food crisis in which increasing demands result in increasing poverty, food insecurity and conflict, the reality is far more nuanced and revolves around the politics of equitable and sustainable development of resources.

The first part of this book provides detailed insight into conditions of water flows within nine river basins. In the second part, authors summarize and re-analyze the outcome of the nine basins, providing a coherent global picture of water, water productivity and development. They assess the impacts of variations of these attributes on development and approaches for poverty alleviation, and explore the institutional factors that support or obstruct change.

How people will manage river systems while protecting vital ecosystem functions will make the difference between catastrophe and survival. As Prof Asit Biswas points out, "... the world is facing a water crisis not because of physical scarcity of water but because of poor management practices in nearly all countries of the world."

The book is based on the four years (2006-2010) of extensive research into the state of ten of the world's major river basins carried out under the CGIAR Challenge Program for Water and Food's Basin Focal Project.

Clay D. E., C. G. Carlson, S. A. Clay, and T. S. Murrell 2012. Mathematics and calculations for agronomists and soil scientists, IPNI, Norcross USA.

Reference ID: 20984

Notes: H 3 #20984

Abstract: A guide to converting biologically-based data in to economically and scientifically-based practical solutions.

Valcarcel D. 2008. Economia Exterior, Estudios de Politica Exterior, Madrid, Spain.

Reference ID: 20985

Notes: S 13.1 #20985

Upton G. J. G. and B. Fingleton 1985. Spatial Data Analysis by Example: Vol 1: Point Pattern and Quantative Data.

Reference ID: 20986

Notes: S 16.1 #20986

Kuit M., D. M. Jansen, and N. van Thiet 2004. Manual for Arabica Cultivation.

Reference ID: 20987

Notes: S 8.1.5 #20987

Abstract: This manual aims to introduce Good Agricultural Practices to farmers. The purpose is to improve coffee quality and sustainability in Arabica production. It is a compilation of the joint experiences of the PPP project "Improvement of Coffee Quality and Sustainability of Coffee Production in Vietnam", the Tan Lam Agricultural Product Joint Stock Company and the farmers from Huong Hoa district, Quang Tri province that participated in this project. The project team would like to thank the Douwe Egebrts Foundations which provided funding for the project. We would also like to thank all the farmers from Huong Hoa who worked with us and provided us with an insight in their management procedures and gave excellent feedback on the technical contents of the manual.

von Uexküll H. R. 1978. A Collection of Papers on Southeast Asian Agriculture.

Reference ID: 20988

Notes: S 26.1 #20988

Bucher S. 2001. Nitrogen and phosphorus availability in irrigated rice as influenced by soil drying during the fallow period, straw incorporation, and tillage. Swiss Federal Institute of Technology Zurich,

Reference ID: 20989

Notes: S 8.2.1.1 #20989

Adviento M. A. A. 1998. Diffusion of Potassium, Calcium, Iron and Acidity in Reduced Rice Soils. University of the Philippines at Los Banos, Philippines.

Reference ID: 20990

Notes: S 8.2.1.1 #20990

Mnzava M. N. W. 2002. Nitrogen Absorption Rate at Different Growth Stages in Relation to Grain Production of Lowland Rice (*Oryza Sativa* L.). University of Philippines Los Banos, Philippines.

Reference ID: 20991

Notes: S 8.2.1.1 #20991

Rasch D., L. R. Verdooren, and J. I. Gowers 1999. Fundamentals in the Design and Analysis of Experiments and Surveys: Grundlagen der Planung und Auswertung von Versuchen und Erhebungen, Oldenbourg.

Reference ID: 20992

Notes: S 16.1 #20992 English-German

Abstract: This book is intended for students and experimental scientists in all disciplines and presumes only elementary statistical knowledge. This prerequisite knowledge is summarised briefly in the Appendix. Knowledge of differential and integral calculus is not necessary for the understanding of the text. Matrix notation is explained in the Appendix. Die Verfasser wenden sich mit diesem Buch an Studenten und empirisch arbeitende Wissenschaftler aus allen Fachbereichen und setzen nur elementare statistische Kenntnisse voraus. Diese vorausgesetzten Grundkenntnisse sind im Anhang komprimiert zusammengefaßt. Kenntnisse der Differential- und Integralrechnung sind für das Verständnis des Textes nicht erforderlich. Die notwendigen Kenntnisse der Matrizenrechnung enthält der Anhang. From the Table of Contents: Introduction. Planning of Experiments and Surveys and the Description of Simple Designs. Design and Analysis of Completely Randomised Designs. Analysis of Variance. Regression Analysis. Appendix. Tables.

Mew T. W., D. S. Brar, S. Peng, D. Dawe, and B. Hardy 2003. Rice Science: Innovations and Impact for Livelihood, IRRI, Philippines.

Reference ID: 20993

Notes: S 8.2.1 #20993

IOPRI. 2010. IOPC 2010: Transforming Oil Palm Industry: 1-3 June 2010, Jogja Expo Center, Yogyakarta Indonesia. Page 1 IOPRI, Indonesia.

Reference ID: 20994

Notes: S 8.1.1 #20994e Abstracts, CD-Rom available

Trenkel M. E. 2010. Slow- and Controlled-Released and Stabilized Fertilizers: An Option for Enhancing Nutrient Use Efficiency in Agriculture, IFIA, France.

Reference ID: 20995

Notes: S 21 #20995

Abstract: This book is a revision of the IFA publication "Improving Fertilizer Use Efficiency: Controlled-Release and Stabilized Fertilizers in Agriculture" by the same author, published in 1997. It is intended for use by the fertilizer industry, policy makers and scientists. The main objectives of the book are to:

- Provide an up-to-date state of scientific knowledge on issues related to the development, production and use of slow- and controlled-release and stabilized fertilizers;
- Explain the importance of slow- and controlled-release and stabilized fertilizers to improve nutrient use efficiency;
- Present slow- and controlled-release and stabilized fertilizer products that are currently available;
- Assess the current market and prospects for slow- and controlled-release and stabilized fertilizers; and
- Discuss the policy and regulatory frameworks needed to maximize the benefits from using slow- and controlled-release and stabilized fertilizers.

This book is a contribution to IFA's efforts to promote nutrient stewardship through the use of the right product(s) at the right rate, right time and right place (IFA, 2009).

Mulato S. and E. Suharyanto 2015. Post Harvest Coffee Processing in Indonesia: An Introduction to Good Manufacturing Practices, Indonesian Coffee and Cocoa Research Institute, Indonesia.

Reference ID: 20996

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Rao C. S., B. Venkateswarlu, S. Dixit, and A. K. Singh 2010. Potassium Deficiency in Soils and Crops: Emerging Soil Fertility Constraint in Dryland Agriculture, Centre Research Institute for Dryland Agriculture, India.

Reference ID: 20997

Notes: S 1.6 #20997

IPNI. 2009. Uso Eficiente de Nutrientes. Pages 1-56 IPNI, Costa Rica.

Reference ID: 20998

Notes: S 1.3 #20998

IPNI 2010. Soil Test Levels in North America, IPNI, Norcross US.

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Notes: S 29 #20999 CD-Rom in book

IPNI. Plant Nutrition Without Borders: Program Report 2013. 1-40. 2013. USA, IPNI.

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IPNI. Plant Nutrition Without Borders: Research Projects: Interpretive Summaries - 2012 Crop Year. 1-92. 2013. Norcross, US, IPNI.

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Notes: S 35 #21001

Davies, D. B. Soil Use and Management. Soil Use and Management 1, 1-73. 2000. Oxon, UK.

Reference ID: 21002

Notes: S 1 #21002

Nelson P. N., M. J. Webb, S. Berthelsen et al. 2011. Nutritional Status of Cocoa in Papua New Guinea, ACIAR, Australia.

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Notes: S 26.4.4 #21003

Zambrano-Franco D. A., N. Rodriguez-Valencia, U. Lopez-Posada, P. A. R. Orozco, and A. J. Zambrano-Giraldo 2006. Tratamiento Anaerobio de las Aguas Mielles del Cafe, Cenicafe, Colombia.

Reference ID: 21004

Notes: S 8.1.5 #21004

Restrepo E. C. M., J. A. Pulgarin, A. J. Robledo, N. M. R. Herrera, and F. Q. Zea 2009. Modelo para simular la produccion potencial del cultivo del cafe en colombia, Cenicafe, Colombia.

Reference ID: 21005

Notes: S 8.1.5 #21005

Arcila-Pulgarin J., L. Buhr, H. Bleiholder, H. Hack, and H. Wicke 2001. Application of the 'Extended BBCH-Scale' for the description of the growth stages of coffee (coffea sp.), Cenicafe, Colombia.

Reference ID: 21006

Notes: S 8.1.5 #21006

Mutert, E. BALCROP: K Mg S: Efficiency of fertilisers K, Mg and S nutrients in rice and coffee systems on representative soils of Vietnam. 1-9. 1998. IPNI.

Reference ID: 21007

Notes: S 35 #21007

Mutert, E. Vietnam BALCROP. 1-14. 1997. IPNI.

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Notes: S 26.1.10 #21008

Tan, D., Dobson, J., Fairhurst, T., and Mutert, E. PPI-PPIC: East & Southeast Asia Programs 1999. 1-10. 1999. Singapore, PPI.

Reference ID: 21009

Notes: S 35.3 #21009

Fairhurst, T. Preliminary Visit to PT Ganda Buanindo to Evaluate Field Agronomy 8-11 September 1998. 1-18. 1998. Singapore, PPI.

Reference ID: 21010

Notes: S 26.1.3 #21010

Fairhurst, T. OMP7 Installation: Agro Hope Sdn Bhd 18-21 April 1999. 1-13. 1999. Singapore, PPI.

Reference ID: 21011

Notes: S 35 #21011

Fairhurst, T. Activities and Plans: PPI East & Southeast Asia Program December 1997. 1-13. 1997. Singapore, PPI.

Reference ID: 21012

Notes: S 35 #21012

Fairhurst, T. and Dendi, A. Photo Annex: Agriculture Component: Bengkulu Regional Development Project. 1-23. 1997. PPI.

Reference ID: 21013

Notes: S 35 #21013

Mutert, E. and Fairhurst, T. Visit to PTPN 13: Ngabang Estate (PIR V) West Kalimantan, Indonesia. 1-11. 1996. Singapore, PPI.

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Reference ID: 21034

Notes: #21034e

Abstract: Drought has emerged as one of the major constraints in banana production. Its effects are pronounced substantially in the tropics and sub-tropics of the world due to climate change. Bananas are quite sensitive to drought; however, genotypes with "B" genome are more tolerant to abiotic stresses than those solely based on "A" genome. In particular, bananas with "ABB" genomes are more tolerant to drought and other abiotic stresses than other genotypes. A good phenotyping plan is a prerequisite for any improvement program for targeted traits. In the present article, known drought tolerant traits of other crop plants are validated in bananas with different genomic backgrounds and presented. Since, banana is recalcitrant to breeding, strategies for making hybrids between different genomic backgrounds are also discussed. Stomatal conductance, cell membrane stability (CMS), leaf emergence rate, rate of leaf senescence, RWC, and bunch yield under soil moisture deficit stress are some of the traits associated with drought tolerance. Among these stress bunch yield under drought should be given top priority for phenotyping. In the light of recently released *Musa* genome draft sequence, the molecular breeders may have interest in developing molecular markers for drought resistance.

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Reference ID: 21039

Notes: #21039e

Abstract: All systems have causes and effects that can be appreciated at different spatial scales. Understanding and representing the complexity of multi scale patterns in maps and spatial models is a key research objective. We describe the use of three types of correlation analyses: (i) a standard Pearsons Correlation Coefficient, (ii) a

'global' multi scale correlation, and (iii) local Geographically Weighted Correlation. These methods were applied to topographic and vegetation indices in a small catchment in Honduras that is representative of the country's hillsides agro-ecosystem which suffers from severe environmental degradation due to land use decisions that lead to deforestation, overgrazing, and unsustainable agricultural. If the geographical scale at which topography matters for land use allocation can be determined then integration of knowledge systems can be focused. Our preliminary results show that: (i) single scale correlations do not adequately represent the relationship between NDVI and topographic indices, (ii) peaks in the global multi scale correlations in agricultural areas coincided with the median farm size but there was no evidence of any community or larger scale land use planning or optimisation, and (iii) local multi scale correlations varied considerably from the global results at all scales, and these variations have strong spatial structure which may indicate local optimisation of land use.

El-Sharkawy M. A. 2004. Cassava Biology and Physiology. *Plant Molecular Biology*, 56:481-501.

Reference ID: 21040

Notes: #21040e

Abstract: Cassava or manioc (*Manihot esculenta* Crantz), a perennial shrub of the New World, currently is the sixth world food crop for more than 500 million people in tropical and sub-tropical Africa, Asia and Latin America. It is cultivated mainly by resource-limited small farmers for its starchy roots, which are used as human food either fresh when low in cyanogens or in many processed forms and products, mostly starch, flour, and for animal feed. Because of its inherent tolerance to stressful environments, where other food crops would fail, it is often considered a food-security source against famine, requiring minimal care. Under optimal environmental conditions, it compares favorably in production of energy with most other major staple food crops due to its high yield potential. Recent research at the Centro Internacional de Agricultura Tropical (CIAT) in Colombia has demonstrated the ability of cassava to assimilate carbon at very high rates under high levels of humidity, temperature and solar radiation, which correlates with productivity across all environments whether dry or humid. When grown on very poor soils under prolonged drought for more than 6 months, the crop reduce both its leaf canopy and transpiration water loss, but its attached leaves remain photosynthetically

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Liverpool-Tasie, L. S. O., Barrett, C. B., and Sheahan, M. B. Understanding Fertilizer Use and Profitability for Rice Production across Nigeria's Diverse Agro Ecological Conditions. 1-36. 2014.

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Notes: #21042e

Atim M., F. Beed, G. Tusiime, L. Tripathi, and P. van Asten. 2013. High Potassium, Calcium, and Nitrogen Application Reduce Susceptibility to Banana *Xanthomonas* Wilt Caused by *Xanthomonas campestris* pv. *musacearum*. *Plant Disease*, 97:123-130.

Reference ID: 21043

Notes: #21043e

Abstract: The effect of exogenous applications of potassium (K), calcium (Ca), and nitrogen (N) on the susceptibility of four banana cultivars to Banana *Xanthomonas* wilt (BXW) was studied. Murashige and Skoog (MS) medium with normal concentrations of K at 783 mg/liter, Ca at 121 mg/liter, and N at 841 mg/liter was modified to contain various concentrations of K, Ca, and N. Each nutrient was varied singly, each with three replicate experiments. The concentrations were K at 78, 157, 391, 783, 1,565, and 3,913 mg/liter; Ca at 12, 24, 60, 121, 241, and 603 mg/liter; and N at 84, 168, 420, 841, and 1,682 mg/liter. Plantlets were generated in vitro on normal MS medium and later exposed to the nutrient concentrations for a total of 8 weeks. Thereafter, they were artificially inoculated with *Xanthomonas campestris* pv. *musacearum* using an insulin syringe. In each nutrient, plantlets exposed to higher nutrient concentrations significantly ($P < 0.0001$) accumulated more nutrient in their tissues compared with those exposed to lesser nutrient concentrations. Wilt incidences were significantly reduced, and incubation periods (time from inoculation to appearance of first disease symptoms) increased, with increasing nutrient application. The study lays a background for in vivo studies aimed at management of BXW using nutrients, such as fertilizer application.

Lessa L. S., T. K. de Oliveira, E. P. Amorim, G. M. L. de Assis, and S. D. E. Silva. 2012. Vegetative Traits And Their Effects On Production Of Banana Evaluated In Three Cycles: Características vegetativas e seus efeitos sobre a produção de bananeira em três ciclos. *Revista Brasileira De Fruticultura*, 34:1098-1104.

Reference ID: 21044

Notes: #21044e

Abstract: The productivity in banana is a complex character that results from the combination of different factors, influenced by environment. This work aimed to study the direct and indirect effects of vegetative traits on production in three cycles in banana. The work was conducted in the Experimental Field of Embrapa Acre in Rio Branco, Acre, among years 2003 and 2006. Thirteen genotypes of banana (Preciosa, Japira, Pacovan Ken, Pacovan, BRS Platina, Prata Ana, ST12-31, Nanicao, Grande Naine, Calypso, Ambrosia, Bucaneiro and FHIA 02) were evaluated, spaced 3 m x 2 m, in the randomized blocks with five replicates. The evaluated traits were: plant height, diameter of pseudostem, number of leaves at flowering and harvest, weight of bunch and number of hands in the bunch. Analysis of variance and path analysis were carried out for each cycle and phenotypic correlation coefficients were estimated. The trait weight of the bunch was adopted as the basic variable and the others were considered the explanatory variables. The study of direct and indirect effects showed that the character output is much influenced by the environment in the first cycle, and the following production cycle is much influenced by vegetative traits, especially number of leaves at harvest.

Santos S. C. and L. C. Carneiro. 2012. Performance Of Banana Genotypes In Jataí-Go Region: Desempenho De Genótipos De Bananeira Na Região De Jataí-Go. *Revista Brasileira De Fruticultura*, 34:783-791.

Reference ID: 21045

Notes: #21045e

Abstract: This research aimed the evaluation of growing and yield of six banana genotypes at the bioclimatic conditions of the Southwest region of the State of Goiás. Field trials were carried out at Fazenda Aroeira, a commercial farm located in Jataí, under the Southwest micro-region of the State of Goiás, without the use of supplemental irrigation. Data were collected in two production cycles and the genotypes evaluated were 'Caipira' (AAA), 'ThapMaeo' (AAB), 'FHIA-01' (AAAB), 'FHIA-21' (AAAB), 'FHIA-18' (AAAB), described as resistant to Black Sigatoka, and 'Terra' (AAB - subgroup Terra), traditionally cultivated by surrounding growers. It was used a randomized block design with six treatments (genotypes) and 6 repetitions (plots). Plants were spaced 3 meters between rows and 2 meters between plants within a row. Growing and yield characterization of the six genotypes were done by the following evaluations: number of days from planting to harvesting, bunch weight, hands number, stem length, stem diameter, stem weight, diameter of the second hand fruit, length of the second hand fruit, second hand weight, number of fruits at the second hand, pseudostalk diameter at flowering, leaf number at harvesting and plants height at flowering. It was observed a well defined water regime, with a rainy season from August to March and a dried season from April to September. Considering that different environments influences genotypes performance and characters expression, the good development of such genotypes suggests their adaptation to the climatic conditions of Southwest region of the state of Goiás. According to data obtained at the second growing cycle, the genotypes 'FHIA-18', 'FHIA-01' and 'FHIA-21' presented favorable agronomic characteristics, and they can be indicated as alternative cultivars to local growers. The low temperatures and altitude contributed for longer growing cycle for all genotypes, with the longest ones observed for 'FHIA-21' and 'Terra'.

Ripoche A., R. Achard, A. Laurens, and P. Tixier. 2012. Modeling Spatial Partitioning Of Light And Nitrogen Resources In Banana Cover-Cropping Systems. *European Journal of Agronomy*, 41:81-91.

Reference ID: 21046

Notes: #21046e

Abstract: In banana cropping systems, cover crops are introduced mainly to manage weeds and mitigate the use of herbicides. But this introduction modifies the structure of the field, its biophysical functioning and then farmers' practices. We designed the SIMBA-IC model to simulate nitrogen and light partitioning and crop management, which can differ across the different zones of the field (banana row, small and large inter-rows), and to assess agronomic and environmental performances of banana cover cropping systems under scenarios of different spatial arrangement. We calibrated and validated the model using independent data sets from a fertilizer and an intercropping experiment, respectively. Results showed that SIMBA-IC realistically simulated the differences between treatments in terms of crop cycle duration (for flowering date, RMSE = 2.3 weeks in the calibration and validation steps) and biomass produced (RMSE = 0.67 and 0.94 kgDM ha⁻¹) at flowering in calibration and validation steps, respectively). We simulated different management options related to the four field zones to optimize fertilization and cover crop management and ensure a tradeoff between agronomic (banana yield) and

environmental (N leaching mitigation) performances. Simulations showed that yield was maximal and N teaching was reduced when fertilization was applied in the banana row. When cover crops were mowed according to the banana N stress, agronomic and environmental performances were higher than when mowing was based on the cover crop leaf area index, but the former approach led to very frequent mowing. Future studies should consider the impacts of these cropping systems from a socio-economic point of view to assess their feasibility and ability to be adopted.

Maia C. E. 2012. Sampling Time of Banana Leaves for Nutritional Diagnosis: Época de amostragem foliar para diagnóstico nutricional em bananeira. *Revista Brasileira De Ciencia Do Solo*, 36:859-864.

Reference ID: 21047

Notes: #21047e

Abstract: The relationship between yield and nutrient concentration in plants is the basis used as a diagnostic criterion for foliar analysis. There are several diagnostic methods that use the analysis of plant tissues where they play a key role in the definition and interpretation of plant nutritional status. The average nutrient concentration changes during the crop cycle, which is important for defining the time of leaf sampling. The purpose of this study was to determine the best sampling time of banana leaves, assuming that the best time is when the relationship between the relative growth rate of dry matter and of nutrient uptake is 1. It was concluded that the best time to sample banana leaves for the evaluation of the nutritional status would be six months after planting.

Cavatte R. P. Q., L. C. C. Salomao, D. L. de Siqueira, L. A. Peternelli, and P. C. Cavatte. 2012. Reduction of the Size And Production of 'Prata Ana' and 'Fhia-01' Banana Trees Treated with Paclobutrazol: Redução do porte e produção das bananeiras 'Prata-Anã' e 'FHIA-01' tratadas com paclobutrazol. *Revista Brasileira De Fruticultura*, 34:356-365.

Reference ID: 21048

Notes: #21048e

Abstract: The aim of this study was to evaluate the yield and the cycle of banana trees treated with paclobutrazol (PBZ). We tested five doses of PBZ (0.0; 0.5; 1.0; 1.5 and 2.0 g plant⁻¹), applied on the soil around 'Prata Ana' and 'FHIA-01' banana trees four months after planting. Data were obtained during the first cycle and the bunches were harvested when yellow color was observed on the peel of the first fruits. The cycle time was of 507 days, not differing in terms of doses and cultivars. The use of PBZ reduced pseudostem length. Increasing of PBZ doses increased the number of active leaves at inflorescence emission period of 'Prata Ana', but the effects on bunch were harmful, with reduction of the number of fruits per bunch, of commercial length and diameter of the fruits, which caused reduction of bunch weight and of productivity. In FHIA-01 cultivar, PBZ applied via soil reduced pseudostem length and improved bunch sustentation, not influencing crop productivity. The optimal dose of PBZ on 'FHIA-01' banana tree is around 1,0 g plant⁻¹. For the 'Prata Ana' is not recommended the use of PBZ.

Kabunga N. S., T. Dubois, and M. Qaim. 2012. Yield Effects of Tissue Culture Bananas in Kenya: Accounting for Selection Bias and the Role of Complementary Inputs. *Journal of Agricultural Economics*, 63:444-464.

Reference ID: 21049

Notes: #21049e

Abstract: We analyse yield effects of tissue culture (TC) banana technology in the Kenyan small farm sector, using recent survey data and an endogenous switching regression approach. TC banana plantlets, which are free from pests and diseases, have been introduced in East Africa since the late 1990s. Although field experiments show significant yield advantages over traditional banana suckers, a rigorous assessment of impacts in farmers fields is still outstanding. A comparison of mean yield levels between TC adopters and non-adopters in our sample shows no significant difference. However, we find evidence of negative selection bias, indicating that farmers with lower than average yields are more likely to adopt TC. Controlling for this bias results in a positive and significant TC net yield gain of 7%. We also find that TC technology is more knowledge intensive and more responsive to irrigation than traditional bananas. Simulations show that improving access to irrigation could lift TC productivity gains to above 20%. The analytical approach developed and applied here and the finding of negative selection bias may also be relevant for the evaluation of other agricultural technologies.

Damour G., H. Ozier-Lafontaine, and M. Dorel. 2012. Simulation of the growth of banana (*Musa spp.*) cultivated on cover-crop with simplified indicators of soil water and nitrogen availability and integrated plant traits. *Field Crops Research*, 130:99-108.

Reference ID: 21050

Notes: #21050e

Abstract: To reduce chemical inputs while maintaining crop yield, disturbed ecosystem functions must be restored, for example by cover-crops. In these cropping systems, because of competition between species, soil resources must be carefully managed. Dedicated tools and models are needed that account for the adverse effects of the cover-crop on the cash crop in terms of resource availability. Besides classical agronomic calculations of stress indices, which are difficult to generalize and require numerous parameters, recent work in ecology has related plant traits, like the biomass accumulated, to the resource availability during the whole plant cycle. Following such a simple approach, the objectives of this study were (i) to determine the effects of water and nitrogen limitations on banana growth and development and to test whether simple integrated traits can highlight the effects of these stresses on banana growth, (ii) to parameterize a simple generic module of soil water and nitrogen availability linked to SIMBA GROW, the growth module of the banana crop model SIMBA, (iii) to assess the ability of the model to simulate banana growth and development in the environmental conditions of a banana/cover-crop system, with particular attention on the effects of changes in plot temperature on model outputs. Three experiments were conducted on whole production cycles to investigate the effects of different water regimes, different nitrogen fertilization levels, and the cover-crop *Neonotonia wightii* on banana growth, nutritional status, and date of flowering. Results showed low nitrogen availability affected banana growth only weakly but decreased leaf nitrogen content and delayed flowering. Low water availability delayed flowering and decreased banana growth. In both cases, the delayed flowering allowed longer banana growth, which balanced the negative effect of low availability on the growth rate. The cover-crop modified both the rooting depth

of the banana, and thus the amount of resources accessible to the banana roots, and the plot microclimate, especially air temperature. The model correctly reproduced the differences of date of flowering and leaf area index at flowering for a first cycle of production between a bare-soil and a cover-crop system, provided air temperature was reduced by 2-3% due to the cover-crop. To conclude, this study showed that in fairly constant environmental conditions (temperature, radiation and rainfall) a simplified model using resource availability over the growing period and integrated plant traits satisfactorily simulates banana growth in an intercropped system.

Costa F. D., E. F. Coelho, A. L. Borges, A. J. M. Pamponet, A. D. S. M. da Silva, and N. F. de Azevedo. 2012. Growth, yield and potassium accumulation in 'Galil 18' banana under irrigation and potassium fertilization: Crescimento, produção e acúmulo de potássio em bananeira 'Galil 18' sob irrigação e fertilização potássica. *Pesquisa Agropecuaria Brasileira*, 47:409-416.

Reference ID: 21051

Notes: #21051e

Abstract: The objective of this work was to evaluate the vegetative growth, yield variables and the accumulation of potassium in the aerial part of the banana, cultivar Galil 18, under different irrigation and potassium levels in the conditions of the coastal tablelands of Bahia state, Brazil. The experimental design was a completely randomized block, in a 4x4 factorial arrangement (irrigation levels x potassium doses), with three replicates. Irrigation water depths were based on 30, 60, 90 and 120% of the reference evapotranspiration (ET_o). The K₂O doses were 0, 400, 800 and 1,200 kg ha⁻¹. Vegetative growth, production variables and K accumulation by the several organs of the aerial portion of the plant were determined. Potassium doses did not significantly affect growth and production variables. Irrigation water depth had a significant effect on the height and diameter of the pseudo-stem, on the number of fruits per bunch, on yield and on water use efficiency. The pseudo-stem is the largest K repository in banana plants.

Aremu A. O., M. G. Kulkarni, M. W. Bairu, J. F. Finnie, and J. Van Staden. 2012. Growth stimulation effects of smoke-water and vermicompost leachate on greenhouse grown-tissue-cultured 'Williams' bananas. *Plant Growth Regulation*, 66:111-118.

Reference ID: 21052

Notes: #21052e

Abstract: A common problem often experienced by both small and large scale banana farmers is the reduction in quality and yield of bananas due to soil moisture deficits and declining soil fertility. To overcome this, mechanisms of improving yield without compromising environmental integrity or public health are being embraced. Globally, researchers have continued to evaluate the competence of environmental-friendly organic fertilizers and smoke solutions to improve the growth, yield and quality of various crops. In the present study, the effect of smoke-water (1:1,000; 1:500 and 1:250 dilutions) and vermicompost leachate (1:20; 1:10 and 1:5 dilutions) treatments on the growth of greenhouse grown bananas was evaluated. Soil drenching (smoke-water and vermicompost leachate) and foliar application (smoke-water) were tested on 1-month-old tissue-cultured banana seedlings under greenhouse conditions. After 3 months, growth parameters such as number and length of roots and shoots; number of leaves and leaf area as well as their fresh and dry weights were analyzed. Soil drenching with smoke-water significantly increased

the root length (1:1,000 and 1:500 dilutions) as well as fresh and dry weight (1:1,000; 1:500 and 1:250 dilutions) when compared to foliar application. Vermicompost leachate (1:10 and 1:5 dilutions) significantly enhanced the shoot length, root length, leaf area and dry weights. Vermicompost leachate (1:20; 1:10 and 1:5 dilutions) also significantly increased the number of off-shoots. The positive effect on rooting is beneficial for acclimatization and establishment of tissue-cultured banana plantlets in nurseries and subsequent transfer to the field. Moreover, the high cost of inorganic fertilizers as well as environmental safety concerns makes the use of smoke-water and vermicompost leachate potential alternatives to improving the growth and cultivation of bananas.

Zucoloto M., J. S. D. Lima, and R. I. Coelho. 2011. Spatial Variability of Chemical Attributes in the Soil and Yield of Banana 'Prata Ana': Correlação e variabilidade espacial de atributos químicos do solo e produção de bananeira 'Prata-Anã'. Revista Brasileira De Fruticultura, 33:479-484.

Reference ID: 21053

Notes: #21053e

Abstract: The aim was to study the spatial variability of the soil chemical properties and the production of banana 'Prata-Ana', by classical statistics and geostatistics, and the correlation between them. Samples were collected at four points around the plants making a composite sample, at a depth of 0-0.2 m in a regular grid, total of 100 sampling points, spaced 6 x 4 m. The production of banana showed a negative correlation of 0.20 with H+Al. All soil chemical properties and the production of banana showed spatial dependence.

Martins A. N., L. A. J. Teixeira, E. Suguino, J. M. Hashimoto, and N. Narita. 2011. Irrigation and Potassium Fertilization by Fertigation in Banana 'Willians' - Production and Fruit Quality: Irrigação e adubação potássica via fertirrigação em bananeira 'willians' : produção e qualidade de frutos. Revista Brasileira De Fruticultura, 33: 743-751.

Reference ID: 21054

Notes: #21054e

Abstract: The application of nutrients through irrigation water increases their efficiency of utilization by plants. The objective of this study was to evaluate the effects of potassium fertilization and irrigation on the yield and fruit quality of banana cv. Willians, in the Medio Paranapanema Region, Sao Paulo. Four water regimes were evaluated: rainfed, 0.7 of the reference evapotranspiration (ET_o), 1.4 ET_o and 2.1 ET_o, combined with four doses of potassium: 0, 300, 600 and 900 kg ha year⁻¹) K₂O, applied weekly by fertigation. Under rainfed, potassium fertilization was applied during the rainy season, split into four times. Potassium fertigation affects positively both the production and the quality of the fruits of banana cv. Willians. In addition, the fertigation increased nutrient use efficiency when compared to fertilization under rainfed conditions.

Costa M. C. G., E. L. de Almeida, T. O. Ferreira, D. P. de Oliveira, and R. E. Romero. 2011. Soil depth and microrelief in irrigated banana plantation: impacts on mineral nutrition and yield potential: Profundidade do solo e micro-relevo em bananeiras irrigadas: impactos na nutrição mineral e potencial produtivo. *Revista Ciencia Agronomica*, 42:567-578.

Reference ID: 21055

Notes: #21055e

Abstract: The aim of this research was to verify whether soil depth affects aspects of mineral nutrition and yield potential of irrigated banana plantations. The study was carried out at Apodi Plateau (CE), Brazil, in an area characterized by soil depth variations. The treatments were sites in different microrelief classes (concave, convex and retilinea) with four different soil depths: A) 0.92 m; B) 0.77 m; C) 0.65 m; D) 0.52 m. The following measures were done: high of mother plant (APM), high of daughter plant (APF), pseudostem diameter of mother plant (DPPM), weight of fresh (MFF) and dry leaves (MFS), contents of phosphorus (P), potassium (K), calcium (Ca), sulphur (S) and sodium (Na) in plant tissue and bunch weight. Data were submitted to ANOVA and to least significant differences (LSD) with 5% of significance. APM and DPPM were higher in A and C, while the lower values were found in the shallow soil (D). Values of MFF and MFS were higher in both sites A and D that also presented larger amount of nutrients in plant leaves. However, higher amount and adequate levels of P in plant leaves were observed in the site A, on which plants presented higher bunch weight. It showed that effective soil depth and soil microrelief have influence in nutrients uptake, plants growth, and productive potential of banana plants irrigated at Apodi Plateau.

Filho J. R. B., J. L. Nascimento, R. V. Naves, M. C. L. Torres, R. M. Geraldine, E. R. B. de Souza, and F. V. Barroso. 2011. Irrigation levels and genotypes on banana tree fruits quality and yield: Lâminas de irrigação e genótipos na produção e qualidade de frutos de bananeira. *Pesquisa Agropecuaria Tropical*, 41:155-162.

Reference ID: 21056

Notes: #21056e

Abstract: Brazil is the fourth biggest banana producer. However, its social function is more important than the economic one. In this study, the productive features of banana tree genotypes, under different irrigation levels, and the sensorial characteristic for taste of ripe fruits were evaluated. The experiment was carried out from January 2004 to July 2005, with the following genotypes: false FHIA 18, Grand Naine, Prata, and Thap Maeo. After resting for two days in a cold chamber, the fruits were evaluated in the third, fourth and fifth days, for determining the preferred sample. The four genotypes presented significant results to irrigation. The water levels effect was verified in the weight of the bunch, rachis, and hands, and in the total number of fruits, bunch length and number of hands. The weight of the bunch and hands, and the total number of fruits, in the false FHIA 18, Grand Naine, and Thap Maeo genotypes, presented similar responses, except for the weight of bunch and hands, in Thap Maeo. The effect of the water levels among the genotypes occurred on most variables, except for the weight and the number of fruits of the second hand and diameter of the central fruit. False FHIA 18 presented more variables influenced by the irrigation levels and, for Prata, the only influence occurred in the number of hands. The irrigation positively influenced the productive characteristics of the false FHIA 18, Grand Naine, and Thap Maeo banana trees, which showed to be promising for the Brazilian savannah region. Consumers prefer the Prata and Grand Naine genotypes.

Furlaneto F. P. B., A. N. Martins, and M. S. T. Esperancini. 2011. Economic viability of nutrient management practices for banana crop: Viabilidade econômica de manejos nutricionais na cultura de banana. *Pesquisa Agropecuaria Tropical*, 41:205-212.

Reference ID: 21057

Notes: #21057e

Abstract: Proper fertilizing management, in order to optimize fruit quality and yield, is a relevant stage on the production process to the rural entrepreneur profitability. So, the aim of this study was to analyze the economic feasibility of five nutrient management practices for banana crop, Cavendish cultivars, in the Médio Parapanema region, São Paulo State, Brazil, in 2009/2010. The effective operational cost (EOC) and total operational cost (TOC) structures and three profitability indicators were used. Significant differences were observed among the management systems, and the system that resulted in major economic advantage to the producer provided an average profit rate 25.6% higher than other treatments, with total net revenue about 29.5% higher than other management types. The unitary cost was lower for the most profitable nutrient management practice, although the yield was 9.5% lower than the management system that presented the highest yield levels.

Okumu M. O., P. J. A. van Asten, E. Kahangi, S. H. Okech, J. Jefwa, and B. Vanlauwe. 2011. Production gradients in smallholder banana (cv. Giant Cavendish) farms in Central Kenya. *Scientia Horticulturae*, 127:475-481.

Reference ID: 21058

Notes: #21058e

Abstract: Banana is an increasingly demanded food and cash crop in sub-Saharan Africa. Reported yields in smallholder farms vary substantially. The importance and spread of yield constraints have not been properly quantified. A study was carried out in Central Kenya to (i) quantify the yield levels, the primary yield constraints, and the spatial production gradients in such systems (ii) explore how soil fertility gradients relate to gradients in soil fertility management, and whether this is a function of farmer resource availability. Data was collected on crop management aspects, pests and diseases, and soil and plant tissue samples analyzed for nutrient contents. Bunch yields were higher near homesteads (29.8 t ha⁻¹ yr⁻¹) than at mid-distance (26.8 t ha⁻¹ yr⁻¹), or far away 20.2 t ha⁻¹ yr⁻¹). Yields were much higher than previously reported (11-14 t ha⁻¹ yr⁻¹) in Kenya. Both soil and tissue K levels were higher near and mid-distance, than far from the homestead. Gradients of soil pH, total N, available P and Organic carbon were found, being higher near the homestead, while Mg and Ca were lowest near the homesteads. K was the most deficient nutrient, with tissue K index (I(K)) decreasing when moving away from the homesteads. P and Ca deficiencies were also observed. Resource-poor farmers' soils were higher in exchangeable K and Mg, pH, and total N. and supported higher mat densities compared to resource-endowed farmers' farms. Soil quality problems were the biggest yield loss factors and not pests and diseases.

van Asten P. J. A., A. M. Fermont, and G. Taulya. 2011. Drought is a major yield loss factor for rainfed East African highland banana. *Agricultural Water Management*, 98:541-552.

Reference ID: 21059

Notes: #21059e

Abstract: Although drought stress has been identified among the production constraints of East African highland bananas (*Musa* spp., AAA-EA genome), no quantitative data were available to support this assumption. This study uses data from three on-station fertilizer trials (5-6 cycles) in Central and Southwest Uganda to quantify the effect of drought stress on banana production and explore possible interactions with nutrient availability. Production data were collected at individual plant basis from 1996 to 2002 in one trial and from 2004 to 2009 in two trials. Cumulative rainfall in the 12 months before harvest (CRF(12)) was computed per plant from daily rainfall measurements. Average bunch weight ranged from 8.0 to 21.9 kg between trials and cycles and was 8-28% less in dry (CRF(12) \leq 905 mm) than in normal (905 < CRF(12) \leq 1365 mm) rainfall periods. Linear relations were observed between CRF(12) and maximum bunch weight over the whole range of observed CRF(12) (500-1750 mm), whereby every 100 mm decline in rainfall caused maximum bunch weight losses of 1.5-3.1 kg or 8-10%. Optimum annual rainfall for East African highland bananas may thus be well above 1200-1300 mm yr⁻¹) as suggested earlier. Relative drought-induced yield losses were independent of soil fertility. Absolute losses on fertile/fertilized soils were similar to those recorded in well fertilized irrigation studies in Latin America. Our study suggests that drought-induced yield losses in areas of the East African highlands with annual rainfall < 1100 mm are perhaps as high as 20-65% compared to the wetter areas in this region. To improve productivity of smallholder banana farmers in Africa, more attention should be given to research geared towards improved water/drought stress management.

Htin A. S. 2015. Soil Types and Soil Characteristics in Myanmar, Ministry Of Agriculture And Irrigation, Department of Agriculture, Myanmar.

Reference ID: 21060

Notes: S 1.1 #21060 Language in Burmese

Moreira A., C. Castro, and N. K. Fageria. 2011. Effects of Boron Application on Yield, Foliar Boron Concentration, and Efficiency of Soil Boron Extracting Solutions in a Xanthic Ferralsol Cultivated with Banana in Central Amazon. *Communications in Soil Science and Plant Analysis*, 42:2169-2178.

Reference ID: 21061

Notes: #21061e

Abstract: Boron (B) is known to play important roles in the structures of cell walls and membranes and in the integrity and functions of membranes in plants. Under the conditions in the central Amazon region, there are few studies about this nutrient. In Brazilian soils, the hot-water B extraction method has been extensively used for evaluation of soil B status. However, difficulties with this method result in poor accuracy and precision of extraction of available B in soil. The objective of this study was to evaluate the yield, foliar concentration, and efficiency of B extracting solutions and the effect of B fertilization on B uptake in banana (*Musa* spp.) leaves and fruits, subgroup Cavendish (AAA), cultivated in a Xanthic Ferralsol (dystrophic Yellow Latosol) located in Amazonas State, Brazil. The experimental design was a completely randomized split plot, with four B rates (0, 4, 8, and 12 kg ha⁻¹), two harvest cycles (subtreatments), and four replicates. Available B was determined with seven extractant solutions: Mehlich 1, Mehlich 3, hot water, hydrochloric acid (HCl) 0.05 mol L⁻¹, HCl 0.1 mol L⁻¹, HCl 5.0 mol L⁻¹, and potassium chloride (KCl 1.0 mol L⁻¹). The application of B fertilizer increased the yield and B concentration in leaves and fruits. Hot water and KCl 1.0 mol L⁻¹ were the most efficient extracting solutions for the determination of available B in soil. The application of 3.4 kg B ha⁻¹) in the

first cycle and 1.3 kg B ha⁻¹) in the second cycle guarantees an adequate nutritional status in banana plants.

Cabrera J. C., I. R. Hergueta, and V. G. Sauco. 2010. Influence of Leaf Removal in Yield of Cv. Gruesa, *Musa Acuminata* Colla (Aaa), Cultivated under Greenhouse in the Canary Islands. *Revista Brasileira De Fruticultura*, 32:970-975.

Reference ID: 21062

Notes: #21062e

Abstract: The banana cultivar Gruesa, a local Dwarf Cavendish selection, is increasingly planted in the Canary Islands, both in greenhouse and in the open air. Both methods present some degree of leaf loss throughout the crop cycle: the leaves of greenhouse plants are traditionally cut back after flowering, and open air plantations experience frequent wind damage. A trial was set up four months prior to harvest to evaluate fruit filling rate and yield of Gruesa subjected to five levels of defoliation (0%, 25%, 50%, 75%, and 100% loss of leaf area). Two defoliation techniques were used to simulate damage: removal of the midrib, and slashing the leaf blade followed later by complete removal. Morphological, phenological and production data are presented.

Moreira A., C. de Castro, and N. K. Fageria. 2010. Efficiency of boron application in an Oxisol cultivated with banana in the Central Amazon. *Anais Da Academia Brasileira De Ciencias*, 82:1137-1145.

Reference ID: 21063

Notes: #21063e

Abstract: In the Amazon region, there is no information on the fertilization of banana plants with boron (B). Besides this, the extractant (hot water) currently used to test B concentrations has many limitations. The aim of this work was to study the effect of B on the fruit yield and quality of banana plants of the Cavendish (AAA) sub-group, grown in dystrophic Yellow Latosol (Oxisol or Xanthic Ferralsol), in the Amazonas State, Brazil. The experimental design was completely randomized split plot in a 4 x 2 factorial scheme, composed of four B rates (0, 4, 8 and 12 kg ha⁻¹) and two harvest cycles (sub-treatments), with four replicates. The B availability in the soil was determined by three extractants: Mehlich 3, hot water and KCl 1.0 mol L⁻¹. The application of B influences the fruit yield, pulp/peel ratio, pulp resistance and B content in the leaves and fruits. The KCl 1.0 mol L⁻¹ extractant was similar to the hot water in the evaluation of available B. To obtain maximum yield, it is necessary to apply 4.1 and 6.1 kg ha⁻¹) of B in the first and second cycles, respectively.

de Azevedo V. F., S. L. R. Donato, A. D. Arantes, V. M. Maia, and S. D. E. Silva. 2010. Evaluation of banana prata, tall type, in the semi-arid: Avaliação de bananeiras tipo prata, de porte alto, no semiárido. *Ciencia E Agrotecnologia*, 34:1372-1380.

Reference ID: 21064

Notes: #21064e

Abstract: This work aimed to evaluate, agronomically, in two production cycles, seven genotypes (treatments) of banana Prata, tall type, in the semi-arid. Pacovan (AAB) variety and hybrids 'Pacovan-Ken', PV42-53, 'Preciosa', 'Japira' and PV79-34 (AAAB) and the 'Garantida' (AAAB), from the 'Prata Sao Tome' hybrid were evaluated. The experimental design was completely randomized with 10 replicates in the planting spacing 3.0 x 2.5 meters. At the time of flowering and harvesting, vegetative phenotypic descriptors, cycle, yield, and severity assessment of yellow

Sigatoka were considered. The data were submitted to variance analysis and the average grouped by Scott-Knott criterion at 5% probability. Values increased between production cycles. There is variability in the characteristics between the genotypes belonging to the same genomic group and subgroup, including hybrids originated from the same genitor. The hybrids are more vigorous than the Pacovan variety. Garantida cultivar is the least productive. 'Pacovan' is the most susceptible (score six), the PV79-34 hybrid presents intermediate susceptibility (score three) and other hybrids are resistant to yellow Sigatoka (score one). The PV79-34 hybrid has characteristics favorable to its cultivation due the smallest height, greatest vigor, minor cycle and largest number of hands and fingers.

Wairegi L. W. I. and P. J. A. van Asten. 2010. The agronomic and economic benefits of fertilizer and mulch use in highland banana systems in Uganda. *Agricultural Systems*, 103:543-550.

Reference ID: 21065

Notes: #21065e

Abstract: Banana is the most important food crop in Uganda. However, there has been a decline in productivity, attributed to declining soil fertility, drought, pests and diseases and crop management factors. This study aimed to explore the possibility of increasing yields through the use of fertilizer and mulch, and to evaluate the benefits of these inputs across the major banana producing regions in Uganda. This study was carried out in 179 smallholder plots in Central, South, Southwest and East Uganda in 2006/7. Half of the plots were 'demonstration plots' of an agricultural development project, while the other half were neighboring farmer plots that acted as 'control'. Demonstration plots received mineral fertilizer (100% of plots), averaging 71 N, 8 P, 32 K kg ha⁻¹ yr⁻¹ and external mulch from grass and crop residues (64% of plots), whereas control plots received no mineral fertilizer and little external mulch (26% of plots). Demonstration plots had significantly ($P \leq 0.05$) higher yields than control plot in Central, South and Southwest, but average yield increases varied from 4.8 t ha⁻¹ yr⁻¹ (Southwest) to 8.0 (Central), and 10.0 (South). Average weevil corm damage (3%) and nematode-induced root necrosis (7%) was low and similar for both plot types, so yield increases could only be explained by the use of fertilizer and mulch. The highest demonstration plot yield increases were observed where fertilizer addressed key nutrient deficiencies identified using the compositional nutrient diagnosis approach. Farm gate bunch prices declined from 0.17 (Central Uganda) to 0.07 USD kg⁻¹ (Southwest Uganda). Consequently, average marginal rate of return (MRR) of fertilizer and mulch use ranged from 0.1 (Southwest) to 5.8 (Central). The technologies were likely to be acceptable to farmers (MRR ≥ 1.00) up to 160 km away from the capital. Fertilizer use is likely to be acceptable in all regions (MRR = 0.7-9.4) if local fertilizer prices of 2006/7 (average USD 0.56 kg⁻¹ of fertilizer) declined by 50%. Doubling of fertilizer prices is likely to make fertilizer use unacceptable beyond 100 km away from the capital. The study concludes that there is scope for increased input use in banana systems in Uganda, but that regional variations in crop response, input/output prices, and price fluctuations have to be taken into account.

Mattos L. A., E. P. Amorim, K. D. Cohen, T. B. de Amorim, and S. D. E. Silva. 2010. Agronomic, physical and chemical characterization of banana fruits. *Crop Breeding And Applied Biotechnology*, 10:225-231.

Reference ID: 21066

Notes: #21066e

Abstract: The purpose of this study was to characterize 26 banana accessions of the active genebank of Embrapa Cassava and Tropical Fruits (Brazil) for agronomic, physical and physicochemical characteristics. The plant height of the diploid 028003-01 and triploid Walha was short. Regarding the number of fruits and bunch weight, the triploids Caipira, Thap Maeo and the tetraploids Ambrosia and Calipso performed particularly well. Total carotenoid contents were highest in the diploids Ioran and Malbut. The total contents of flavonoid and polyphenol, two natural antioxidants, were highest in tetraploid Teparod. Wide genetic variability was detected for most agronomic, physical and chemical characteristics of the fruits of the banana accessions, enabling the planning of breeding for the development of hybrids with short stature, high yield, pest resistance and high carotenoid, flavonoid and/or polyphenol contents.

Donato S. L. R., A. A. Ledo, M. C. T. Pereira, E. F. Coelho, C. E. Cotrim, and A. M. Coelho. 2010. Nutritional status of Prata type bananas under different irrigation systems: Estado nutricional de bananeiras tipo Prata sob diferentes sistemas de irrigação. *Pesquisa Agropecuária Brasileira*, 45:980-988.

Reference ID: 21067

Notes: #21067e

Abstract: The objective of this work was to evaluate nutrient leaf contents and the productivity of 'Prata-Ana' banana submitted to different irrigation systems, during the first production cycle. The experimental design was in randomized blocks, with six treatments in 3x2 factorial arrangement: three irrigation systems (conventional sprinkler, microsprinkler and drip), and two genotypes (Prata-Ana and its hybrid PA42-44). Four replicates were used in a 3 0x2 5-m spacing. The evaluations were done at 90, 180 and 360 days after planting. The genotypes and the irrigation systems showed significant interaction for leaf contents of B and Cu, at 180 days after planting, and the genotypes differed from each other for leaf contents of N, P, K, Ca, Mg, Cu and Mn, independently of the irrigation system used. Nutrient leaf contents occurred in sufficient levels or above them. The lowest micronutrient leaf contents occur under drip irrigation. The genotypes have similar yield under the different irrigation systems.

Fehlauer T. J., B. M. Rodrigues-Otobo, M. Sandrini, and D. Destro. 2010. Characterization of the Production of Banana Genotypes in Bonito Region, State Of Mato Grosso Do Sul: Caracterização da produção de genótipos de banana introduzidos na região de Bonito – MS. *Revista Brasileira De Fruticultura*, 32:938-943.

Reference ID: 21068

Notes: #21068e

Abstract: This work aimed to evaluate the behavior of four banana genotypes: FHIA 1, FHIA 18 hybrids and Caipira and Prata-Ana cultivars during the first production cycle under the environmental conditions of Bonito - MS. The hybrids FHIA 1 and FHIA 18 presented the highest yield with 27 and 24.5 t/ha respectively. The hybrids were statistically higher when compared with the cultivars for the characters bunch mass, number of hand, rachis mass and total mass of fruits. The hybrids and the Caipira cultivar presented similar mean for total number of fruits, with FHIA 18 presenting the highest mean of 119.30. In relation to the production cycle, the FHIA 18 hybrid and the cultivars showed the same cycle from flowering to harvest (142 days). FHIA 18 hybrid and 'Prata-Ana' presented shorter cycle up to flowering while FHIA 1 hybrid was later, presenting a shorter period from flowering to harvest (120

days). From the results obtained in this evaluation, the hybrids FHIA 1 and FHIA 18 presented larger productivity. The FHIA 18 hybrid had the lower production cycle in Bonito-MS region.

de Melo A. S., P. D. Fernandes, L. F. Sobral, M. E. B. Brito, and J. D. M. Dantas. 2010. Growth, biomass yield and photosynthetic efficiency of banana, under fertirrigation with nitrogen and potassium: Crescimento, produção de biomassa e eficiência fotossintética da bananeira sob fertirrigação com nitrogênio e potássio. *Revista Ciencia Agronomica*, 41:417-426.

Reference ID: 21069

Notes: #21069e

Abstract: The objective of this study was to evaluate effects of nitrogen and potassium applied through water irrigation on physiological characteristics of banana cv Prata Ana in the coastal tablelands of Sergipe State. The experiment was carried out in the Sergipe Federal University Experiment Station, as 4x4 factorial, in randomized blocks with four replications. Doses of nitrogen as ureia were (0; 250; 500 e 750 kg ha⁻¹) and doses of potassium as potassium chloride were (0; 290; 580 e 870, in kg ha⁻¹) of K₂O). Vegetative growth, biomass partition and photosynthesis efficiency were determined. Plant aerial biomass of 8054.88 g plant⁻¹ was achieved with the application of 700 kg ha⁻¹ year⁻¹ of N and 1200 kg ha⁻¹ year⁻¹ of K₂O. Biomass distribution was: 16.515 to the leaves, 43.77% to the stem and 39.71% to fruit branches. Higher nitrogen and low potassium causes ontogeny, decreasing leaf area index and yield. Maximum solar irradiation conversion into biomass was observed at 732 kg ha⁻¹ of N e 1200 kg ha⁻¹ of K₂O.

Memon N. U. N., K. S. Memon, R. Anwar, S. Ahmad, and M. Nafees. 2010. Status and Response to Improved NPK Fertilization Practices in Banana. *Pakistan Journal Of Botany*, 42:2369-2381.

Reference ID: 21070

Notes: #21070e

Abstract: Banana is a heavy feeder crop and requires high quantity of nutrients which must be supplied through fertilization to obtain optimum yield on sustainable basis. This study was conducted in order to assess banana nutrition status and its response to improved fertilizer management, especially K fertilizer. The study was conducted to evaluate NPK status of banana through soil and plant analysis and obtain quantitative data on the use of manures and mineral fertilizers along with the yield levels achieved. Field experiment involved at two locations comparing banana response to improved practice of fertilization (IP, 544-227-494 kg N-P₂O₅-K₂O ha⁻¹ yr⁻¹) with that of the farmer's traditional practice (FP, avg. rate 381-227-93 kg N-P₂O₅-K₂O ha⁻¹ yr⁻¹). Plant and soil samples were secured during the month of March and additionally in June from grower's surveyed sites and fertilizer trials and analyzed for N, P and K. The average quantity of fertilizer nutrients used by banana growers were 437 kg N, 241.6 kg P₂O₅, and 15.4 kg K₂O ha⁻¹ with average manure application of 13 ton ha⁻¹ and average banana yield of 29.3 ton ha⁻¹. Analytical data showed that leaf contents of N, P and K ranged from 1.74% to 4.32% (average = 3.00%), 0.17 to 0.29% (average = 0.24%), and 1.99 to 3.56% (average = 3.15%) respectively. Regression analysis of the data showed that the relationship between leaf N (Y) and the N rate (X) could be described by the equation of the form $Y = 0.7446 + 0.005X$, $R^2 = 0.96$. In case of P, the relationship was $Y = 0.209 + 0.0001X$ with $R^2 = 0.32$. Fertilizer response experiment showed that IP was

significantly superior to FP in that it increased leaf K from 2.56% to 3.308% and banana yield from 51.2 to 60.8 ton ha⁻¹). However N and P contents were statistically similar under both FP and IP treatments.

Anderson D. L. and J. E. Bowen 1994. *Nutricion de la Cana de Azucar*, PPI, Norcross, GA.

Reference ID: 21071

Notes: S 8.3.1.1 #21071

Sanchez D. A. C., D. F. J. Jaramillo, and J. M. C. Torres. 2010. Components of the spatial variability in site-specific management in banana: Componentes de la variabilidad espacial en el manejo por sitio específico en banano. *Pesquisa Agropecuaria Brasileira*, 45:836-845.

Reference ID: 21072

Notes: #21072e

Abstract: The objective of this work was to evaluate the spatial variability of banana production, in function of physical and chemical variables of soil and of farm physiographic characteristics, in order to select those with the greatest potential for use in site-specific management program. One hundred thirty productive units of banana clone Williams (Cavendish AAA) distributed in four lots and tree soils units of the farm were georeferenced. The bunch weight and root functionality were determined for each plant, as well as 35 physical and chemical soil variables. The spatial variability of the production was evaluated in function of these soil variables, using four different strategies: axes as covariates; both physic and chemical soil properties as covariates; analysis made by individual plot; and analysis made by soil unit. The individual plot study was the best strategy to model the spatial variability of banana production. This analysis model allowed to set soil variable groups which were significantly correlated and precisely explained more than 69% of the bunch weight inside the plots. These groups of variables are the ones with higher potential for the establishment of a site-specific management program.

Gaidashova S. V., P. J. A. van Asten, B. Delvaux, and D. de Waele. 2010. The influence of the topographic position within highlands of Western Rwanda on the interactions between banana (*Musa* spp. AAA-EA), parasitic nematodes and soil factors. *Scientia Horticulturae*, 125:316-322.

Reference ID: 21073

Notes: #21073e

Abstract: Soil properties vary according to the topography. They affect water uptake and root exploration in the soil. Consequently, they may also influence the spread of plant-parasitic nematodes. This study reports on the effect of toposequence-related variations in soil on banana yields, foliar nutrient status, and nematode impact. Twenty banana plots were visited within 6 hills/valleys at each of the three toposequence positions: valley bottom, mid-slope and crest. Important variability in plant growth, nutrition and soil properties was observed within the toposequence. Significantly better plant growth (height and girth) was observed in the valley bottoms, where banana bunch weight was 1.7-3.4 kg higher (although not significant) than at upper toposequence positions. Best plant growth was observed in valley bottoms in contrast to the highest N and K foliar deficiencies in this position. Plants in the valley bottoms had higher foliar Ca and Mg, and K compared to those in the crest. Plants in the mid-slope had greater percentage of dead roots (19.1%), compared to the plants in the valley bottoms (12.3%) and the crest (14.2%). Soils in

the valley bottoms were deeper, sandier, with lower organic matter, lower N. and K compared to the soils at higher toposequence. Nematodes likely play a key role in banana root damage, however, their effect appear to be in relation to various soil factors at each position. The abundance of *Pratylenchus goodeyi* had generally limited impact on banana yields in fields having less than 5% slope (crest and valley bottom) where soil conditions were more optimal for root growth. However, in the presence of increased run-off on steeper middle slopes, root death was increased even under moderate pressure from *P. goodeyi*.

Potash and Phosphate Institute (PPI), Potash and Phosphate Institute of Canada (PPIC), and Foundation for Agronomic Research (FAR) 2004. Understanding Potassium in our World, PPI, PPIC, FAR, Georgia.

Reference ID: 21074

Notes: S Education #21074

Potash and Phosphate Institute (PPI), Potash and Phosphate Institute of Canada (PPIC), and Foundation for Agronomic Research (FAR) 2004. Understanding Nitrogen In Our World, PPI, PPIC, FAR, US and Canada.

Reference ID: 21075

Notes: S Education #21075

Potash and Phosphate Institute (PPI), Potash and Phosphate Institute of Canada (PPIC), and Foundation for Agronomic Research (FAR) 2004. Fun With The Plant Nutrient Team, PPI, PPIC, FAR, US, Canada.

Reference ID: 21076

Notes: S Education #21076

Fairhurst T. H. 1997. Nutrient Deficiency Symptoms and Disorders in Oil Palm (*Elaeis guineensis* Jacq.), Potash and Phosphate Institute, Singapore.

Reference ID: 21077

Notes: S 8.1.1.1 #21077

PPI/PPIC. Planters' Diary 2002. 2002. Singapore.

Reference ID: 21078

Notes: S 36 #21078

Fairhurst T. 1998. Guia De Bolsillo: Sintomas de Deficiencias de Nutrientes y Desordenes en Palma Aceitera (*Elaeis guineensis* Jacq.): Symptoms of nutrient deficiencies and disorders in oil palm, PPI, PPIC, Singapore/Ecuador.

Reference ID: 21079

Notes: S 8.1.1.4 #21079 in Spanish

PPI/PPIC. Planters' Diary 2003. 2003. Singapore.

Reference ID: 21080

Notes: S 36 #21080

PPI/PPIC. Planters' Diary 2004. 2004. Singapore.

Reference ID: 21081

Notes: S 36 #21081

PPI/PPIC. Planters' Diary 2005. 2005. Singapore.

Reference ID: 21082

Notes: S 36 #21082

PPI/PPIC and IPI. PRPOL Diary 2005. 2005. Singapore.

Reference ID: 21083

Notes: S 36 #21083

Tham, S. CTP Diary June 2006-May 2007. 2006. Singapore.

Reference ID: 21084

Notes: S 36 #21084

Maibaum, W. and Krauss, A. Potash Review 1993-1995. Potash Review [1-12]. 1995. Basel, Switzerland.

Reference ID: 21085

Notes: S 21 #21085

Anon. Potash Review 1987-1992. Potash Review [1-12]. 1992. Base, Switzerland.

Reference ID: 21086

Notes: S 21 #21086

Anon. Potash Review 1979-1986 Vol 1. Potash Review 1[1-10]. 1986. Basel, Switzerland.

Reference ID: 21087

Notes: S 21 #21087

Anon. Potash Review 1979-1986 Vol 2. Potash Review 2[11-30]. 1986. Basel, Switzerland.

Reference ID: 21088

Notes: S 21 #21088

Nyombi K., P. J. A. van Asten, M. Corbeels, G. Taulya, P. A. Leffelaar, and K. E. Giller. 2010. Mineral Fertilizer Response and Nutrient Use Efficiencies of East African Highland Banana (Musa spp., AAA-EAHB, cv Kisansa). Field Crops Research, 117:38-50.

Reference ID: 21089

Notes: #21089e

Abstract: Poor yields of East African highland bananas (Musa spp., AAA-EAHB) on smallholder farms have often been attributed to problems of poor soil fertility. We measured the effects of mineral fertilizers on crop performance at two sites over two to three crop cycles: Kawanda in central Uganda and Ntungamo in southwest Uganda. Fertilizers were applied at rates of 0N-50P-600K, 150N-50P-600K, 400N-0P-600K, 400N-50P-0K, 400N-50P-250K and 400N-50P-600K kg ha⁻¹ yr⁻¹. In addition 60Mg-6Zn-0.5Mo-1B kg ha⁻¹ yr⁻¹ was applied to all treatments, with the exception of the control plots which received no fertilizer. Fresh bunch mass and yield increased with successive cycles. Yield increases above the control ranged from 3.1 to 6.2 kg bunch⁻¹ (average bunch weight for all treatments 11.5 kg bunch⁻¹) and 2.2-11.2 Mg ha⁻¹ yr⁻¹ (average yield for all treatments 15.8 Mg ha⁻¹ yr⁻¹) at Kawanda, compared with 12.4-16.0 kg bunch⁻¹ (average bunch weight for all treatments 14.7 kg bunch⁻¹) and 7.0-29.5 Mg ha⁻¹ yr⁻¹ (average

yield for all treatments 17.9 Mg ha⁻¹ yr⁻¹) at Ntungamo. The limiting nutrients at both sites were in the order K > P > N. Potassium, N and P foliar nutrient mass fractions were below previously established Diagnosis and Recommendation Integrated System (DRIS) norms, with the smallest K mass fractions observed in the best yielding plots at Ntungamo. Total nutrient uptakes (K > N > P) were higher at Ntungamo as compared with Kawanda, probably due to better soil moisture availability and root exploration of the soil. Average N, P and K conversion efficiencies for two crop cycles at both sites amounted to 49.2 kg finger DM kg⁻¹ N, 587 kg finger DM kg⁻¹ P and 10.8 kg finger DM kg⁻¹ K. Calibration results of the model QUEFTS using data from Ntungamo were reasonable (R(2) = 0.57, RMSE = 648 kg ha⁻¹). Using the measured soil chemical properties and yield data from an experiment at Mbarara in southwest Uganda, the calibrated QUEFTS model predicted yields well (R(2) = 0.68, RMSE = 562 kg ha⁻¹). We conclude that banana yields can be increased by use of mineral fertilizers, but fertilizer recovery efficiencies need to improve substantially before promoting wide-scale adoption.

Mia M. A. B., Z. H. Shamsuddin, and M. Mahmood. 2010. Use of Plant Growth Promoting Bacteria in Banana: A New Insight for Sustainable Banana Production. *International Journal of Agricultural And Biology*, 12: 459-467.

Reference ID: 21090

Notes: #21090e

Abstract: Banana, an important fruit crop, requires high amounts of chemical fertilizers for commercial cultivation, which is costly and can be hazardous to the environment, when used excessively. Plant growth promoting rhizobacteria (PGPR) could be used for growth promotion, nutrient uptake and some time as an alternative source of N-fertilizer of non-leguminous crops. Recently, research on PGPR for crop improvements are gaining prominence and thousands of research works have been published so far. However, use of this noble technique in banana production system is limited. Nevertheless, reports from various experimental findings suggested that PGPR strains could successfully formed colonies on the root surface of bananas, where more bacterial cells were found in the root hair proliferation zone. Application of PGPR alone could not produce significant benefits that require minimal or reduced levels of fertilizer-N consequently could produce a synergistic effect on root growth and development. The inoculation also increased the N yield and fixed N(2) in association with banana roots subsequently increased the yield, improved the physical attributes of fruit quality and initiated early flowering. The summarized review suggested that PGPR are effective as a bioenhancer and biofertilizer for banana cultivation. For consistent and precise results extensive field experiments of bananas inoculated with PGPR strains should be continued.

Dorel M., S. Lakhia, C. Petetin, S. Bouamer, and J. M. Risede. 2010. No-till banana planting on crop residue mulch: effect on soil quality and crop functioning. *Fruits*, 65:55-68.

Reference ID: 21091

Notes: #21091e

Abstract: Introduction. In the French West Indies, farmers generally consider that periodical soil tillage is necessary to increase soil porosity and maintain high yield. However, in the non-tilled perennial banana plantations of the highlands, the soil exhibits better physical and biological properties than in the conventional banana plantations. To determine if tillage before banana planting is necessary for proper banana crop functioning and to assess the effect of tillage on soil quality, banana

planting after conventional tillage was compared with no-till banana planting on crop residue mulch on an experimental plot. Materials and methods. Soil quality was assessed through indicators such as porosity, organic status, microbial biomass and structure of nematode communities. Crop functioning was assessed through plant growth, root distribution, and soil water and nitrogen availability. Results. We found that tillage reduced soil microbial biomass and the number of nematode functional guilds. Tillage had only a short-term effect on soil porosity and did not allow deeper extension of the root system. Although soil organic nitrogen mineralization was higher with conventional tillage, banana nitrogen nutrition was not better, probably because the high nitrogen fertilization offset the variations in availability of nitrogen from organic origin. We found that banana growth was better with no-till treatment. This could be explained by less drying out of soil due to the crop residue mulch left on the soil surface with no-till treatment. Conclusion. Relative to conventional tillage, no-till banana planting improved soil quality and crop performance.

Alves M. S., E. F. Coelho, V. P. S. Paz, and T. M. Andrade Neto. 2010. Growth and yield of banana crop under different combinations of calcium nitrate and urea: Crescimento e produtividade da bananeira cv. Grande Naine sob diferentes combinações de nitrato de cálcio e ureia. *Revista Ceres*, 57:125-131.

Reference ID: 21092

Notes: #21092e

Abstract: The use of nitrogen sources through fertigation requires improved techniques so that farmers may obtain maximum economic benefit combined with lower soil impact. The objective of this work was to evaluate different combinations of two nitrogen sources applied by fertigation on the growth and yield of banana cv. Grand Naine during the first, second and third production cycles. The experiment was arranged in a randomized block design with five replications, where six complementary percentages of urea and nitrate were applied by irrigation water in a drip irrigation system. Plant height, pseudostem diameter, total leaf area, productivity, fruit length and diameter of the second bunch were evaluated. Results showed that the combination of different nitrogen sources applied by fertigation did not affect the growth and yield of cv. Grand Naine.

Perin A., J. G. M. Guerra, J. A. A. Espindola, M. G. Teixeira, and R. N. B. Busquet. 2009. Banana plant performance intercropping with perennial herbaceous legumes: Desempenho de bananeiras consorciadas com leguminosas herbáceas perenes. *Ciencia E Agrotecnologia*, 33:1511-1517.

Reference ID: 21093

Notes: #21093e

Abstract: The use of coverage plants in cover cropping with bananas can be a management strategy, increasing in productivity associated with the optimization of biological processes and greater stability of production system. The objective of this work was to evaluate the effect of live coverage by herbaceous perennial legume on the yield of banana cultivar Nanicao. The treatments were: forage groundnut (*Arachis pintoi* Krap. & Greg), tropical cudzu (*Pueraria phaseoloides* Benth.), siratro (*Macroptilium atropurpureum* Urb.), spontaneous vegetation (mainly *Panicum maximum* Jacq.) and spontaneous vegetation + N-fertilizer. Banana plant vegetative development and yield attributes between April/1999 and August/2000 were assessed. In comparison to other treatments, bunch and hand weight were more positively influenced by tropical cudzu and siratro legumes employed as live coverage. All legumes promoted higher vegetative growth for banana plants (notably

from the 6th month on), a greater number of leaves, and a higher proportion of harvested bunches in relation to spontaneous vegetation (with and without N-fertilizer). Siratro and tropical cudzu legumes promoted adequate conditions for the development of the banana plants, generating yield gains, and the elimination of the need of nitrogenous fertilization in the banana plantation. The beneficial potential of tropical cudzu and siratro legumes as live coverage intercropping with banana plants qualify these species as promising alternatives for soil fertility and banana nutrition.

Ramos D. P. and S. Leonel. 2009. Growth, Yield And Quality Of 'Figo Cinza' Banana Fruits In Botucatu-Sp: Crescimento, produção e qualidade de frutos da bananeira 'Figo cinza', em Botucatu-SP. *Revista Brasileira De Fruticultura*, 31:749-754.

Reference ID: 21094

Notes: #21094e

Abstract: 'Figo Cinza' is a cultivar of the genomic group ABB, Figo subgroup, which provides tolerance to Panama and Sigatoka diseases that may be useful in genetic breeding programs. Then, this work aimed to evaluate the plants growth, production and also the physical and chemical characteristics of the fruits from this cultivar in Botucatu city, Sao Paulo state, Brazil. Some growth characteristics were evaluated such as: plant height, the pseudostem circumference, number of leaves, number of days between planting and flowering, number of days between flowering and harvest and number of days from planting to harvest. These characteristics were measured at the flowering time. The production characteristics such as the bunch weight, number of fruits, average weight of the fruits, number of bunches and weight; in the second bunch it was evaluated the weight, the number, the length and the diameter of the fruits. The analyzed physical and chemical characteristics were: firmness, pH, titratable acidity, soluble solids, total Sugars, starch and potassium. The used method was descriptive statistics for the characterization of cultivar by the average calculations. The results showed that 'Figo Cinza' presented a high height (2.9 m), a cycle of 420 days, yield of 12.74 t ha⁻¹) and the lowest acidity of the fruits (0.06%).

Blazy J. M., M. Dorel, F. Salmon, H. Ozier-Lafontaine, J. Wery, and P. Tixier. 2009. Model-based assessment of technological innovation in banana cropping systems contextualized by farm types in Guadeloupe. *European Journal of Agronomy*, 31:10-19.

Reference ID: 21095

Notes: #21095e

Abstract: Farmers are inundated with advertisements about many innovations that are supposed to increase their yields or reduce environmental impact. However, the benefit of these innovations depends on the farming context. Here we present the ad hoc adaptation of the crop model SIMBA and a method to evaluate 16 innovations in six types of farms previously selected through a typology of the banana farming systems in Guadeloupe. The innovations include regulation of pesticide use, rotations and fallows, intercropping, conditional application of pesticides, resistant cultivars, and integrated systems. Our results show that, for a given innovation, the yield and pesticide reduction vary widely with different farm types. We show that environmentally friendly innovations often cause a greater decrease in yield in more productive farm types. Nevertheless, despite an apparent trade-off between yield and pesticide use, some innovations address both production and environmental issues, e.g., rotation with fallows improved with cover crops, regular fallows, and rotations with pineapples for the most intensive farm types. Our modelling study confirms the importance of innovation-farm type interactions and the usefulness of

models for assessing large numbers of technological innovations among a wide range of biophysical and technical contexts.

Dos Santos V. P., P. D. Fernandes, A. S. de Melo, L. F. Sobral, M. E. B. Brito, J. D. D. Dantas, and L. V. Bonfim. 2009. Fertigation of Banana Cv Pratana with N and K in an Ultisol: Fertirrigacao da bananeira cv. prata-ana com n e k em um argissolo vermelho-amarelo. *Revista Brasileira De Fruticultura*, 31:567-573.

Reference ID: 21096

Notes: #21096e

Abstract: The Brazilian Northeast is the main producing area, being responsible for about 35,80% of banana's national production. In spite of the favorable conditions to its cultivation, the average national yield has been a lot below its potential, due mainly to water and nutrients supply. Among all nutrients, nitrogen (N) and potassium (K) are the ones required in larger amounts by the banana. With the objective of studying the effect of four rates of N (0, 117, 235 and 352 kg ha⁻¹) of N), and Of four rates K (0 157, 3 13 and 470 ka ha⁻¹) of K(2)O) applied by fertirrigation in the 2 degrees cycle of cultivation of the cv. Prata Ana, data was collected in an factorial experiment in randomized blocks, in an Ultisol of the coastal tableland, of the northeast of Brazil. There was not response to N but a linear one was observed for K. Soil K by Mehlich-1 critical level at 0,20- 0,40 m was 0,71 mmol(c) kg⁻¹).

dela Cruz F. S., L. S. Gueco, V. C. Huelgas, O. P. Damasco, I. G. Banasihan, V. G. O. Sinohin, and A. B. Molina. 2009. Agronomic and Yield Performance of Introduced and Popular Banana Cultivars (*Musa* spp.) in the Philippines. *Philippine Journal of Crop Science*, 34:88-98.

Reference ID: 21097

Notes: #21097e

Abstract: An experiment was conducted to determine the performance of introduced banana cultivars from October 2002 to December 2004 at the Institute of Plant Breeding (IPB) Experimental Farm in Bay, Laguna, Philippines. Nineteen introduced hybrids and landraces were planted together with eight local cultivars to determine their agronomic and yield performance. Significant differences were observed among cultivars in pseudostem, flowering, harvesting and yield characteristics. Among the introduced cultivars, FHIA-17 (AAAA), FHIA-23 (AAAA) and SH 3436 -9 (AAAA) had heavy bunches (20-22 kg per bunch in the mother crop) and heavy individual fingers, but with lower total soluble solids compared with the local cultivars. The potential of these cultivars for processing and for planting in areas with high biotic stress pressures need further assessment.

Ribeiro R. C. F., C. C. Costa, A. A. Xavier, F. P. de Figueiredo, F. G. Oliveira, V. P. Campos, C. R. Dias-Areira, and E. H. Mizobutsi. 2009. Effect Of Different Levels Of Irrigation On Population Of *Meloidogyne Javanica* And Banana Productivity In North Of Minas Gerais: Efeito de diferentes lâminas de irrigação sobre a população de *meloidogyne javanica* e a produtividade de bananeira no norte de minas gerais. *Revista Brasileira De Fruticultura*, 31:90-95.

Reference ID: 21098

Notes: #21098e

Abstract: The present work aimed to assess in the field the effect of irrigation different levels (100%, 125%, 150% and 175%) determined by evapotranspiration

from the tank class A (ETtca), on the population of *Meloidogyne javanica* in the soil, banana productivity and number of days needs for flowering and yield of Prata-Ana cultivar of banana on the North of Minas Gerais state, Brazil. The number of second stage juveniles of *M. javanica* increased reaching the maximum J2 level at 118% of ETtca. The irrigation levels, 125, 150 and 175% ETtca increased the banana productivity in kg/ha(-1) significantly as compared to 100% level. However, no effect was observed on the number of days for flowering and for harvesting of Prata-Ana banana.

Moreira A., J. C. R. Pereira, and A. R. Freitas. 2009. Nitrogen and potassium on yield and quality of banana cultivar Thap Maeo: Nitrogênio e potássio na produtividade e qualidade da bananeira cultivar Thap Maeo. *Bragantia*, 68:483-491.

Reference ID: 21099

Notes: #21099e

Abstract: The experiment was carried out in a Xanthic Ferralsol (dystrophic Yellow Latosol) of Central Amazon with the objective to verify the effect of nitrogen and potassium rates on yield and quality of banana cultivar Thap Maeo (triploid - AAB). The experimental design was factorial randomized blocks (3x4), with the following treatments: three N rates (0, 267 and 534 kg per ha cycle - source: urea) and four K₂O rates (200, 800, 1600 and 2400 kg per ha cycle - source: potassium chloride), with three replicates and two cycles of harvest. The results showed that N and K rates did not affect the diameter of fruits, acidity and total soluble solids. After the first cycle, regardless of N rates, the application of K₂O rates reduced the resistance of pulp. Banana yield reduced with increased N rates. In the second cycle, K₂O rates showed significant interaction with N, and the largest yield was obtained with application of 1600 kg ha⁻¹ of K₂O

Moreira A. and N. K. Fageria. 2009. Yield, Uptake, and Retranslocation of Nutrients in Banana Plants Cultivated in Upland Soil of Central Amazonian. *Journal of Plant Nutrition*, 32:443-457.

Reference ID: 21100

Notes: #21100e

Abstract: Banana cultivation is considered one of the most important agricultural activities of economic and social importance in Brazil. The objective of this work was to investigate the uptake, retranslocation and the effect of fertilization on the yield and uniformity of banana bunches (*Musa* spp.) cultivated in Central Amazonian, region with approximately 1.5 million km² or 150 million hectares. Two experiments were conducted in a Xanthic Ferralsol (dystrophic Yellow Latosol), the predominant soil of the region, examining: i) the nutrient uptake and translocation rate in twelve plants; and ii) the efficiency of zinc use, in a completely randomized blocks in a 42 factorial scheme in split plot design with four zinc sulfate (ZnSO₄) rates (0, 30, 60, and 120 g plant⁻¹ cycle⁻¹) and two application times (in the hole together with the seedling or as surface broadcast in the fifth month after planting), with four replicates. Uptake of macronutrients was in the order of potassium (K) nitrogen (N) calcium (Ca) magnesium (Mg) phosphorus (P) and micronutrients in the order of manganese (Mn) iron (Fe) boron (B) zinc (Zn) copper (Cu). The N, P, K, Mg, and Cu have a high retranslocation rate compared to other nutrients investigated. The bunch yield increased significantly in a quadratic fashion with increasing Zn rate and hole application method of zinc was more efficient compared to broadcast application. At high concentration, Zn presents a low mobility in the phloem from the leaves to the fruits. The critical leaf concentration of zinc at the start of inflorescence was 12.9 mg

kg-1.

Gaidashova S. V., P. van Asten, D. de Waele, and B. Delvaux. 2015. Relationship between soil properties, crop management, plant growth and vigour, nematode occurrence and root damage in East African Highland banana-cropping systems: a case study in Rwanda. *Nematology*, 11:883-894.

Reference ID: 21101

Notes: #21101e

Abstract: Parasitic nematodes are widespread in Musa cropping systems in African lowlands where they are known to limit crop production. However, their distribution is very poorly known in the large parts of the East African Highland banana ecology. We carried out a survey in 188 fields in Rwanda to assess and understand nematode occurrence and damage under a wide range of agro-ecological conditions. Altitude varied from 900 to 1800 m above sea level and soil types were distinctly different in the five eco-regions sampled and derived from diverse parent materials; i.e., Ruhengeri (Andosol), Gitarama-Butare (Acrisol), Kibungo (Nitisol), Gashonga (Ferralsol) and Bugarama (Fluvisol and Vertisol). Crop management practices, root health parameters and nematode infection in roots were recorded for a single East African highland banana cultivar (Intuntu, AAA-EA). Plant-parasitic nematodes from five genera were identified: *Pratylenchus goodeyi*, *Helicotylenchus multicinctus*, *Meloidogyne* spp., *Radopholus similis* and *Hoplolaimus pararobustus*. *Pratylenchus goodeyi* was the dominant species in all eco-regions except in Bugarama (lowland). Only the presence of *P. goodeyi* significantly correlated with root necroses. Altitude was strongly correlated with root densities of *P. goodeyi* and *R. similis*. A possible negative impact by *P. goodeyi* on banana yields was masked by the fact that nematode populations were positively correlated with high plant density and/or mulching practices, which led to relatively high plant vigour irrespective of soil type. Therefore, controlled field experiments will be needed to assess whether root necrosis caused by *P. goodeyi* at high altitude (>1400 m) actually has a detrimental impact on banana yields, similar to that observed for root-lesion nematodes at lower altitudes.

Gervacio D. D., N. M. Dawi, E. G. Fabregar, A. B. Molina, and I. Van der Bergh. 2008. Agronomic Performance of Selected Local and Introduced Banana Cultivars (*Musa* spp.) under Commercial Management Practices in Davao, Philippines. *Philippine Journal of Crop Science*, 33:71-81.

Reference ID: 21102

Notes: #21102e

Abstract: Twenty-three introduced and four locally grown banana cultivars were evaluated in the field for their agronomic performance (measured in terms of yield and yield components, plant height and girth, and crop cycle) under, commercial growing management practices in Davao, Philippines from April 2002 to April 2004. Several introduced varieties performed very well under the local conditions in terms of bunch weight. Almost all of them reached harvest in less than 1 year FHIA-17, a dessert variety, produced the heaviest bunch in the trial (46.1 kg). Grand Naine, another dessert variety, combined a very short crop cycle with a bunch weight of 31.9 kg. FHIA-21, the only plantain in the trial, produced an intermediate-weight bunch of 29.1 kg. Among the cooking bananas, FHIA-25 had the highest bunch weight of 44.1 kg. With bunch weights ranging 18-32 kg, the local cultivars had a relatively lower production than most of the introduced varieties, but still performed well above their average reported yield under normal Philippine growing conditions.

Tall Williams exhibited a short crop cycle and produced a bunch of 30.5 kg. The local varieties Lakatan and Latundan had bunch weights of 17.7 and 21.3 kg, respectively. The local cooking banana Cardaba took more than 1 year to harvest, but produced a relatively heavy bunch of 32 kg.

Fernandes L. A., S. J. Ramos, S. V. Valaderas, P. S. N. Lopes, and V. Faquin. 2008. Soil fertility, plant mineral nutrition and productivity of irrigated banana for a ten-year period. *Pesquisa Agropecuaria Brasileira*, 43:1575-1581.

Reference ID: 21103

Notes: #21103e

Abstract: The objective of this study was to evaluate changes in soil fertility, in plant mineral nutrition and in the productivity of banana irrigated for a ten-year period. The experiment was carried out in an Oxisol, from 1997 to 2007, in the county of Janauba, Minas Gerais, Brazil, in a commercial banana 'Prata-Ana' (AAB) plantation, where water from a tubular deep-well - containing high salinity and medium concentration of sodium - was used for drip irrigation. The use of irrigation for ten years promotes a sharp rise in pH and in soil electrical conductivity, and causes nutrient imbalances, which limits the productivity of banana. The foliar levels of macro and micronutrients remain above the reference values for the culture.

Tixier P., E. Malezieux, M. Dorel, and J. Wery. 2008. SIMBA, a model for designing sustainable banana-based cropping systems. *Agricultural Systems*, 97:139-150.

Reference ID: 21104

Notes: #21104e

Abstract: Banana monocultures (*Musa* spp., AAA, Cavendish sub-group cv. Grande Naine) can have a detrimental impact on the environment. In these agro-systems, pesticide treatments can lead to surface and groundwater pollution, as is the case in the tropical insular conditions of the French West Indies. Using models to design alternative cropping systems is of growing interest but most of the research work has been concentrated on annual crops and most often in temperate climate. A specific model called SIMBA was built to assess environmental risks under a large range of cropping techniques and to help design more sustainable cropping systems. SIMBA simulates banana-cropping systems at field level over several cropping cycles. It includes sub-models that simulate soil structure, water balance, root nematode populations, yield, and economic outputs with a sound balance between representing the major phenomena well and keeping the model simple to reduce the parameterization costs in a large range of conditions. Agro-environmental indicators generated by the model make it possible to assess the major potential environmental impacts. The model has been developed and calibrated in Guadeloupe and Martinique and is used to draw up practical recommendations for farmers and for virtual experiments of agro-technological innovations or field management strategies. The structure of SIMBA is presented and a methodology is proposed for designing sustainable banana-based cropping systems using the model. SIMBA has been evaluated in a broad range of cropping systems in Guadeloupe by comparing model estimates to data collected in field experiments and surveys. Simulations lead to trends in rotation-based cropping systems characterized by systems that can be considered as intensive for profit evaluation, and combinations of frequent replanting, low nematicide application, no ploughing, and low fertilization level, for environmental evaluation. Simulations performed to optimize the replanting decision rule showed that relatively frequent replanting is good for profit while low frequency

replantations (over four banana cycles) give a better environmental evaluation.

Angeles D. E. 2007. Establishment of sampling techniques and standard sap NO₃-N in banana using the rapid nitrate test. *Philippine Journal of Crop Science*, 32:69-79.

Reference ID: 21105

Notes: #21105e

Abstract: Rapid nitrate test using the Merckoquant test strip was applied to diagnose the nitrogen requirements of 'Lakatan' banana. The study was conducted to establish the sampling procedures, determine the standard sap NO₃-N level and determine its sensitivity to predict the plant's nitrogen needs. Sap NO₃-N did not vary significantly along the petiole and midrib and therefore, any of their sections can be used as index tissue for sap analysis. Any section of the petiole and midrib can be used as index tissue for sap analysis. Bihourly changes of sap NO₃-N level were noted but the highest level was obtained at 9:30 AM. The standard sap NO₃-N level of 390 ppm was established from a survey of bananas grown in Laguna, Batangas, Tagaytay City and Davao City. Validation trials to determine whether or not the standard sap NO₃-N level can accurately predict yield showed negative results.

Jimenez M., L. Van der Veken, H. Neiryneck, H. Rodriguez, O. Ruiz, and R. Swennen. 2007. Organic banana production in Ecuador: Its implications on black Sigatoka development and plant-soil nutritional status. *Renewable Agriculture and Food Systems*, 22:297-306.

Reference ID: 21106

Notes: #21106e

Abstract: Black Sigatoka, caused by the leaf fungus *Mycosphaerella fijiensis* Morelet, is a major constraint to banana production around the world. In Ecuador, the biggest banana-exporting country in the world, this disease has become increasingly aggressive. This has resulted in more fungicide applications, which have significantly increased costs in production and for the environment. Consequently, many banana growers have shifted to organic production, which produces greater economic returns as a result of higher sale prices. In addition, production costs are lower as no fungicides are applied. These organic bananas receive substantial amounts of organic products. This study describes the black Sigatoka disease and nutrient status in an organic banana plantation and compares it with a conventionally fertilized and fungicide-treated plantation. Black Sigatoka symptoms were evaluated in the vegetative and flowering stages under both production conditions and in vitro conditions. Univariate and multivariate descriptive statistics were used to analyze the parameters. Disease symptoms were more severe in leaves from the organic field than in leaves from the inorganic field, but the nutrient status (soil and foliar) did not differ between the two farms. Banana plants from the organic farm had 12 functional leaves at flowering and eight functional leaves at harvest. Average banana yields were over 40% lower for organic versus inorganic management; however, the average price received for organic bananas was over two times higher. Profit-cost analysis has shown that the organic banana farm was substantially more profitable than the inorganic one during the time period analyzed. These results indicated that bananas can be grown commercially without fungicides, and the lower productivity levels are compensated by the higher prices of organic fruits in international markets. In addition, organic production has beneficial impacts on social and environmental issues.

Silva E. D., M. M. D. Farnezi, P. J. de Pinho, M. G. V. Rodrigues, and J. G. de Carvalho. 2007. Application of zinc doses via soil to irrigated banana "Prata Ana"(AAB) in northern Minas Gerais, Brazil: Aplicação de doses de zinco, via solo, na bananeira "Prata Anã" (AAB) irrigada, no norte de Minas Gerais. *Revista Brasileira De Ciencia Do Solo*, 31:1497-1502.

Reference ID: 21107

Notes: #21107e

Abstract: A field experiment was conducted in Nova Porteirinha, MG, Brazil, in a dystrophic Red Yellow Latossol, to detect the response of the banana tree 'Prata Ana' to Zn doses through soil and critical Zn levels in soil and leaves. Four Zn doses were applied, corresponding to 0, 10, 20 and 40 kg ha⁻¹ year⁻¹, using zinc sulfate as source. The treatments were arranged in a randomized block design, with three repetitions per block, totaling 36 experimental plots. The following traits were evaluated: fruit yield, soil Zn content (Mehlich-1 and DTPA pH 7.3) and leaf Zn, in two cropping years. The fruit yield increased with Zn doses in the soil, reaching an average yield of 22.2 t ha⁻¹ with application of 4.1 kg Zn ha⁻¹ year⁻¹ in two crops. The mean critical level of soil Zn by the extractors Mehlich-1 and DTPA, was 14.5 and 5.2 mg dm⁻³ respectively and 15.8 mg kg⁻¹ for leaf Zn, in the edaphoclimatic conditions of northern Minas Gerais.

Moreira A., R. Heinrichs, and J. C. R. Pereira. 2007. Plants density on yield and nutrients concentration in leaves and fruits of banana cv. Thap Maeo: Densidade de plantio na produtividade e nos teores de nutrientes nas folhas e frutos da bananeira cv. Thap Maeo. *Revista Brasileira De Fruticultura*, 29:626-631.

Reference ID: 21108

Notes: #21108e

Abstract: This study aimed to evaluate the effect of plants density on yield, period of harvest and nutrients concentration in leaves and fruits of banana cv. Thap Maeo (AAB), cultivated in Manaus, State of Amazonas, Brazil. The experiment was conducted in a randomized blocks, with three replicates. Treatments were comprised of planting density (1, 111; 1,667 and 3,333 plants ha⁻¹), and two cycles of harvest (sub treatments). The results obtained from 1(st) cycle and 2(nd) cycle showed significant increase in the yield per unit area as the employed plant density increased. The shortest average period to harvest banana bunches (1(st) cycle, 338 days and 2(nd) cycle, 401 days) was observed for the lower density (1, 111 plants ha⁻¹). Pooled data of density and cycles showed that exportation of macronutrients through the fruits was, in order: K>N>P>Mg>Ca=S, while in micronutrients was: 1(st) cycle - Cl>Fe>Mn=B>Zn>Cu, and 2(nd) cycle - Cl>Fe>Zn>B=Mn>Cu.

Heslop-Harrison J. S. and T. Schwarzacher. 2007. Domestication, genomics and the future for banana. *Annals of Botany*, 100:1073-1084.

Reference ID: 21109

Notes: #21109e

Abstract: Background Cultivated bananas and plantains are giant herbaceous plants within the genus *Musa*. They are both sterile and parthenocarpic so the fruit develops without seed. The cultivated hybrids and species are mostly triploid (2n = 3x = 33; a few are diploid or tetraploid), and most have been propagated from mutants found in the wild. With a production of 100 million tons annually, banana is a staple food across the Asian, African and American tropics, with the 15% that is exported being important to many economies.

Scope There are well over a thousand domesticated *Musa* cultivars and their genetic diversity is high, indicating multiple origins from different wild hybrids between two principle ancestral species. However, the difficulty of genetics and sterility of the crop has meant that the development of new varieties through hybridization, mutation or transformation was not very successful in the 20th century. Knowledge of structural and functional genomics and genes, reproductive physiology, cytogenetics, and comparative genomics with rice, *Arabidopsis* and other model species has increased our understanding of *Musa* and its diversity enormously.

Conclusions There are major challenges to banana production from virulent diseases, abiotic stresses and new demands for sustainability, quality, transport and yield. Within the genepool of cultivars and wild species there are genetic resistances to many stresses. Genomic approaches are now rapidly advancing in *Musa* and have the prospect of helping enable banana to maintain and increase its importance as a staple food and cash crop through integration of genetical, evolutionary and structural data, allowing targeted breeding, transformation and efficient use of *Musa* biodiversity in the future.

Thangaselvabai T., J. P. Joshua, C. G. L. Justin, and M. Jayasekhar. 2007. The uptake and distribution of nutrients by banana in response to application of nitrogen and *Azospirillum*. *Plant Archives*, 7:137-140.

Reference ID: 21110

Notes: #21110e

Abstract: A field experiment was conducted at Horticultural College and Research Institute, Coimbatore during 2001-02 to study the effect of split application of higher dose of nitrogen and *Azospirillum* on the uptake and distribution of nutrients by the Banana cv. Rasthali. The results revealed that the total uptake of nitrogen, phosphorus, potassium, calcium and magnesium were increased due to *Azospirillum* inoculation and split application of higher doses of nitrogen. Throughout the plant life the uptake of potassium was rapid and heavy. Calcium and magnesium were not the limiting factors in the growth and development of banana when compared to nitrogen and potassium. The distribution of nutrients in different plant parts at different growth stages indicated that the leaves were the highest reservoir of nitrogen during the vegetative phase but in the fruiting phase fruits contained more nitrogen. Leaves and pseudostem were the main repositories of phosphorus at all stages of growth. During vegetative phase pseudostem contained more potassium and at harvest stage fruits contained more potassium. Higher uptake of nutrients significantly influenced the yield.

Faturoti B. O., M. C. Madukwe, A. Tenkouano, and A. E. Agwu. 2007. A review of policy acts and initiatives in plantain and banana innovation system in Nigeria. *African Journal of Biotechnology*, 6:2297-2302.

Reference ID: 21111

Notes: #21111e

Abstract: Plantain and banana are among the most important staple food crops in humid forest zone of West and Central Africa. These has made the crop one of the key research mandates of International and national research institutes, both of which has developed many technologies aimed at improving the production of the crop and removing constraints posed by pest and diseases, marketing opportunities and perishability. Despite these efforts and research breakthrough the production of the crops has been on consistent downward trend in recent years. A ten years (1996

- 2005) production figure of the crops showed that land under plantain and banana production increased by 24.6% while yield reduction of 21.8% was recorded during the same period (FAOSTAT, 2006). This abysmal trend prompted a 40 years (1967 - 2006) review of policy acts and initiatives on the crops, with an examination of various efforts in the areas of research, dissemination, utilization, production and marketing. Seven gaps of critical implications to production and commercialization were identified; these include government nonintervention, marketing and constraints to production, weak/ fragile links among stakeholders, research-farmers dichotomy, project sustainability, lack of documentation and funding. Linkages among stakeholders were generally weak and without cohesion, objectives were at variance and unhealthy. The study concluded that stakeholder's cohesion and coordination of efforts is needed for increased production and commercialization. Also governmental intervention is needed in the areas of policy initiatives and acts that will go beyond the ad-hoc response which are usually triggered by natural disaster such as pest and diseases as is the case with black Sigatoka outbreak in mid 80's which was the only period government really intervened in plantain and banana production in Nigeria.

Figueiredo F. P., E. C. Mantovani, A. A. Soares, L. C. Costa, M. M. Ramos, and F. G. Oliveira. 2006. Productivity and quality of banana prata anã influenced by water depths, cultivated in the Northern Minas Gerais, Brazil: Produtividade e qualidade da banana prata anã, influenciada por lâminas de água, cultivada no Norte de Minas Gerais. *Revista Brasileira De Engenharia Agrícola e Ambiental*, 10:798-803.

Reference ID: 21112

Notes: #21112e

Abstract: This study evaluated the effects of different irrigation water depths on the vegetative development, yield and quality of banana. The basic parameters of the irrigation management were determined for a banana crop, for the first and second cycles in the Northern Minas Gerais, Brazil. The irrigation water depths applied to the treatments were 40, 60, 80, 100 and 120% of the reference evapotranspiration (ET_o) estimated by Penman-Monteith equation. The leaf area index and the degrees-day accumulated for each phenological stage, as well as the shade percentages, were determined. The results show that the treatment corresponding to 120% of the ET_o provided higher productivities in comparison to other treatments. The irrigation water depths affected the fruit quality at the harvesting time, showing that the irrigation depth of 120% of the ET_o was superior. The amount of water applied in treatments of 100 and 120% of the ET_o in relation to the other treatments promoted early flowering and, consequently, harvest. The crop coefficients (K_c) presented for the first cycle values of 0.71, 1.00 and 0.87 for the phenological stages corresponding to II, III and IV, respectively, and 0.97 for the only one stage for the second cycle.

Coelho E. F., C. A. da Silva Ledo, and S. O. Silva. 2006. Yield of banana 'Prata Ana' and 'Grande Naine' at the third cycle under microsprinkler irrigation in the coastland of Bahia State: Produtividade da bananeira 'Prata-Anã' e 'Grande Naine' no terceiro ciclo sob irrigação por microaspersão em tabuleiros costeiros da Bahia. *Revista Brasileira De Fruticultura*, 28:435-438.

Reference ID: 21113

Notes: #21113e

Abstract: The work had as objective to define the most adequate irrigation system to banana crop in the third cycle under Bahia Coast Tableland conditions. The experiment followed a random block design with four replications and 10 treatments, in a 5 x 2 factorial scheme with five levels of water depths and two banana cultivars:

"Prata Anã" (Prata Group) and "Grande Naine" (Cavendish Group). The treatments or irrigation systems were defined from five fractions of the crop evapotranspiration, defined by the product of potential evapotranspiration and the recommended crop coefficients. The Grande Naine cultivar was harvested 45 days earlier than the Prata Ana, under irrigation. The irrigation depth of 415 mm was considered the most adequate to be applied to the Grande Naine cv., while the water depth of 554 mm was the most adequate for the 'Prata Anã'. The crop coefficients had limits from 0.44 to 0.89 and 0.58 to 1.18 for Grande Naine and Prata Anã cultivars respectively.

Rodriguez C., G. Cayon, and J. J. Mira. 2006. Influence of the harvested mother plant pseudostem on follower sucker growth and yield in banana (Musa AAA Simmonds): Influencia del seudotallo de la planta madre cosechada sobre el crecimiento y producción del hijo de sucesión en banano (Musa AAA Simmonds). *Agronomía Colombiana*, 24:274-279.

Reference ID: 21114

Notes: #21114e

Abstract: A study was carried out to determine the effect on the cutting height of the recently harvested pseudostem over the growth and yield of Grand Naine banana plant from its follower sucker. The experiment was established in the Urabá region (Antioquia, Colombia) using two commercial farms and during two seasons of the year, in which the same average precipitation rate was presented. Treatments comprised three cutting heights from ground surface (2.0, 1.2 and 0 m) at the moment of mother plant harvest. The suckers that presented cutting heights of the 2 and 1.2 m, increased plant height, pseudostem diameter and decreased time to flowering compared with the mother plant suckers, whose pseudostem was totally eliminated. Over the two farms, the suckers with a cutting height of 2 m increased significantly bunch weight compared to the mother plant suckers without a pseudostem. The length and caliber of the fingers were no affected by the treatments. Results show that there is an influence of the harvested mother plant pseudostem over the follower sucker. This favores early sucker growth caused by reserves and water supplies from the part of this structure, which is reflected by an increase in yield.

Scandelai L. H. M., S. Leonel, and L. M. Apponi. 2006. Agronomic characteristics of 'Prata-anã' and 'Maçã' bananas micropropagated: Desempenho agronomico de bananeiras 'prata-ana e 'maca' micropropagadas. *Revista Brasileira De Fruticultura*, 28:148-150.

Reference ID: 21115

Notes: #21115e

Abstract: The experiment evaluated the agronomic characteristics of 'Prata-anã' and 'Maçã' banana plants, in the São Manuel region of São Paulo state. In the first crop cycle, the number of days from planting to inflorescence and from inflorescence to harvest; the number of shoots until the appearance of inflorescence and during the harvest period; active leaves number at inflorescence appearance and during the harvest period. Were evaluated yield parameters: like average weight of bunch, hand, rachis and fruit; average fruit number per hand and bunch; average fruit diameter and length. Incidences of plague diseases, as well as their severity were also evaluated. Delineation was totally at random, with 2 treatments, 15 replications and 5 useful plants per experimental plot. Both cultivars were characterized by values of descriptive average statistics and standard deviation, for characteristic interests. Number of days from planting to harvest was similar for both 'Prata-anã'

and 'Maçã', 574 and 567 days respectively. Banana plants showed good phytosanitary quality throughout the whole cycle.

Espindola J. A. A., J. G. M. Guerra, A. Perin, M. G. Teixeira, D. L. de Almeida, S. Urquiaga, and R. N. B. Busquet. 2006. Banana plants intercropped with perennial herbaceous legumes used as living mulches: Banneiras consorciadas com leguminosas herbáceas perenes utilizadas como coberturas vivas. *Pesquisa Agropecuaria Brasileira*, 41:415-420.

Reference ID: 21116

Notes: #21116e

Abstract: The objective of this work was to evaluate the yield of banana plants intercropped with the perennial herbaceous legumes forage groundnut (*Arachis pintoi*), tropical kudzu (*Pueraria phaseoloides*) and siratro (*Macroptilium atropurpureum*). The control treatments were spontaneous vegetation (mainly *Panicum maximum*) and spontaneous vegetation plus nitrogen fertilizer application to banana plants. The vegetative growth of banana plants was also evaluated. Among the treatments, spontaneous vegetation and tropical kudzu promoted the highest dry matter productions; tropical kudzu had the highest amounts of accumulated and fixed N. Forage groundnut, tropical kudzu and siratro promoted the fastest vegetative growth for banana plants in this intercropped system. Tropical kudzu and siratro promoted the highest values for bunch weight and hands weight. All legume treatments result in an increase in the percentage of harvested bunches and a reduction in the harvesting time and are related to higher yields, compared to spontaneous vegetation treatment.

Gondim A. R. O., J. F. de Medeiros, G. A. Carmo, F. H. F. Pereira, H. R. Gheyi, and J. C. Tavares. 2006. Productivity of banana submitted to different levels of salinity of irrigation water: second cycle: Produtividade de banana submetida a diferentes níveis de salinidade da água de irrigação: segundo ciclo. *Revista Brasileira De Engenharia Agrícola e Ambiental*, 10:38-42.

Reference ID: 21117

Notes: #21117e

Abstract: Keeping in view the salinity problems in the Northeast region and the inexistence of information of how to use the saline waters appropriately, the objective of this work was to verify the effects of different levels of irrigation water salinity on the productivity of banana (*Musa* spp.), in the second cycle. A randomized block design was used, with four replications in split-plot. The plots were constituted by three levels of salinity of irrigation water (1.7, 2.8 and 4.0 dS m⁻¹) and the subplot by two varieties of banana (Pacovan - AAB and Marmelo - ABB). Reductions of 21.27, 17.90, 19.67, 5.89, 1.93 and 17.90% were verified, respectively, in the total mass of the bunches, mass of the bunch, mean mass of the fruits, number of bunches per bunch, number of fruits per bunch and productivity, with the increase in the electrical conductivity of the irrigation water from 1.7 to 4.0 dS m⁻¹. The lowest level of salinity of the irrigation water studied (1.7 dS m⁻¹), promoted satisfactory production. The variety Marmelo showed higher productive potential in relationship to Pacovan. The effect of salinity on the cultivars was similar.

Donato S. L. R., S. D. E. Silva, O. A. Lucca, M. B. Lima, H. Domingues, and J. D. Alves. 2006. Correlations among characters of the plant and of the bunch in banana (*Musa* spp.): Correlações entre caracteres da planta e do cacho em bananeira (*Musa* spp.). *Ciencia E Agrotecnologia*, 30:21-30.

Reference ID: 21118

Notes: #21118e

Abstract: The characters observed in a experimental areas has phenotypic nature and their correlations are estimated with the purpose to verify alterations in one character when is altered another. The objectives of this work were to quantify the relationships among characters development and yield attributes in flowering and harvesting periods of 13 banana (*Musa* spp.) genotypes (varieties and hybrids), in Guanambi State of Bahia, Brazil. The varieties were Prata ana e Pacovan (AAB), Grande naine e Nanicao (AAA), and the hybrids PA42-44, PV42-85, PV42-142, PV42-68 e ST12-31 (AAAB) e Ambrosia, Calipso, Bucaneiro e FHIA 02 (AAAA), selected in Embrapa Mandioca e Fruticultura. The characters analyzed were plant height; pseudostem perimeter; number of functional leaves in the flowering and in the harvesting; number of days from planting to flowering and to harvesting; number of days from flowering to harvesting; bunch weight, of raquis and of the hands; length and diameter of the peduncle; number of hands and fruits; weight of the second hand; weight, length and diameter of finger and peel thickness. The correlations among the weight of the bunch and the other studied characters, varied among the genotypes and cycles. The associations among the weight of the bunch and the characters of the plant, in a general were no significant, and among the weight of the bunch and the characters of the bunch significant and positive for most of the genotypes in the two cycles evaluated. The correlations among the characters involving all the genotypes along the two cycles was predominantly positive and no significant, however, the associations among the characters of the bunch were in majority significant, positive and with expressive values.

Van den Bergh I., D. T. M. Nguyet, N. T. Tuyet, H. H. Nhi, and D. de Waele. 2006. Influence of *Pratylenchus coffeae* and *Meloidogyne* spp. on plant growth and yield of banana (*Musa* spp.) in Vietnam. *Nematology*, 8:265-271.

Reference ID: 21119

Notes: #21119e

Abstract: The objective of the presented study was to look at the effect of *Pratylenchus coffeae* and *Meloidogyne* spp., the two major nematode species associated with banana (*Musa* spp.) in North Vietnam, on the plant growth and yield of cv. Grand Name (AAA) and four local banana cultivars, Ngu Tien (AA), Hot (BB), Ben Tre (AAA) and Tay Tia (ABB). Inoculated plants were compared with nematode-free control plants in terms of plant growth, crop cycle duration and yield under field conditions in Hanoi, North Vietnam. Infection with *P. coffeae* did not affect the crop cycle duration or the plant height, the pseudostem girth or the number of standing leaves at harvest of any of the cultivars, but did significantly reduce the bunch weight of cv. Ngu Tien from 6.6 to 5.3 kg (20% reduction), the bunch weight of cv. Tay Tia from 7.3 to 5.9 kg (19% reduction) and the bunch weight of cv. Grand Name from 6.9 to 6.0 kg (13% reduction). The bunch weight of cvs Hot and Ben Tre was not significantly affected. The number of hands of the inoculated and the control plants did not differ for any of the cultivars but infection with *P. coffeae* resulted in a 34% reduction in the number of fingers of cv. Grand Naine (from 67 to 44 fingers). The number of fingers of the other cultivars were not affected by inoculation with *P. coffeae*. Infection with *Meloidogyne* spp. did not affect the time from planting to

harvest for any of the cultivars, but the time from planting to shooting was increased from 367 to 387 days for cv. Ngu Tien. The plant height and the pseudostem girth at harvest of cv. Grand Naine were significantly reduced by 27% and 18%, respectively. The number of standing leaves as well as the plant height and the pseudostem girth at harvest of the other cultivars were unaffected. Infection with *Meloidogyne* spp. significantly reduced the bunch weight of cv. Ngu Tien from 6.6 to 5.1 kg (23% reduction) and the bunch weight of cv. Grand Naine from 6.9 to 5.6 kg (19% reduction). The bunch weight of cv. Hot was unaffected. Infection with *Meloidogyne* spp. reduced the number of hands of cv. Ngu Tien by 14% (from 6.2 to 5.4 hands) the number of fingers of cv. Grand Naine by 25% (from 67 to 50 fingers). The number of hands and fingers of the other cultivars were not affected. The results indicate that in areas where the burrowing nematode, *Radopholus similis*, is not present, other nematodes, especially *Meloidogyne* spp., may become more important in terms of damage and yield loss.

da Silva Filho L. P. and A. Moreira. 2005. Bag enclose on the yield, ripening period and fruit quality of banana planted in the Amazonas State, Brazil: Ensacamento de cachos na produção, maturação e qualidade dos frutos de bananeiras cultivadas no Estado do Amazonas. *Acta Amazonica*, 35:407-412.

Reference ID: 21120

Notes: #21120e

Abstract: The objective of this work was to evaluated the effect of bag enclose on the yield, ripening period and fruit quality of bananas cultivars (Thap maeo, FHIA 18, Nanicao 2001 and Prata Zulu). A randomized experimental design was employed, in a 4x2 factorial, comprising the four cultivars and two procedures (bagged and not bagged bunches), with four replicates. The bagging was done with bags impregnated with organophosphorated insecticide. The variables analyzed were the time elapsed between the emergence of the inflorescence and the fruit harvest; bunch yield, hand yield; pulp diameter; fruit diameter; pulp/rind ratio; pH; texture and soluble solids. In the edaphoclimatic conditions, the results showed, on an average for all cultivars, that the baggin had no significative effect on the emergence of the inflorescence, pulp diameter, fruit diameter, pulp/rind ratio, pH, texture and soluble solids. It is noteworthy that even without significant difference, it was verified that, irrespective of cultivar, there was a decrease of the ripening period and a reduction of the bunch weight. The bags enclose reduced by cultivar Prata Zulu yield.

de Oliveira A. N. and L. A. de Oliveira. 2005. Arbuscular mycorrhizae fungi and nutrient contents in five banana cultivars on an Amazonian Oxisol: Colonização por fungos micorrízicos arbusculares e teores de nutrientes em cinco cultivares de bananeiras em um Latossolo da Amazônia. *Revista Brasileira De Ciencia Do Solo*, 29:481-488.

Reference ID: 21121

Notes: #21121e

Abstract: The Amazon banana plant is of great socio-economical importance, despite its requirement for high agricultural input in order to obtain good yields. An association with arbuscular mycorrhizae fungi could minimize the crop's nutritional needs in the poor soils of the Amazon. The present study aimed at verifying how the plant-fungus mycorrhizal symbiosis influences nutrient concentration in five varieties of adult banana plants cultivated in an acid Amazon Oxisol under field conditions. The banana plantation was defficient in macro (Ca, Mg and P) and micronutrients (Fe, Mn, Zn and Cu). The mycorrhizae colonization varied from 33.6 to 66.5 % of the

sampled roots. The average mycorrhizae colonization was 54.9 % in the Mysore, 51.5 % in Maca, 47.6 % in Pacovan, 47.3 % in Nanica, and 44.7 % in Prata varieties, and they were significantly different from each other. The mycorrhizae colonization indexes of Mysore and Maca varieties were highest in January and August and those of Nanica peaked in July, January and August. Pacovan and Prata did not present significant variations of mycorrhizae colonization during the studied period. The mycorrhizae association was significantly correlated with the leaf concentration of K, Mg, P, and Zn in the Maca variety, of K and P in Nanica, and of Zn in Prata variety.

de Jesus S. C., M. S. Folegatti, F. C. A. U. Matsuura, and R. L. Cardoso. 2004. Physical and chemical characterization of fruits of different banana genotypes: Caracterização física e química de frutos de diferentes genótipos de bananeira. *Bragantia*, 63:315-323.

Reference ID: 21122

Notes: #21122e

Abstract: Banana is a very appreciated tropical fruit used in human diet due to its sensorial characteristics and nutrients. Despite of the diversity of varieties existent in Brazil, only a few of them have potential for commercial exploration. Besides agronomic characteristics, fruit quality is of great importance for the selection of new varieties. The present work aimed to evaluate physical and chemical characteristics of fruits of ten banana clones from the Germoplasm Active Bank of Embrapa Cassava and Fruit Crops. The evaluated genotypes were: 'Pacovan' and its hybrids PV03-44 and PV03-76; 'Prata Anã' and its hybrids 'FHIA-18', 'Pioneira' and 'Prata Graúda'; 'Caipira', 'Nanica' and 'Thap Maeo'. The fruits were analyzed as to fresh mass, diameter, length, total soluble solids content (TSS), moisture, pH, total titratable acidity (TTA), sugars (total, reducing and nonreducing), starch and ascorbic acid. 'Prata Anã' 'Pacovan' and its hybrids PV03-44 and PV03-76 presented the highest contents for TSS, total and reducing sugars, characteristics related to the sensorial quality of the product. 'Caipira' presented the highest TSS/TTA ratio, 'Prata Anã' the highest vitamin C content and Thap Maeo highest pulp yield, the last an important parameter for the industry of concentrated and dried products.

Gubbuk H. and M. Pekmezci. 2004. Comparison of open-field and protected cultivation of banana (*Musa* spp. AAA) in the coastal area of Turkey. *New Zealand Journal of Crop and Horticultural Science*, 32:375-378.

Reference ID: 21123

Notes: #21123e

Abstract: This study was conducted to determine the yield and quality of 'Dwarf Cavendish' banana (*Musa* spp. AAA), cultivated in open fields and also in protected (plastic greenhouse) cultivation. The site is located in the central south coastal region (altitude 50 in, latitude 36degrees33'N) of Turkey. In both cultivation systems we determined the following: pseudostem circumference, pseudostem height, total leaf number, bunch stalk circumference, days from shooting to harvest, number of hands, number of fingers, finger circumference, finger length, and bunch weight. Protected cultivation was found to be better than open-field cultivation in terms of total production, expressed as the number of hands and fingers per bunch and bunch weight. Average annual yield under plastic greenhouse was 53% higher than in the open field (65.5 t/ha compared with 42.8 t/ha).

Silva S. D. E., E. J. Alves, T. M. D. Neto, L. A. Lichtemberg, and F. R. Ferreira. 2004. Evaluation of banana Cavendish clones in Cruz das Almas City, Bahia State, Brazil: Avaliação de clones de bananeira do subgrupo Cavendish (*Musa acuminata*, AAA) em Cruz das Almas-BA. *Ciencia E Agrotecnologia*, 28:1247-1258.

Reference ID: 21124

Notes: #21124e

Abstract: Sixty-nine clones of Cavendish type bananas (49 Nanicao and 20 Grande Naine) collected in the States of Sao Paulo, Minas Gerais, Bahia and Santa Catarina were evaluated. The clones were established in an experimental area at the Cassava and Fruit Crops Research Center - EMBRAPA, using micro-aspiration irrigation, in plants spaced at 3.0 m x 2.0 m, and conducted with three plants/bushes. Random blocks were used with five replications and five plants per plot. All cultural requirements for the crop were carried out. For the clone evaluations, the following variables were considered: plant height in centimeters (PH); number of days from planting to yield (ND); weight of bunch in kilograms (WB); number of fruits per bunch (FB) and length of fruit in centimeters (LF). The results obtained showed medium variability in all the characteristics evaluated and five clones of Grande Naine (G.N. Taperao, G.N. Rossete, G.N. Williams, G.N. Magario, G.N. SC-074) and four of Nanicao (N. IAC Green Vault, N. Rossete, N. SC-0008 and N. SC-063) were selected for presenting superior characteristics.

Flori J. E., G. M. de Resende, and L. E. Paiva. 2004. Yield of banana irrigated "Grande Naine" with high densities in Sao Francisco River Valley: Produção de bananeira 'Grande Naine' superadensada e irrigada no Vale do São Francisco. *Ciencia E Agrotecnologia*, 28:1060-1065.

Reference ID: 21125

Notes: #21125e

Abstract: The objective of this work was to verify the influence of the density on yield of the banana 'Grande Naine', planted in Juazeiro, BA, Brazil. Four densities (2000, 4000, 6000 e 8000 plants ha⁻¹) at systems double rows were evaluated for first and second crops cycle. Banana suckers were planted at T(1)= 3.75 x 1.25 x 2 m (2.000 pl. ha⁻¹); T(2)= 3.75 x 1.25 x 1 m (4.000 pl. ha⁻¹); T(3)= 3.75 x 1.25 x 0,66 m (6.000 pl. ha⁻¹); T(4)= 3.75 x 1.25 x 0,50 (8.000 pl. ha⁻¹); T(5)= 3.75 x 1.25 x 2 m (2.000 pl. ha⁻¹), respectively between double rows, between inter rows and distance among plants in rows. The characteristic availed were diameter (PD) and height (PH) of plant, mass of bunch (BM), number of hands (HN), number of fruit (FN), mass of stem/bunch (RM), length of fruit (FL), diameter of fruit (FD), mass of fruit (FM), cycle crop (CC), yield per ha and yield per ha per year of crop. The yield in the first cycle T(2) (4.000 pl.ha⁻¹) was higher than at the yield of T1 and T5 (2.000 pl.ha⁻¹). On the second cycle does not were difference significance among the treatments. The yield and quality de fruit from T(1), T(2) e T(5) and were best than the T(3) e T(4).

de Sousa V. F., M. E. D. Veloso, L. F. L. Vasconcelos, V. Q. Ribeiro, V. A. B. de Souza, and B. S. Jr. d'Albuquerque. 2004. Nitrogen and potassium applied by fertirrigation on the yield characteristics of banana 'Grand Naine': Nitrogênio e potássio via água de irrigação nas características de produção da bananeira 'Grand Naine'. *Pesquisa Agropecuaria Brasileira*, 39:865-869.

Reference ID: 21126

Notes: #21126e

Abstract: The objective of this work was to evaluate the effect of nitrogen and potassium, applied through irrigation water by microsprinkler, on the production characteristics of banana, cv. Grand Naine. The experimental design was a randomized block with four replications. The treatments consisted of 30, 180, 300, 420 and 570 kg ha⁻¹ year⁻¹ of N and of 55, 330, 550, 770 and 1,045 kg ha⁻¹ year⁻¹ of K₂O and a control treatment (no fertilizers), totalizing 11 treatments, according to the Plan Puebla III experimental matrix model. The following characteristics were evaluated: average fruit mass, average bunch mass, and fruit yield, referent to the first and the second production cycles. In the first and second production cycle, average fruit mass, average bunch mass and fruit yield were influenced only by the potassium. Higher values of average fruit mass (253.47 g), average bunch mass (28 kg) and fruit yield (55.42 t ha⁻¹), for the first production cycle, were obtained with the application of 938.46, 665.38 and 635.00 kg ha⁻¹ of K₂O, respectively. In the second cycle, higher values in relation average fruit mass (174.22 g), average bunch mass (32.04 kg) and yield (60.89 t ha⁻¹) were gathered with the application of 725.50, 907.50 and 933.33 kg ha⁻¹ of K₂O, respectively. There was no response of evaluated characteristics to nitrogen.

Moens T., M. Araya, R. Swennen, and D. de Waele. 2004. Enhanced biodegradation of nematicides after repetitive applications and its effect on root and yield parameters in commercial banana plantations. *Biology and Fertility of Soils*, 39:407-414.

Reference ID: 21127

Notes: #21127e

Abstract: The effects of five consecutive applications, every 4 months, of Counter, Furadan, Mocap, Nematicur, Rugby, and Vydate on functional root percentage, production parameters, and on enhanced biodegradation were compared in a commercial banana plantation in Costa Rica. To quantify nematode numbers and estimate functional root percentage, root samples were taken monthly from the field experiment. The enhanced biodegradation test was carried out in the laboratory. Samples taken from the field after five consecutive applications of each nematicide were treated in the following way: (1) not sterilized and no nematicide applied; (2) not sterilized but nematicide applied; and (3) nematicide applied after sterilization. The number of *Radopholus similis* which had penetrated the maize plantlets was used as a parameter to determine the degradation of the applied nematicide. Degradation was measured 0, 2, 4, 6 and 8 weeks after inoculation of pregerminated maize plantlets with 500 nematodes in soil under laboratory conditions. At harvest, 20 months after starting the field experiment, the lowest percentage of functional roots ($P = 0.024$) and bunch weight ($P = 0.0001$) were found in the non-treated control, followed by the Furadan treatment. On average, nematicides increased the bunch weight by 38%. In general, higher bunch weights coincided with higher percentages of functional roots. Furadan showed a high level of enhanced biodegradation while for Counter and Rugby this phenomenon was not detected. In the case of Mocap and Nematicur, a relatively high level of enhanced biodegradation in the soil biotest coincided with a high number of nematodes per 100 g roots in the field experiment. A high correlation between mean nematode numbers per 100 g roots and mean percentage of functional roots was observed ($R(2) = 0.81$, $P = 0.006$) for all treatments together. Data show that a rotation of different nematocidal molecules is the best option for long-term nematode management in commercial banana plantations.

Smithson P. C., B. D. McIntyre, C. S. Gold, H. Ssali, G. Night, and S. Okech. 2004. Potassium and magnesium fertilizers on banana in Uganda: yields, weevil damage, foliar nutrient status and DRIS analysis. *Nutrient Cycling in Agroecosystems*, 69:43-49.

Reference ID: 21128

Notes: #21128e

Abstract: Low soil fertility and pest pressure are two causes of the decline in banana (*Musa AAA*) production in central Uganda. Foliar analysis by the Diagnosis and Recommendation Integrated System (DRIS) pinpoints K and Mg as the most limiting nutrients. This study tested the effects of K and Mg additions on plant performance and weevil damage for 2.75 yr, at Buligwe in central Uganda and Muyogo in southwest Uganda. All treatments received 25 kg P ha⁻¹ and 100 kg N ha⁻¹ annually, while K and Mg were applied (kg ha⁻¹) at 0 K-0 Mg, 100 K-0 Mg, 100 K-25 Mg and 100 K-50 Mg. Fresh fruit yields (Mg ha⁻¹) yr⁻¹) ranged from 3.2 to 5.0 at Buligwe and 14.4 to 18.9 at Muyogo, with similar treatment trends at both sites. The 100 K-0 Mg treatment produced higher yields than no-K control ($p=0.022$ for the combined dataset). Yields with K+Mg tended to be lower than with K only, though not significantly different. Foliar nutrient concentrations were little affected by treatments, but varied substantially among sample dates. With increasing cumulative rainfall between foliar samplings, foliar P declined ($p=0.077$), K declined (ns), and Ca and Mg increased ($p=0.02$ to 0.03). Weevil damage was higher at Buligwe, but was little affected by K and Mg treatments at either site.

da Silva J. T. A. and J. G. de Carvalho. 2004. Soil properties, nutritional status and yield of 'prata ana' (aab) banana plants under irrigation with calcareous water: Propriedades do solo, estado nutricional e produtividade de bananeiras 'prata anã' (aab) irrigadas com águas calcárias. *Ciencia E Agrotecnologia*, 28:332-338.

Reference ID: 21129

Notes: #21129e

Abstract: The effects of the irrigation using calcareous water on some chemical and physical properties of the soil, on the foliar nutrient content and on the productivity of 'Prata Ana' (AAB) banana crops were evaluated. A total of 100 commercial banana crops were selected, being 50 commercial banana crops irrigated with calcareous water. It was verified that the banana crops irrigated with calcareous water presented greater foliar content of Ca, greater productivity and the soils of these banana crops presented greater pH, eletric conductivity, Ca and organic matter content and smaller density in relation to those irrigated with non calcareous water.

Yamaguchi J. and S. Araki. 2004. Biomass production of banana plants in the indigenous farming system of the East African Highland - A case study on the Kamachumu Plateau in northwest Tanzania. *Agriculture Ecosystems and Environment*, 102:93-111.

Reference ID: 21130

Notes: #21130e

Abstract: The Haya people in northwest Tanzania have thrived by practising a unique farming system in which banana (*Musa acuminata* and *M. balbisiana*) is a staple food. Recent population pressure and long-term shortage of manure, however, have caused disputes about the decline in banana. production. In this study, to begin to solve the issue, the biomass of banana plants grown in Haya fields on the Kamachumu Plateau was estimated by using a non-destructive method. Twelve quadrats of 100 or 225 m² were established. Pseudostem height and

diameter of all banana plants in each quadrat were measured, and the pseudostem volume was calculated. The fresh weight (FW) and dry weight (DW) of each plant in the quadrats were calculated from the relationship between the pseudostem volume and FW and DW of various organs in 14 sampled plants. The total DW of banana plants in each unit field area varied greatly among quadrats (from 0.12 to 1.45 kg m⁻²), but it averaged 0.92 ± 0.08 kg m⁻² on a farm scale, which was reasonably homogeneous despite the differences in farm size of each household and fertility management. The annual production of banana bunches was estimated at 3.4 kg m⁻² from the average bunch FW and the annual bunch-bearing proportion: it was much higher than in the surrounding areas. Nevertheless, owing to a small proportion of edible part in a banana bunch, the current system would provide a net dry matter yield (pulp) of 0.38 kg m⁻² a year. This yield is comparable to a reasonably good yield (grains) of cereal crops in the tropics. However, the banana yield for each unit time should be at least halved because the plants need 1 year to produce the yield. The turnover rate of total dry matter was 0.7-0.9 a year, showing a dynamic exchange of photosynthates and nutrients in permanent banana fields. Further study is needed to strengthen the sustainability of the current farming system from wider perspectives, including the nutrient balance and socio-economic aspect.

McIntyre B. D., C. S. Gold, H. Ssali, and S. J. Riha. 2003. Effects of mulch location on banana weevil, soil and plant nutrients, soil water and biomass in banana fields. *Biology and Fertility of Soils*, 39:74-79.

Reference ID: 21131

Notes: #21131e

Abstract: Major constraints to banana (*Musa* spp., genome group AAA) production, a dietary staple for over 70 million people in sub-Saharan Africa, are pest infestations, poor nutrition and inadequate water. Although mulch can improve soil water and nutrient status, many farmers believe it also promotes the proliferation of banana weevil (*Cosmopolites sordidus*), one of the most serious banana pests. In this study, we evaluated the effects of mulch location (mulch to base of banana pseudostem; mulch recessed 1 m from the pseudostem) on banana weevil, soil and plant nutrient status, soil water, and banana growth and development. After 3 years, the fully mulched plots had significantly more soil Ca and Mg than plots that did not receive mulch. Banana foliar K concentration was significantly higher in both mulch treatments (full and recessed) than in the control (no mulch) plots. The mulched plots had greater recharge after rainfall events and higher soil water contents during dry periods due to increased infiltration in the mulched plots. However, the mulched plots also exhibited significantly higher banana weevil densities and greater plant damage than the control plots. There was no difference in weevil damage with mulch location, although weevil density was higher in the fully mulched plots throughout most of the trial. Despite greater weevil damage, the treatments that were mulched yielded significantly heavier bunches. Hence the effects of the mulch on soil water infiltration and banana foliar nutrient status outweighed the detrimental effects of banana weevil damage.

Pereira L. V., S. D. E. Silva, E. J. Alves, and C. R. D. E. Silva. 2003. Banana Hybrids and Cultivar Evaluation in Lavras-MG: Avaliação de cultivares e híbridos de bananeira em lavras, MG. *Ciencia E Agrotecnologia*, 27:17-25.

Reference ID: 21132

Notes: #21132e

Abstract: The banana genotypes Nam, Caipira, Pioneira, Prata ana, Grande Naine, FHIA 01, FHIA 18, SH 36-44, and PV 03-44 were evaluated from 1997 to 1999. The objective was to identify the most productive and most adapted genotype compared to the traditional Prata and Prata-Ana cultivars in the southern State of Minas Gerais, Brazil. The experiment was established in the EPAMIG Experimental Station in Lavras-MG. Fifty plants of each genotype were planted in a 3,0 x 3,0 m plant spacing. The SH 36-40 hybrid presented the greater bunch medium weight (16.56 kg) and fruits (171 g/unit), diameter (4.21 cm) and length (17.64 cm) of the fruits. It is equivalent to a yield of 18.5 t/ha, which is about twice the yield of the Prata Ana, Pioneira, Caipira, and Nam, and thrice the yield of PV 03-44. SH 36-40 and FHIA 01 hybrids presented the greatest increases in bunches and fruits weight from one cycle to the next. Nam produced bunches with medium weight inferior to 9.0 kg, and the PV 03-44 hybrid produced 6.0 kg. The hybrid SH 36-40 showed plant height of 2.75 m, crop cycle of 17.5 months, the smallest period from flowering to harvesting, inferior to 4,87 months, and smaller and later sprouting. The cultivars Caipira, Prata Ana, Pioneira, and Nam produced bunches with medium weight inferior to 9.0 kg and the PV 03-44 hybrid inferior to 6.0 kg. The Caipira was the tardiest cultivar, with 22.0 month of crop cycle, and the cultivars Pioneira and Prata Ana were the most precocious, 16.6 months, in the first cycle and 15.5 months in the second and third cycles.

Tsegaye A. and P. C. Struik. 2003. Growth, radiation use efficiency and yield potential of enset (*Ensete ventricosum*) at different sites in southern Ethiopia. *Annals of Applied Biology*, 142:71-81.

Reference ID: 21133

Notes: #21133e

Abstract: Knowledge on the physiological parameters that determine the growth of enset (*Ensete ventricosum*) and on how these parameters develop over time and affect yield under field conditions is scarce. Field experiments were carried out at three sites in southern Ethiopia using suckers of several clones to generate crop physiological parameters and to describe the time course of leaf number, leaf area and plant height. Yield potentials at different sites were estimated using these parameters and weather data, and compared with the actual yield. Plant height and LAI increased faster at Awassa and Areka than at Hageresalam because of a higher leaf appearance rate associated with temperatures being closer to the optimum. The trend in plant height was best described by a logistic function, whereas the trend in LAI was best described by a logistic function only at Awassa and Areka.

A high leaf appearance rate (0.18 leaves day⁻¹) during early growth at Awassa and Areka made it possible that leaves that were senesced during unfavourable climatic conditions could be rapidly replaced without strong fluctuation in leaf area index. At Hageresalam, however, the rate of leaf appearance (0.09 leaves day⁻¹) was too small to compensate for the decline in the number of green leaves per plant during adverse conditions and thus LAI fluctuated over the whole growing period. The trend in fraction of PAR intercepted was best described by a generalised logistic function. At 300 days after transplanting the suckers, LAI reached a value of 4.5 and enset clones intercepted 92-97% of incoming PAR. The mean extinction coefficient was between 0.56-0.91 and radiation use efficiency (RUE) ranged from 1.43-2.67 g MJ⁻¹. Dry matter kocho yield potentials of 17.1 to 33.9 t ha⁻¹ yr⁻¹ were estimated for enset clones. Important yield potential differences existed between

clones mainly because of differences in radiation use efficiency that was probably partly associated with viral infection. The average ratio of actual yield:yield potential (0.24) was low mainly because of large losses associated with traditional fermentation techniques, yield reducing cultivation methods such as repetitive transplanting and leaf pruning, presence of diseases, lack of adequate fertilisation and shortage and uneven distribution of rainfall.

Alvares M. D. and L. S. Caldas. 2002. Growth, yield and somaclonal variation of micropropagated bananas: Crescimento, produção e variação somaclonal em bananeiras micropropagadas. *Pesquisa Agropecuaria Brasileira*, 37:415-420.

Reference ID: 21134

Notes: #21134e

Abstract: The development and productivity of micropropagated and conventionally propagated banana plants of the cvs. Prata-Ana and Nanicao were evaluated. Micropropagated plants of cv. Prata-Ana were significantly superior to conventionally propagated plants for all variables studied during the vegetative growth period, while for 'Nanicao' this superiority was observed only in the first eight months. There was no significant difference in fruit parameters in 'Nanicao' but productivity of micropropagated 'Prata-Ana' was significantly superior to that of conventional plants. The frequency of somaclonal variation was higher in 'Nanicao' but it was less than 5%.

McIntyre B. D., C. S. Gold, I. N. Kashaija, H. Ssali, G. Night, and D. P. Bwamiki. 2001. Effects of legume intercrops on soil-borne pests, biomass, nutrients and soil water in banana. *Biology and Fertility of Soils*, 34:342-348.

Reference ID: 21135

Notes: #21135e

Abstract: Banana (*Musa AAA*) and plantain (*Musa AAB*) are important dietary staples for over 70 million people in sub-Saharan Africa. Banana weevil (*Cosmopolites sordidus*) and nematodes (*Radopholus similis*, *Helicotylenchus multicinctus*) are often the largest constraints to production. Leguminous crops in the genera *Canavalia*, *Mucuna* and *Tephrosia* have been reported as having repellent or insecticidal properties. We assessed: weevil and nematode populations and damage; banana growth and development; soil and foliar nutrient concentrations; and soil moisture status in banana intercropped with three legumes (*Canavalia ensiformis*, *Mucuna pruriens* and *Tephrosia vogelii*). The research took place at Kawanda, Uganda, on a field site infested with weevils and nematodes. The legume intercrops did not affect weevil populations or damage. The legumes also provided no benefit in terms of nematode control; in fact, banana root necrosis was higher in the *T. vogelii* intercrop than in the banana monoculture. Banana fruit yield was not adversely affected by the legume intercrops. The low yield noted across treatments was attributed to the high level of damage by the weevils and the nematodes. Significantly more NO₃-N accumulated from 0- to 0.3-m depth in the *M. pruriens* intercrop than in the other treatments. There was no treatment difference in soil moisture. In summary, there was no significant advantage in banana production associated with the legume intercrops. However, the lack of a significant difference in banana fruit production between the monoculture and the intercrops suggests that land use efficiency may be increased by incorporating food and or/fodder legumes into the banana cropping system.

Scarpore J. A. and R. A. Kluge. 2001. Yield of 'Nanicao' banana at different plant densities and spacing systems: Produção da bananeira 'Nanicão' em diferentes densidades de plantas e sistemas de espaçamento. Pesquisa Agropecuária Brasileira, 36:105-113.

Reference ID: 21136

Notes: #21136e

Abstract: The objective of this research was to study the effect of different planting densities and spacing systems on the yield of the 'Nanicao' banana, evaluating the first four cycles. Four density (3,333; 2,222; 1,666 and 1,333 plants ha⁻¹) and two spacing systems (rectangle and triangle) were tested for the conditions of Piracicaba, SP, Brazil. The increase of the density of 1,333 to 3,333 plants ha⁻¹ decreased bunch weight in 15% to 20%, due to reduction in number of fruit by bunch and fruit size. The yield was always higher as the density increased; however, there was not the same behavior for the productivity. Until the third cycle, the highest plant density overcame the productivity of the others. In the fourth cycle there was no difference in productivity among the densities, due to the increase in the duration of crop cycle in the highest density. The spacing system in triangle promoted higher bunch weight in the first cycle and productivity slightly higher along the cycles if compared with rectangle system.

Baiyeri K. P., B. N. Mbah, and A. Tenkouano. 2000. Yield components of triploid and tetraploid Musa genotypes in Nigeria. HortScience, 35:1338-1343.

Reference ID: 21137

Notes: #21137e

Abstract: The additive main effects and multiplicative interaction (AMMI) model was used to evaluate the stability patterns of 36 Musa genotypes in four cropping environments for bunch weight, pulp weight, and dry matter content. Alleycropping generally induced higher means for all traits than did sole cropping. The triploid plantains produced smaller bunch weights and were less stable than dessert and cooking bananas. In this ploidy group, bunch weight was highest for the cooking bananas 'Cardaba' and 'Fougamou', but only 'Fougamou' was stable across environments. Among the hybrids, only 'FHIA23' (dessert banana) expressed high and stable bunch weights, while other high-yielding hybrids displayed specific adaptation to alleycropping. Pulp weight was lower but more stable in plantains than in other triploid genotypes. Among the hybrids, pulp weight was high and stable for one cooking banana ('FHIA3'), one dessert banana ('FHIA1'), and three plantains ('PITA1', 'PITA2', and 'PITA7'). Dry matter content was highest in plantains and lowest in dessert bananas at both triploid and tetraploid levels, and was also more stable than the other traits. Thus, the adaptation patterns of genotypes across environments varied according to the trait studied. When rank changes were not observed across traits for a given genotype, differences were still noted in the relative magnitude of the IPCA1 score. Hence, both farm gate traits and postharvest processing traits should be considered in selecting for broad or specific adaptation. Determination of the genetic relationships between processing traits and farm gate traits could allow Musa breeders to construct selection indices that would facilitate multiple trait selection and enhance breeding efficiency, with respect to cultivar stability and adaptation across environments.

Goenaga R. and H. Irizarry. 2000. Yield and quality of banana irrigated with fractions of class A pan evaporation on an oxisol. *Agronomy Journal*, 92:1008-1012.

Reference ID: 21138

Notes: #21138e

Abstract: There is a scarcity of information regarding the optimum water requirement for banana (*Musa acuminata* Colla, AAA group) grown with supplemental drip irrigation on an Oxisol. A 3-yr study was conducted on a very-fine, kaolinitic, Isohyperthermic Typic Hapludox to determine water requirement, yield, and fruit-quality traits of the plant crop (PC) and two ratoon crops (R2 and R3) of 'Grande Naine' and 'Johnson' banana subjected to five levels of irrigation. The irrigation treatments were based on Class A pan factors that ranged from 0.25 to 1.25 in increments of 0.25. Drip irrigation was supplied three times a week on alternate days. Results showed significant ($P < 0.001$) irrigation treatment and crop effects for all yield components, fruit length and diameter, number of leaves at flowering and harvest, and number of hands per bunch. Cultivar and the treatment by cultivar interaction were not significant ($P < 0.05$). The highest marketable yield (70.7 Mg ha⁻¹) was obtained from the R2 crop with water application according to a pan factor of 1.25. Plant crop and R3 plants irrigated using the same pan factor yielded 48 and 65 Mg ha⁻¹, respectively. Increasing the pan factors from 0.25 to 1.25 resulted in weight gains of the third-upper hand of 594 g in PC, 1284 g in R2, and 1429 g in R3. It was concluded that banana grown on an Oxisol should be drip irrigated with a pan factor of 1.0 or more three times a week.

Kluge R. A., J. A. Scarpere, R. Victoria, and A. P. Jacomino. 2000. Yield and bunch stem/bunch ratio of 'Nanicao' bananas at different densities and arrangements: Produção E Relação Ráquis/Cacho Da Bananeira 'Nanicao' Em Diferentes Densidades E Arranjos De Plantio. *Pesquisa Agropecuária Brasileira*, 35:1759-1764.

Reference ID: 21139

Notes: #21139e

Abstract: This research was carried out with the objective to evaluate the effects of different densities and plant arrangement on components of yield and bunch stem/bunch ratio of 'Nanicao' banana established in Piracicaba, SP. Four densities (1,333, 1,666, 2,222 and 3,333 plants ha⁻¹) and two arrangements (rectangle and triangle) were studied. Independent of arrangement the increase of density raised fruit yield of 37.24 to 75.83 t ha⁻¹. However bunch mass was reduced of 30.30 to 24.79 kg due to reduced fruit mass. The bunch stem/bunch ratio was 8% independent of density and arrangement. At density of 3,333 plants ha⁻¹ can be exported 6.80 t ha⁻¹ of bunch stem of plantation and these component of yield can be used as raw material to manufacture paper.

Baiyeri K. P., A. Tenkouano, B. N. Mbah, and J. S. C. Mbagwu. 2000. Ploidy and genomic group effects on yield components interaction in bananas and plantains across four environments in Nigeria. *Scientia Horticulturae*, 85:51-62.

Reference ID: 21140

Notes: #21140e

Abstract: Thirty-six *Musa* genotypes, comprising the three major genomic groups (AAA, AAB, ABB) and their hybrids, were evaluated in four environments in Nigeria. Multiple correlation and path coefficient analysis was performed on phenological and yield traits. Bunch weight was more associated with phenological traits in triploid *Musa*, especially in resource-poor environments. In tetraploid *Musa* hybrids, bunch weight was consistently correlated with fruit traits. Path coefficient analysis

demonstrated that, as expected, bunch weight was essentially determined by the number and weight of fruits. Phenological traits such as plant height and number of days to flowering had low direct effects on bunch weight, but their indirect effects via fruit traits were high. We conclude that ideotype breeding should aim at increasing the number of fruits and the fruit weight regardless of the target environment. Additional gains could be achieved by adopting crop management options that improve the expression of these traits.

Pereira M. C. T., L. C. C. Salomao, S. D. E. Silva, C. S. Sedyama, F. A. D. Couto, and S. P. D. Neto. 2000. Growth and yield in plant crop of bananas 'Prata Ana' (AAB) at seven spacings: Crescimento E Produção De Primeiro Ciclo Da Bananeira 'Prata Anã' (Aab) Em Sete Espaçamentos. Pesquisa Agropecuaria Brasileira, 35:1377-1387.

Reference ID: 21141

Notes: #21141e

Abstract: The objective of this study was to evaluate the behavior of 'Prata Ana' banana (*Musa* spp.) in the plant crop, in Jaiba, MG, Brazil, submitted to seven spacings, in irrigated culture. The treatments were: triangle: 2.7 m x 3.2 m (1,157 holes/ha) and 2.9 m x 3.4 m (1,014 holes/ha); double row in triangle: 4.5 m x 2.0 m x 3.0 m (1,026 holes/ha) and 4.5 m x 2.0 m x 2.0 m (1,538 holes/ha); double row in rectangle: 4.5 m x 2.0 m x 3.5 m (879 holes/ha); and rectangle: 4.0 m x 2.0 m (1,250 holes/ha) and 3.0 m x 2.0 m (1,666 holes/ha). The systems of spacing and populational densities tested did not influence neither the rate of growth of the plants nor the plant characteristics at harvest time. However, the productivity was greater for the bananas planted at greater densities, up to 29.1 ton/ha. The plants showed, in average, cycle from plantation to harvest time of 411 days, cycle from flowering to harvest time of 141 days and bunches with 17.7 kg, 9.1 hands and 134 fingers. The most suitable spacing for the region of Jaiba is 3.0 m x 2.0 m in rectangle, in the plant crop.

Kurien S., B. K. Anil, P. K. Rajeevan, V. Bharathan, and S. Krishnan. 2000. Phosphorus mobilisation to uneconomic tissues and effects of bunch trimming regimes in banana. *Scientia Horticulturae*, 83:25-32.

Reference ID: 21142

Notes: #21142e

Abstract: The movement and mobilisation of phosphorus in various tissues of banana was studied using P-32. The isotope was given by pseudostem injection and activity measured in various tissues. It was inferred that the male inflorescence, rhizome, fruit and fruit peduncle are the major nutrient sinks. The activity pattern in different hands showed that the highest activity was in the fourth followed by the third, second and fifth (terminal) and least in the first hand (first to emerge) in a five hand system. Another experiment conducted on various intensities of bunch trimming in a eight hand system revealed that trimming of three terminal hands improved yield and finger characters like length, girth and weight. The trimmed hands could be used as a vegetable and the retained hands for yielding quality fruits. Thus the same bunch serves the dual purpose of vegetable and fruit. The study underlines the imperative need for removing the male bud, fruit peduncle and undeveloped hands.

Cote F. X., M. Folliot, R. Domergue, and C. Dubois. 2000. Field performance of embryogenic cell suspension-derived banana plants (Musa AAA, cv. Grande naine). *Euphytica*, 112:245-251.

Reference ID: 21143

Notes: #21143e

Abstract: Growth and yield characteristics of two different clones of banana plants (Musa AAA cv. Grande naine) originating from four months old embryogenic cell suspensions were studied. These characteristics were compared with those plants produced by the conventional in vitro budding multiplication method. Two types of variants were observed during the acclimatization phase among 500 embryogenic cell suspension derived plants. The first type related to banana plants with 'variegated or deformed leaves' were also observed in in vitro budding derived plants. The second type concerned 'fasciated-leafed' plants. During the field growth, these two variant types produced plants morphologically similar to the other plants. Thus, none of the cell suspension derived plants exhibited off-type traits in the field. A Fisher block model was used to compare the field performances of the two clones produced through the two in vitro propagation techniques. The analysis of variance showed that there were no significant differences between the plants produced by either micropropagation techniques for the plant height and circumference, the length of the reference leaf, the number of nodal clusters of the inflorescence and of fruits, the bunch weight, the period of time between planting and flowering, and between planting and harvesting. This study showed that banana plants with an agronomical behaviour similar to those produced by the conventional in vitro budding method could be regenerated from embryogenic cell suspension.

Dahal G., R. Ortiz, A. Tenkouano, J. D. Hughes, G. Thottappilly, D. Vuylsteke, and B. E. L. Lockhart. 2000. Relationship between natural occurrence of banana streak badnavirus and symptom expression, relative concentration of viral antigen, and yield characteristics of some micropropagated Musa spp. *Plant Pathology*, 49:68-79.

Reference ID: 21144

Notes: #21144e

Abstract: Micropropagated plants of 36 Musa genotypes with diverse genetic backgrounds, including 14 tetraploid plantain (TMPx) and banana (TMBx) hybrids, were evaluated for their response to banana streak badnavirus (BSV) infection under three environments from 1995 to 1997 in Nigeria. The characteristics evaluated were the natural incidence of BSV based on symptoms and virus indexing, relative concentration of BSV antigens in leaf tissues determined by ELISA, and some growth and yield descriptors. Virus occurrence and symptom expression, as well as the relative concentration of BSV antigens, fluctuated greatly between seasons during the cropping cycle, being high during the rainy season and low or negligible during the hot dry season. The natural incidence of plants with symptoms and BSV-infected plants varied between genotypes. Incidence of BSV on most International Institute of Tropical Agriculture (IITA) TMPx hybrids and three Fundacion Hondureoa de Investigacion Agricola (FHIA) hybrids was high in the three environments, with some variation. Most landraces and some FHIA or Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA) hybrids were not BSV-infected under either environment at Onne. However, a few expressed some foliar symptoms at Ibadan and indexed BSV positive. The relative concentration of BSV antigens in leaf samples was also high in most TMPx and some FHIA hybrids, but low in most landraces. While BSV infection had no significant effect on most growth characteristics, it had a highly variable effect on bunch weight loss among the genotypes. There was no

relationship between the natural incidence of BSV, concentration of viral antigen and bunch weight loss among the 11 TMPx hybrids, three FHIA hybrids and three plantain landraces. Despite the high natural BSV incidence and the high relative antigen concentration in their leaf tissue, TMPx 548-9, TMPx 2637-49, TMPx 7002-1 and FHIA 21 suffered less than 15% bunch weight loss, and TMPx 548-4 and FHIA 22 suffered no loss. These results suggest that under the conditions specified in this study, these hybrids could be tentatively classified as 'field tolerant' to BSV.

Nokoe S. and R. Ortiz. 1998. Optimum plot size for banana trials. HortScience, 33:130-132.

Reference ID: 21145

Notes: #21145e

Abstract: Bananas (*Musa* spp. AAA group) are an important food and a source of income for farmers in tropical countries, Black sigatoka (*Mycosphaerella fijiensis* Morelet), a fungal leaf spot disease, is the major production constraint worldwide, The replacement of most of the susceptible banana landraces requires the proper assessment of host plant response to black sigatoka and the determination of yield potential (per unit area and time) the new selections. Although optimum plot sizes have been reported earlier for banana trials, the number of plants per plot was determined primarily by using a subjective visual assessment, based on the point of maximum curvature. This paper presents an objective method to determine optimum plot size using segmented models. Data on host response to black sigatoka, and growth and yield characteristics recorded in the plant crop and first ratoon on competing plants of the widely grown banana cv. Valery, provided the sample to illustrate the proposed method, With few exceptions, feasible solutions were obtained after <10 iterations, The approximate solutions suggested that nine to 33 plants per plot could be optimal for banana trials. The optimum number of plants per plot depended on the characteristic of interest and the production cycle, About 13 +/- 1 plants may suffice to assess the host response to black sigatoka, whereas 16 +/- 3 plants per plot are needed to evaluate growth characteristics and yield potential of cultivars. The optimum number of plants needed to assess the performance of genotypes had Lower coefficients of variation in the plant crop than in the ratoon crop. Hence, the recommended optimum plot size consisted, on average, of 13 +/- 3 plants per plot for the plant crop, and 15 +/- 2 plants per plot for the ratoon crop, The suggested procedure to determine optimum plot sizes may prove useful for other crops.

Rodrigo V. H. L., C. M. Stirling, Z. Teklehaimanot, and A. Nugawela. 1997. The effect of planting density on growth and development of component crops in rubber/banana intercropping systems. Field Crops Research, 52:95-108.

Reference ID: 21146

Notes: #21146e

Abstract: The effects of planting density on growth and development of rubber (*Hevea brasiliensis* Muell. Arg., clone RRIC 100) and banana (*Musa* spp. cv. Kolikuttu) were examined to determine the optimum planting density of banana when grown in combination with rubber. The experiment comprised five treatments, sole crop rubber (R), sole crop banana (B) and three intercropping treatments consisting of an additive series of one (BR), two (BBR) and three (BBBR) rows of banana to one row of rubber. Planting density of banana was 500, 1000, 1500 and 1700 plants ha(-1) in the BR, BBR, BBBR and B treatments and 500 plant ha(-1) for rubber in all treatments. Growth analysis commenced at 8 months after planting (MAP) and at the

onset of the experiment, rubber plants were four months old. Density had significant effects on both leaf area index (LAT) and total dry matter (TDM) of the stand, with the highest values in the most dense BBR treatment. TDM, leaf area and dry matter partitioning to above-ground components of banana were significantly greater in the BBR and BBR treatments than in the BR crop. Dry matter productivity and the crop performance ratio (CPR) of rubber also increased with planting density. Plant weight of rubber showed similar relations with both stem girth and height measurements, with improved performance in the intercrop relative to sole crop treatments. Treatments had little effect on bunch yield per banana plant, harvested percentage and CPR, with mean values of 6.2 kg, 65.3% and 0.95, respectively. Since yield per plant was similar across treatments, yield per hectare increased significantly with increasing banana density. Amongst intercrops, the highest density BBR treatment always performed best in terms of both stand parameters and performance of individual component crops. It was concluded that increasing the density of banana, from a single to three rows, increased biomass productivity per unit area, with no adverse effect on the growth and yield of either component rubber or banana crops.

Damasco O. P., M. K. Smith, I. D. Godwin, S. W. Adkins, R. M. Smillie, and S. E. Hetherington. 1997. Micropropagated dwarf off-type Cavendish bananas (*Musa* spp, AAA) show improved tolerance to suboptimal temperatures. *Australian Journal of Agricultural Research*, 48:377-384.

Reference ID: 21147

Notes: #21147e

Abstract: The responses of micropropagated normal plants and dwarf off-types of Cavendish (*Musa* spp. AAA) bananas to suboptimal temperatures were evaluated under field and controlled environmental conditions. Compared with bananas grown at 30/25 degrees C (day/night), leaf production at 18/14 degrees C was inhibited by 51% in normal plants and 18% in dwarf off-types. The emergence of the first leaf that developed at low temperature was delayed by 11 days for normal plants and 5 days for the dwarf off-types. Photoinhibition of lamina, measured by decrease in the chlorophyll fluorescence variable F_v/F_m , occurred in all banana plants growing in the field during the winter months. The extent to which the plants were photoinhibited was significantly greater for the normal plants than dwarf off-types. Under controlled environmental conditions, photoinhibition was similarly greater in normal plants than dwarf off-types. After 153 h at 18/14 degrees C and a 9-h photoperiod of photon flux density (PFD) of 380 $\mu\text{mol}/\text{m}^2\cdot\text{s}$, F_v/F_m was reduced by 22 and 13% for normal and dwarf off-types, respectively. When plants were exposed to 18 degrees C and a continuous PFD of 380 $\mu\text{mol}/\text{m}^2\cdot\text{s}$ for 20 h, F_v/F_m was reduced by 50% for normal plants and 36% for dwarf off-types. The results of the study indicate that dwarf off-types generated from banana micropropagation showed improved tolerance to low temperature and light, showing better growth and lower susceptibility to low-temperature induced photoinhibition than normal plants.

Bekunda M. A. and P. L. Woomer. 1996. Organic resource management in banana-based cropping systems of the Lake Victoria Basin, Uganda. *Agriculture, Ecosystems & Environment*, 59:171-180.

Reference ID: 21148

Notes: #21148e

Abstract: The cultivation of plantain and cooking banana in humid areas of Uganda continues to grow in importance as rural population densities increase and as

demand from urban areas intensifies. Difficulties accompany this importance, particularly soil depletion and intensification of pests and diseases of banana. We interviewed 510 farm families practising banana-based cultivation in six districts along the Lake Victoria Basin of southern-central Uganda to determine which resource management strategies are undertaken to mitigate limitations to banana cultivation and the importance of livestock and intercropping within those systems. Of the farmers interviewed, 97% reapply banana stalks and leaves to the banana mats on pruning and upon harvest, a practice that may contribute to banana weevil, stem nematode and sigatoka fungal attacks. Banana stalks were also applied as mulches to cash (4%) and field crops (2%) and used as livestock feed (10%). Farmers applied a wide range of additional resources to bananas including field crop residues (81%), burned residues (3%), on-farm manures (31%), compost (16%), external organic (17%) and chemical (4%) inputs. Of the organic inputs applied to bananas, bean trash (72%), maize stover (68%), cattle manure (45%) and composts (18%) were most frequently applied. It was necessary to consider at least five different organic inputs to account for more than 90% of farmer practices. Overall, intercropping was practised by 69% of the farmers. The six most encountered intercrops were, in decreasing order, beans, maize, cassava, *Ficus nataliensis* and fruit trees. When organic matter management was separated into five general categories depending on the reliance upon bananas, other crops, manures and composts as organic additions to soils, significant differences in reported average bunch weights were obtained. The farmers applying banana stalks, field crop residues and cattle manures reported the largest bunch weights (20.3 kg per bunch). Farmers relying upon banana stalks alone, banana stalks with field crop residues and either small livestock manure or domestic compost reported the lowest yields (13.1, 14.3 and 12.9 kg per bunch, respectively). We conclude that farmers are developing strategies to resist fertility depletion, in part through better recycling of on-farm resources and intercropping but greater reliance upon external inputs may be required to ameliorate declining banana yields.

Israeli Y., A. Schwartz, Z. Plaut, and D. Yakir. 1996. Effects of light regime on delta C-13, photosynthesis and yield of field-grown banana (*Musa* sp, Musaceae). *Plant, Cell and Environment*, 19:225-230.

Reference ID: 21149

Notes: #21149e

Abstract: Banana plants (*Musa* sp., Musaceae) were grown for 2 years in the field in 12x20 m plots under irradiance levels incident upon the canopy of 100, 81, 62 and 32% of sunlight. Time-integrated parameters such as leaf delta(13)C, yield and leaf mass to area ratio were linearly correlated with irradiance level ($R(2) > 0.9$). In contrast, midday CO₂ assimilation and transpiration efficiency (A/g) decreased significantly and substomatal CO₂ concentrations (c(st)) increased significantly only at the lowest irradiance levels (below 81% irradiance). Diurnal gas exchange measurements indicated that the linear response of the long-term parameters may be associated with the significant variations in photosynthetic activity among the irradiance treatments observed only in the early morning hours. The linear fit between yield and irradiance level (per cent of control) had a slope of 0.82 (with apparently constant yield to biomass ratio). These results directly demonstrate the significance of variations in incident light, such as may be associated with increasing cloudiness, on productivity of tropical plants such as the banana. The importance of using time-integrated indicators in general, and the reliability of using C-13

discrimination in particular, in evaluating the responses of plants to changes in incident irradiance is demonstrated.

Israeli Y., Z. Plaut, and A. Schwartz. 1995. Effect of Shade on Banana Morphology, Growth and Production. *Scientia Horticulturae*, 62:45-56.

Reference ID: 21150

Notes: #21150e

Abstract: The effect of three shade levels on morphology, growth and productivity of 'Grand Nain' (AAA) bananas during their first and second production cycles was studied in the Jordan Valley, Israel. In vitro propagated plants that were planted in the field in April 1990 were shaded with black saran screens of different densities, installed above the canopy level. The resultant photosynthetic photon flux density (PPFD) was reduced to 80%, 60% or 30% of the unshaded control. Although only the heaviest shade affected plant vegetative growth in the first cycle, bunch weight was reduced by 7% and 32% under medium and heavy shade, respectively. A highly significant effect on vegetative growth and production was observed during the second cycle. Flowering date was delayed by 6 days, 9 days and 15 days, and bunch weight was reduced by 8%, 21% and 55% under light, medium and heavy shade, respectively. Yield was reduced by all levels of shade, owing to the combined effect of reduced bunch weight and a lower stand. Shading reduced the rate of leaf emergence, leaf and foliage area, plant height and pseudostem circumference. The leaves had thinner laminae, with a reduced number of stomata and higher chlorophyll content. Our observations indicate a significant effect of long-term shade on bananas, and the utilization of high levels of PPFD by the banana plant.

Goenaga R. and H. Irizarry. 1995. Yield Performance of Banana Irrigated with Fractions of Class-A Pan Evaporation in a Semiarid Environment. *Agronomy Journal*, 87:172-176.

Reference ID: 21151

Notes: #21151e

Abstract: There is a scarcity of information regarding the optimum water requirement for banana (*Musa acuminata* Colla, AAA group) grown under semiarid conditions with drip irrigation in the tropics. A 3-yr study was conducted on a fine-loamy, mixed, isohyperthermic Cumulic Haplustoll to determine water requirement, yield, and fruit-quality traits of the plant crop (PC) and two ratoon crops (R1 and R2) of 'Grande Naine' banana subjected to five levels of irrigation. The irrigation treatments were based on Class A pan factors that ranged from 0.25 to 1.25 in increments of 0.25. Drip irrigation was supplied three times a week on alternate days. Results showed significant (P less than or equal to 0.01) irrigation treatment and crop effects for all yield components, fruit length and diameter, days to flower, and days from flowering to harvest. Highest marketable yield (86.3 Mg ha⁻¹) was obtained from the R2 crop with water application according to a pan factor of 1.25. Plant crop and R1 plants irrigated using the same pan factor yielded 45.3 and 70.3 Mg ha⁻¹, respectively. Increasing the pan factor from 0.25 to 1.25 resulted in weight gains of the third-upper hand of 70% in PC, 90% in R1, and 122% in R2. Irrigation according to increasing pan factors resulted in significant increases on the number of hands per bunch and the length and diameter of fruits in the third-upper and last hands in the bunch. It was concluded from this investigation that, to attain high yields, banana grown under semiarid conditions should be irrigated with a pan factor of not less than 1.0.

Akyeampong E., L. Hitimana, S. Franzel, and P. Munyemana. 1995. The Agronomic and Economic-Performance of Banana, Bean and Tree Intercropping in the Highlands of Burundi - An Interim Assessment. *Agroforestry Systems*, 31:199-210.

Reference ID: 21152

Notes: #21152e

Abstract: To meet their wood, fodder and fruit needs, resource-poor farmers with only small land holdings are forced to mix trees in their food crop plots. An experiment was conducted to study the effect of nine tree species planted at 312.5 trees ha⁻¹ (4 x 8 m) on the yield of bananas planted at 625 stools ha⁻¹ (4 x 4 m) and beans (80000 plants ha⁻¹) as well as the wood production of the trees when intercropped. In addition, an economic analysis was done to compare the different tree/banana/bean associations.

After three and one-half years, wood volume (in m³ ha⁻¹) of *Grevillea robusta* (18.1), was highest and that of *Erythrina poeppigiana* (2.7), *Cedrela odorata* (2.4) or *Markhamia lutea* (0.8) was the lowest. Volume of *Cedrela serrata* (13.7) was not significantly different from that of *Albizia chinensis* (12.8) but was significantly higher than that of *Leucaena diversifolia* (6.8), *Acrocarpus fraxinifolius* (6.7) or *Calliandra calothyrsus* (6.0).

None of the tree species had a significant influence on the yields of the bananas and none affected the yield of the bean crops until the seventh cropping season, three years after the trees were planted. In that year, *Grevillea* reduced bean yield by 29%, *Albizia* by 34% and *Leucaena* by 36%. From the economic analyses, all the treatments except *Leucaena* and *Markhamia* had positive net benefits relative to the control (banana/bean) but the results were highly variable. *C. serrata* was found to be the best tree to be intercropped in a banana/bean system.

Goenaga R., H. Irizarry, B. Coleman, and E. Ortiz. 1995. Drip Irrigation Recommendations for Plantain and Banana Grown on the Semiarid Southern Coast of Puerto-Rico. *Journal of Agriculture of The University of Puerto Rico*, 79:13-27.

Reference ID: 21153

Notes: #21153e

Abstract: Plantain and banana production in the semiarid lowlands of the southern coast of Puerto Rico has been increasing because of a greater demand for high-quality fruits, high farm-gate prices and the availability of arable land with an irrigation infrastructure. There is, however, a scarcity of information on optimum water requirements and practical irrigation recommendations for growers of these crops. Five irrigation regimes based on class A pan factors, ranging from 0.25 to 1.25 were used to obtain fractions of the potential evapotranspiration and to evaluate their influence on yield and other crop traits. Results were extrapolated to make projections on productivity, gross sales, and on irrigation costs incurred in the operation of a 20-hectare farm of drip irrigated plantains or bananas. Increasing the amount of applied irrigation in a 20-hectare plantation from a pan factor of 0.75 to 1.25 increased the number of banana fruit boxes by 6,747 in the plant crop, and by 18,009 in the first banana ratoon. This irrigation increment resulted in gross sales increases of \$40,482 for the banana plant crop, and \$108,054 for the first banana ratoon, with an additional water and energy cost of only \$2,388. The net income for the plant crop and first banana ratoon irrigated according to a pan factor of 1.0 was estimated to be \$51,780 and \$163,500, respectively, in a 20 hectare banana plantation. There were no significant differences in the number of plantain fruits in

irrigated plants when pan factors ranged from 0.75 to 1.25. However, irrigating plantains according to a pan factor of 1.25 significantly increased bunch yield and fruit weight. This article presents a detailed economic analysis of all the operational costs involved in the establishment and management of a banana plantation on the southern coast of Puerto Rico.

Robinson J. and D. Nel. 1990. Competitive-Inhibition of Yield Potential in a Williams Banana Plantation Due to Excessive Sucker Growth. *Scientia Horticulturae*, 43:225-236.

Reference ID: 21154

Notes: #21154e

Abstract: A desuckering experiment with cultivar 'Williams' banana was established at Burgershall Research Station in the subtropical Eastern Transvaal. Unwanted suckers were excised when they attained a height of 300 (control), 500 or 800 mm, leaving one sucker per mat as the ratoon follower. A fourth treatment entailed desuckering at a height of 300 mm, but with a large nursery sucker left on the mat for later excavation. In the plant crop there was no significant reduction of bunch mass or yield per annum due to desuckering at 800-mm height. However the selected first (R1) and second (R2) ratoon followers which were competing with large unwanted suckers produced smaller bunches, an extended cycle time and lower yield per annum. In the R1 and R2 cycles, the yield reductions with 500-mm desuckering were 8.3 and 9.1%, whereas for 800-mm desuckering yield was reduced by 16.9 and 17.5%, respectively. No treatment differences occurred in the number of R1 suckers excised per mat. The presence of a large nursery sucker in addition to the follower decreased yield by 7.9 and 12.6%, respectively. Leaf area on an 800-mm sucker was 39 times greater than for a 300-mm sucker. Early desuckering of small suckers is recommended to improve yields and reduce labour costs.

Hegde D. M. and K. Srinivas. 1989. Effect of Soil Matric Potential and Nitrogen on Growth, Yield, Nutrient-Uptake and Water-Use of Banana. *Agricultural Water Management*, 16:109-117.

Reference ID: 21155

Notes: #21155e

Abstract: The influence of irrigating at different soil matric potentials (-25, -45, -65 and -85 kPa at 15 cm depth) under different levels of nitrogen (100, 200 and 300 g/plant) on growth, yield, nutrient uptake and water use of banana ("Robusta") were investigated at the Indian Institute of Horticultural Research, Bangalore. The most frequent irrigation at a soil matric potential of -25 kPa resulted in maximums of growth, dry matter and yield, although data were not significantly different from those for irrigation at -45 kPa. Infrequent irrigations at -65 and -85 kPa delayed flowering and had a significantly adverse effect on growth and yield. Nutrient uptake declined with decreasing frequency of irrigation except in the case of K and mostly followed the changes in dry matter. Banana irrigated at -45 kPa used 1601 mm of water in 485 days. Increasing nitrogen fertilization improved growth, yield, nutrient uptake and water use, although no difference between application rates of 200 and 300 g/plant was found.

Hegde D. M. 1988. Growth and Yield Analysis of Robusta Banana in Relation to Soil-Water Potential and Nitrogen-Fertilization. *Scientia Horticulturae*, 37:145-155.

Reference ID: 21156

Notes: #21156e

Abstract: 'Robusta' banana was subjected to 4 soil water potentials (-25, -45, -65 and -85 kPa SWP) under 3 levels of N fertilization (100, 200 and 300 g plant⁻¹). Most frequent irrigation when the SWP reached -25 kPa resulted in maximum dry-matter production, leaf area index (LAI), leaf area duration (LAD) and crop growth rate (CGR), producing the highest fruit yield (52.8 t ha⁻¹) although it was not significantly different from less frequent irrigation at -45 kPa (51.8 t ha⁻¹). Irrigation at SWP of -65 and -85 kPa had significant adverse effects on growth and productivity as compared to frequent irrigation.

Increasing N application from 100 to 200 g plant⁻¹ significantly increased the fruit yield (from 45.3 to 49.3 t ha⁻¹), this improvement being due to significant increases in LAI, LAD and CGR leading to higher dry-matter production. Net assimilation rate (NAR) and relative growth rate (RGR) remained largely unaffected by SWP and N fertilization.

ISP. The Planter June 2010. 1011[86], 373-442. 2010. Kuala Lumpur, The Incorporated Society Of Planters.

Reference ID: 21157

Notes: S #21157

Abstract: In this issue: Good Plantation Practices Water Management Techniques- A practical experience at Foong Lee Plantation Production, Agro-Management and Performance of MATAG hybrids Lingerin Memories - On the shore of the 'The Land Below the Wind': Part 10 A Walk to the Chattri Did You Know?

ISP. The Planter July 2010. 1012[86], 451-520. 2010. Kuala Lumpur, The Incorporated Society Of Planters.

Reference ID: 21158

Notes: S #21158

Abstract: In This Issue: Global Demand For Land Strategy to Manage Herbicide Resistant *Eleusine indica* in an Oil Palm Nursery in Jerantut Area The Development of the Rubber Manufacturing Industrial Sector in Malaysia Re-vitalizing the Coconut Industry in Malaysia- Policies and Strategies for Implementation Lingerin Memories Giram Estate Police Auxiliary Home Guard TES Examination Schedule

ISP. The Planter August 2010. 1013[86], 529-598. 2010. Kuala Lumpur, The Incorporated Society of Planters.

Reference ID: 21159

Notes: S #21159

Abstract: In this issue: New Kid on the Block- China compound Rubber Development of Oil Palm on Peat: A Socio-economic Perspective Raising Performance Through Improved Professionalism Save the Jungle: Plant Palms Lingerin Memories Intruders in the Bungalow No.2 Obituary- Allahyarham Dato' Ismayudin bin Abdul Manan

ISP. The Planter September 2010. 1014[86], 607-670. 2010. Kuala Lumpur, The Incorporated Society of Planters.

Reference ID: 21160

Notes: S #21160

Abstract: In this issue: Addressing Needs of Rubber Growers in Malaysia- Manuring as an example The Status of Weed Resistance in Plantation Crops in Malaysia Global Trends and New Opportunities for the Coconut Industry Lingerin Memories The Rayan Decisions

ISP. The Planter November 2010. 1016[86], 749-820. 2010. Kuala Lumpur, The Incorporated Society of Planters.

Reference ID: 21161

Notes: S #21161 Abstract: In this issue: Herbicide Resistance Awareness in Malaysia A Blunder or Miracle Crop: Jatropha Curcas Dilemma in the Tropics Managing Oil Palm Nurseries: IOI's experience Early Experience at the Rubber Research Institute of Malaya's Experiment Station (RRIES) at Sungai Buloh The Planter Interview- H V Speldewinde Preparing for a Happy Retirement Letter to the editor Obituary- Hunter Crawford

ISP. The Planter December 2010. 1017[86], 829-912. 2010. Kuala Lumpur, The Incorporated Society of Planters.

Reference ID: 21162

Notes: S #21162

Abstract: In this issue: Labour Shortage: Addressing the Issue of Seasonal Crop Losses Impact of El Nino Occurrence on Oil Palm Yield in Malaysia Weed and Cover Crop Management in Oil Palm The Resort Owner in Tambea Sikon Lo and Sumitro The Planter Interview: Boon Weng Siew FISP, AISP, LISP Holders of ISP TES Examination Schedule

ISP. The Planter February 2015. 1067[91], 73-140. 2015. Kuala Lumpur, The Incorporated Society of Planters.

Reference ID: 21163

Notes: S #21163

Abstract: In this issue: Conservation of Malaysian Plantation Heritage Benchmarking Yield for Sustainable Intensification of Oil Palm Production in Indonesia using PALMSIM Evaluation of Organic Matter as Potting Media Unfolding the Indonesian Saga- A Volatile Situation Sadness in Riau

ISP. The Planter March 2015. 1068[91], 149-210. 2015. Kuala Lumpur, The Incorporated Society of Planters.

Reference ID: 21164

Notes: S #21164

Abstract: In this issue: Who Cares About the Technical Competency of a Planter? The Control of Swamp Giant Rat (Sundamys Melleri(Jentik), Muridae, Rodentia) Infestation by Shooting Unfolding the Indonesian Saga Mr Orchard and Dunlop's Way Forward Barn Owl (Tyto Alba) Management in Southerin Perak Plantations Sdn Bhd- A Pictorial Essay

ISP. The Planter April 2015. 1069[91], 219-284. 2015. Kuala Lumpur, The Incorporated Society of Planters.

Reference ID: 21165

Notes: S #21165

Abstract: In this issue: Have We Resolved Our Issues? Control of *Alocasia* sp. And *Etlingera brevilabrum* in Oil Palm Plantations in the Kinabatangan Region Oil Palm Insect Pests- Field Control by Field Investigation Unfolding the Indonesian Saga The Storage Tank Obituary- Sarkunanantham Thiruchitumbalam

ISP. The Planter May 2015. 1070[91], 293-350. 2015. Kuala Lumpur, The Incorporated Society of Planters.

Reference ID: 21166

Notes: S #21166

Abstract: In this issue: Oil Palm- Meeting the Global Soil Security Challenge Evaluation of Thiosultap disodium by Targeted Trunk Injection for the Control of Oil Palm Pests in Papua New Guinea Oil Palm Rat Infestation- Field Control by Field Investigation Pages from the past- Responsibilities and Duties of Junior Executives in Plantation Management A Tale of Two Secretaries

Daniells J. and P. J. O'Farell. 1987. Effect of Cutting Height of the Parent Pseudostem on Yield and Time of Production of the Following Sucker in Banana. *Scientia Horticulturae*, 31:89-94.

Reference ID: 21167

Notes: #21167e

Abstract: Parent pseudostems of bananas were cut at three different heights at harvest. Growth and yield of the following sucker were examined. Cutting high (200 cm) increased bunch weight by 4.6 kg (12%) and decreased the time to harvest by 18 days (5%) compared to cutting low (10 cm). Cutting at medium height (100 cm) resulted in an intermediate bunch weight, but there was no difference in time to harvest compared to cutting high. The increase in bunch weight resulted from an increase in the number of fingers per bunch, with no change in finger size. The pseudostem height of the follower at the commencement of the experiment was used as a covariate in the analysis of results. There was a 16.5-kg increase in bunch weight with increase in follower height across the range 115-217 cm. The crop cycle of the follower was decreased by 113 days across the same range.

Robinson J. C. and A. J. Alberts. 1986. Growth and Yield Responses of Banana (Cultivar Williams) to Drip Irrigation under Drought and Normal Rainfall Conditions in the Subtropics. *Scientia Horticulturae*, 30: 187-202.

Reference ID: 21168

Notes: #21168e

Abstract: In a drip-irrigation trial with bananas (cultivar 'Williams') at Levubu, North-Eastern Transvaal, supplementary water was applied daily using ratios (crop water-use coefficients) of 0.25, 0.50 and 0.75 to schedule irrigations. Growth and yield responses were recorded over three successive cropping cycles. In both plant crop and first ratoon cycles, growth and yield were improved at the highest (0.75), the differences being more pronounced in the first ratoon. At the lowest (0.25), a stress-induced growth reduction occurred during the hot summer months. Bunch mass in the first ratoon increased from 31.7 to 44.6 kg as crop coefficient increased from 0.25 to 0.75, this improvement being due to more hands per bunch, more fingers per hand and longer fingers. Hand and finger initiation appeared to be

more sensitive to water stress than fruit development. As a result of larger bunches and shorter cycles, yield $\text{ha}^{-1} \text{ year}^{-1}$ (first ratoon) increased from 55.1 to 73.7 to 83.4 $\text{t ha}^{-1} \text{ year}^{-1}$ at of 0.25, 0.50 and 0.75, respectively. Before irrigations, average soil moisture potential in the drip rootzone during summer decreased from -55 to -23 to -4 kPa for of 0.25, 0.50 and 0.75, respectively.

In the second ratoon cycle, only a small yield increase (8%) was recorded between treatments 0.25 and 0.50, with no further increase at 0.75. Rainfall was double that falling during the first ratoon cycle, and consequently all components of evaporative demand were reduced. There was also an absence of soil moisture stress with all three treatments in the second ratoon. The crop E_t estimated at maximum yield level was 1566 mm year^{-1} in the first ratoon and 1026 mm year^{-1} in the second ratoon cycle, although maximum yield potential was 18% less in the latter. A standard summer crop coefficient for irrigation cannot be recommended in the subtropics due to large climatic variations from year to year. Evaporation pan scheduling should therefore be supported by soil moisture potential data to relate irrigation to actual crop water demand.

Robinson J. C. and D. J. Nel. 1986. The Influence of Planting Date, Sucker Selection and Density on Yield and Crop-Timing of Bananas (Cultivar Williams) in the Eastern Transvaal. *Scientia Horticulturae*, 29:347-358.

Reference ID: 21169

Notes: #21169e

Abstract: In the subtropical banana-growing areas of South Africa, there is a pronounced and consistent tendency for fruit to be oversupplied in the spring (September-November) and undersupplied in the autumn (March-May). Under identical soil, planting material and general management conditions, a crop-timing trial with 'Williams' banana was established at Burgershall Research Station, Eastern Transvaal, to compare the effects of planting date (September, December, March), time of first sucker selection (5 and 10 months after planting) and density (1666 and 1250 plants ha^{-1}) on yield and harvest season over 3 crop cycles. Cumulating the yield/ha/annum for the plant crop and first ratoon cycles, there was a small but significant decrease (4%) as planting date was delayed from September to December, and a larger significant reduction in yield (18%) with delay from December to March planting. While cumulative yield/ha/annum for plant crop plus first ratoon increased significantly (19%) at the higher density of 1666 plants ha^{-1} , no differences occurred as a result of sucker selection treatment. March-planted bananas were harvested during the undesirable spring period, and this effect was largely carried over into the first ratoon and second ratoon cycles. December planting was optimal and September planting intermediate from a crop-timing viewpoint. Cumulating all 3 crop cycles, 50% of the total bunch harvest could be timed during the autumn from December planting at a density of 1666 plants ha^{-1} . From September planting, the proportion of autumn-harvested fruit could also be increased by delaying the selection of the first ratoon sucker until at least 10 months after planting. Results demonstrated the in-field potential for overcoming the natural banana shortage in South Africa during autumn.

Turner D. W. and B. Barkus. 1982. Yield, Chemical-Composition, Growth and Maturity of Williams Banana Fruit in Relation to Supply of Potassium, Magnesium and Manganese. *Scientia Horticulturae*, 16:239-252.

Reference ID: 21170

Notes: #21170e

Abstract: In New South Wales, banana plantations are subject to shortages of K, Mg and possibly high Mn. We investigated the effects of a low supply of K and Mg and high Mn on 'Williams' banana grown in drainage lysimeters over 3 crop cycles. Low K supply reduced yield by 73%, low Mg reduced it by 17% and high Mn had no effect. The bunch-weight component, mean finger weight, was reduced most (57 and 13% by low K and Mg, respectively) and the fruit number per hand was reduced least (16 and 8%, respectively). Fruit growth was exponential, and the relative fruit growth rate was influenced by K supply and seasonal conditions. High Mn supply decreased fruit maturity (greenlife) by 23%. Low K supply increased greenlife 79%, but only in relation to its effect on fruit size. The concentrations of K and Mg in the fruit dry matter were largely independent of the concentration in the solution around the roots. Mn concentration in fruit dry matter was directly proportional to Mn supply. The concentration of Ca in fruit dry matter showed a significant ($P = 0.01$) positive association with greenlife over all treatments.

Turner D. W. 1980. Some Factors Related to Yield Components of Bananas, in Relation to Sampling to Assess Nutrient Status. *Fruits*, 35:19-23.

Reference ID: 21171

Notes: #21171e

Abstract: In this study from Australia the mid floral stage of banana (*Musa* sp.) plant growth (plant in reproductive state but bunch not emerged) is suggested as being physiologically the best for sampling for leaf analysis. The leaf area emerging at that time was positively correlated with the total number of fruit per bunch. The leaf area x longevity of the last 3 leaves was related to the mean fruit weight. Which leaf is chosen is not important as their concentrations of nutritive elements is nearly the same during this stage of growth.

Sharaf A., A. S. Ola, S. M. Hegazi, and K. Sedky. 1979. Chemical and Biological Studies on Banana Fruit. *Zeitschrift fur Ernährungswissenschaft*, 18:8-15.

Reference ID: 21172

Notes: #21172e

Abstract: Chemical and biological evaluation of both the edible and nonedible portion of banana fruit was carried out. The possibility of using the nonedible portion (peel) as animal feed was also explored. The results showed a remarkable difference concerning the chemical composition of both the edible and nonedible portions. The amino acid contents were proved to be vastly deficient with regard to the indispensable amino acids with exception of phenylalanine which was found in good amounts in the edible portion (pulp). The biological results demonstrated that neither the pulp nor the peel portions yielded good P.E.R. values when used at 6% protein level. The P.E.R values showed negative values which amounted to -1.75, -5.85 and -4.67 for the pulp and peel diets respectively. Incorporation of the stock diet to the peel diet resulted in a slight increase which amounted to 6% in both male and female rat groups.

Goenaga R. and H. Irizarry. 1998. Yield Of Banana Grown With Supplemental Drip-Irrigation On An Ultisol. *Experimental Agriculture*, 34:439-448.

Reference ID: 21173

Notes: #21173e

Abstract: A three-year study was conducted on an Ultisol to determine the water requirement, yield and fruit-quality traits of three ratoon crops (R1, R2, R3) of 'Grande Naine' Banana (*Musa acuminata* Colla, AAA group) subjected to four levels of irrigation. The irrigation treatments were based on Class A pan factors ranging from 0.0 (rainfed) to 1.0 in increments of 0.25. When needed, drip irrigation was supplied three times a week on alternate days. Results showed significant ($p>0.01$) irrigation treatment and crop effects on bunch weight, yield, bunch mean hand weight, weight and fruit diameter of the third and last hands, and length of fruits of the third hand. Highest marketable yield (47.9t ha⁻¹) was obtained from the R2 crop with water application according to a pan factor of 1.0. It was concluded that irrigating the crop according to a pan factor of 1.0 was sufficient to justify the investment of a drip-irrigation system for a farm in the mountain region.

Phirke N. V., S. B. Patil, R. M. Chincholkar, and R. M. Kothari. 2001. Recycling Of Banana Pseudostem Waste For Economical Production Of Quality Banana. *Resources, Conservation and Recycling*, 31:347-353.

Reference ID: 21174

Notes: #21174e

Abstract: Banana pseudostem biomass, traditionally incinerated and wasted, has been conserved and recycled by solid state fermentation (SSF) into plant growth stimulating soil conditioner (SC). This SC alone or combined with biofertilizers showed reduced mortality (10 and 12%) of plant suckers, enhanced chlorophyll contents (593 and 661 ug g⁻¹), gave biomass (35.0 and 36.6kg) at par and improved yield (54.2 and 55.0 MT ha⁻¹, respectively). This has afforded (i) saving of chemical fertilizers by 50%, (ii) reduction in quantum (40%) and frequency (15%) of irrigation and (iii) reduction in cost of electricity and labor without sacrificing quality and quantity of banana. Thus, voluminous agro-waste is converted into an eco-friendly agro-input for sustainable productivity.

de Barros I., J. M. Blazy, G. S. Rodrigues, R. Tournebize, and J. P. Cinna. 2009. Emergy evaluation and economic performance of banana cropping systems in Guadeloupe (French West Indies). *Agriculture, Ecosystems & Environment*, 129:437-449.

Reference ID: 21175

Notes: #21175e

Abstract: Banana is the second most important agricultural commodity in Guadeloupe (French West Indies-FWI) and, to compensate the decline in international prices during the last 15 years, banana growers have intensified their production systems by increasing the use of technological inputs. Such intensification strategies, that require both material and investment increases, may impose economic as well as environmental risks, given the fragile island ecosystems. In order to assess the environmental performance of banana production in Guadeloupe, emergy synthesis methods were applied to six different types of banana cropping systems previously identified in the island. Additionally, aiming at improving managerial capacity and investment decision making, environmental performance results were contrasted with economic analysis for the six cropping systems. As a general outcome, these analyses showed that the better the

environmental performance of the cropping system, the worse its economic performance. This result was corroborated by an increased contrast among cropping systems as related to their dependence on purchased inputs, although all cropping systems followed the same intensive and arguably wasteful agricultural model. Therefore, the analyses point out that sustainable banana production in Guadeloupe depends on a shift from the high fossil input model to a natural resources intensive one. In this sense, emergy flow analysis shows that innovation towards environmentally sound practices that would enhance nutrient cycling: integrate weeds, pests and diseases control; and improve the banana packing process might result in most positive impacts on overall sustainability. Economic analysis showed that the high labour costs contribute largely to the dependency of banana production on agricultural subsidies. However, reorienting the current European agricultural income policy to an environmental performance-based subvention might be a policy opportunity to achieve the present social goals while promoting sustainability in banana production. Furthermore, the EC regulation on quality standards for commercial bananas, by imposing strict aesthetic benchmarks, has a negative effect on the sustainability of banana production because substantial non-renewable and purchased emergy inflows into banana production systems aim to improve aesthetic standards over sound ecological management.

Powers J. S. 2004. Changes in soil carbon and nitrogen after contrasting land-use transitions in northeastern Costa Rica. *Ecosystems*, 7:134-146.

Reference ID: 21176

Notes: #21176e

Abstract: Northeastern Costa Rica is a mosaic of primary and secondary forests, tree plantations, pastures, and cash crops. many studies have quantified the effects of one type of land-use transition (for example, deforestation or reforestation) on soil properties Such as organic carbon (C) storage, but few have compared different land-use transitions simultaneously. We can best understand the effects of land-use change on regional and global ecosystem processes by considering all of the land-use transitions that occur in a landscape. In this study, I examined the changes in total soil C and nitrogen (N) pools (to 0.3 m) that have accompanied different land-use transitions in a 140,000-ha region in northeastern Costa Rica. I paired sites that had similar topography and soils but differed in recent land-use history. The following land-use transitions were represented: 12 conversions of primary forests to banana plantations, 15 conversions of pastures to cash crops, and four conversions of pastures to *Vochysia guatemalensis* tree plantations. The Conversion of forests to bananas decreased soil C concentrations and inventories (Mg C ha⁻¹) in the surface soil by 37% and 16.5%, respectively. The conversion of pastures to cash crops reduced soil C concentrations and inventories to the same extent that forest-to-banana cropping did. Furthermore, young *Vochysia* plantations do not appear to increase soil C storage, at least over the 1st decade. When data from all land-use transitions were pooled, the difference in root biomass and leaf litter pools between land-use pairs explained 50% of the differences in soil C concentrations and 36% of the differences in soil C inventories. Thus, reduced productivity or C inputs to the soil is one mechanism that could explain the losses in soil C pools with land-use change. in this landscape, losses of soil C due to cultivation are rapid, whereas re-accumulation rates are slow. Total soil N pools (0-10 cm) were also reduced after the conversion of forests to banana plantations or the conversion of pastures to crops, despite fertilization of the cropped soils. This suggests that the added N fertilizer is

not retained but instead is exported via produce, N gas emissions, and hydrologic processes.

Villa J. E. L., R. R. A. Peixoto, and S. Cadore. 2014. Cadmium and Lead in Chocolates Commercialized in Brazil. *Journal of Agricultural and Food Chemistry*, 62:8759-8763.

Reference ID: 21177

Notes: #21177e

Abstract: Cadmium (Cd) and lead (Pb) concentrations and their relationship to the cocoa content of chocolates commercialized in Brazil were evaluated by graphite furnace atomic absorption spectrometry (GF AAS) after microwave-assisted acid digestion. Several chemical modifiers were tested during method development, and analytical parameters, including the limits of detection and quantification as well as the accuracy and precision of the overall procedure, were assessed. The study examined 30 chocolate samples, and the concentrations of Cd and Pb were in the range of <1.7-107.6 and <21-138.4 ng/g, respectively. The results indicated that dark chocolates have higher concentrations of Cd and Pb than milk and white chocolates. Furthermore, samples with five different cocoa contents (ranging from 34 to 85%) from the same brand were analyzed, and linear correlations between the cocoa content and the concentrations of Cd ($R^2 = 0.907$) and Pb ($R^2 = 0.955$) were observed. The results showed that chocolate might be a significant source of Cd and Pb ingestion, particularly for children.

Dahiya S., R. Karpe, A. G. Hegde, and R. M. Sharma. 2005. Lead, cadmium and nickel in chocolates and candies from suburban areas of Mumbai, India. *Journal Of Food Composition And Analysis*, 18:517-522.

Reference ID: 21178

Notes: #21178e

Abstract: Nickel, lead and cadmium contents were determined in 69 different brands of chocolates and candies available in local markets of suburban areas of Mumbai, India. The majority of these chocolates and candies are made mainly from cocoa, milk solids, dry fruits, fruit flavours and sugar. Out of 69 brands of chocolates and candies analysed, 23 were cocoa-based, 22 milk-based and another 24 were of fruit flavour and sugar-based. Cadmium level ranged from 0.001 to 2.73 $\mu\text{g/g}$ with an average of 0.105 $\mu\text{g/g}$. Nickel ranged from 0.041 to 8.29 $\mu\text{g/g}$ with an average of 1.63 $\mu\text{g/g}$ and lead level ranged from 0.049 to 8.04 $\mu\text{g/g}$ with an average of 0.93 $\mu\text{g/g}$. Cocoa-based chocolates are found to have higher contents of the analysed heavy metals than milk-based chocolates, fruit flavour- or sugar-based candies.

Mounicou S., J. Szpunar, C. Blake, and R. Lobinski. 2002. Development of a sequential enzymolysis approach for the evaluation of the bioaccessibility of Cd and Pb from cocoa. *Analyst*, 127:1638-1641.

Reference ID: 21179

Notes: #21179e

Abstract: An in vitro model simulating enzymatic activity in the gastrointestinal tract was developed for the assessment of the potential bioaccessibility of Cd and Pb in cocoa powder and liquor. The model was based on the sequential extraction with simulated gastric and intestinal juices; the residue after the latter extraction was further investigated by using, in parallel, solutions of phytase and cellulase. The solubility of Cd and Pb in the corresponding enzymatic extracts was measured by

ICP MS. The bioaccessibility of Cd in cocoa varied from 10 to 50% in gastrointestinal conditions. An additional 20 or 30% of Cd could be recovered by phytase and cellulase, respectively. The bioaccessibility of Pb in gastrointestinal conditions did not exceed 5-10%. Only a few percent more of this metal could be recovered by extraction with phytase and cellulase.

Mounicou S., J. Szpunar, R. Lobinski, D. Andrey, and C. J. Blake. 2002. Bioavailability of cadmium and lead in cocoa: comparison of extraction procedures prior to size- exclusion fast-flow liquid chromatography with inductively coupled plasma mass spectrometric detection (SEC-ICP-MS). *Journal Of Analytical Atomic Spectrometry*, 17:880-886.

Reference ID: 21180

Notes: #21180e

Abstract: Fifteen extraction methods were investigated for the recovery of different classes of Cd and Pb species in 8 different cocoa powder samples. The procedures targeted water-soluble compounds, polypeptide and polysaccharide complexes and compounds soluble in simulated gastrointestinal conditions. The extracts were analysed by size-exclusion fast-flow liquid chromatography with ICP-MS detection. The detection limit was 0.5 $\mu\text{g l}^{-1}$ and the RSD was less than 7.5%. Cd and Pb were very firmly bound to the insoluble matrix components, of which the binding capacity exceeded about 1000 times the naturally present metal levels. Cocoa powder may show possible detoxifying properties for Pb and Cd by binding them into stable complexes, which are resistant in gastrointestinal conditions. The maximum average recovery for Cd and Pb was, respectively, 15% and 5% of the total metal present.

Valiente C., E. Molla, M. M. Martin-Cabrejas, F. J. Lopez-Andreu, and R. M. Esteban. 1996. Cadmium binding capacity of cocoa and isolated total dietary fibre under physiological pH conditions. *Journal of the Science of Food and Agriculture*, 72:476-482.

Reference ID: 21181

Notes: #21181e

Abstract: Cadmium binding capacity of cocoa and isolated total dietary fibre (TDF) was investigated in vitro under simulated physiological pH conditions. The effect of Cd^{2+} retention on the bioavailability of essential endogenous minerals was also studied. The sample was mixed with buffered Cd^{2+} solution and, after equilibration, the residue was separated for quantitative measurement of soluble Cd^{2+} in the supernatant. Cocoa exhibited a high affinity for Cd^{2+} in solution. The amount of bound Cd^{2+} rose with increasing metal concentration and pH. TDF was the major fraction responsible for binding of Cd^{2+} by cocoa. Phytate was probably another important cause of the decrease of Cd^{2+} solubility. The addition of various concentrations of Cd^{2+} to cocoa and TDF was shown to affect the solubility of endogenous minerals. When Cd^{2+} was bound by TDF there was a marked increase in the availability of endogenous Fe, Zn, Ca and Mg, specially at duodenal pH conditions.

Low K. S. and C. K. Lee. 1994. Effect of pH and Inorganic Reagents on the Immobilization of Cadmium in Some Malaysian Cocoa-growing Soils. *Pertanika Journal Of Science & Technology*, 2:181-187.

Reference ID: 21182

Notes: #21182e

Abstract: The effects of pH and various inorganic reagents on the immobility of cadmium in three Malaysian cocoa-growing soils (Rengam, Bernam and Malacca) were investigated. Results show that $\text{Ca}(\text{OH})_2$ was most efficient in immobilizing cadmium. Carbonates and phosphates were also effective, though to a lesser extent.

Aikpokpodion P. E. 2010. Assessment of heavy metals pollution in fungicide treated Cocoa plantations in Ondo state, Nigeria. *Journal Of Applied Biosciences*, 33:2037-2046.

Reference ID: 21183

Notes: #21183e

Abstract: Objective: To assess the impacts of copper-based cocoa fungicides on the environmental quality of cocoa plantations in Ondo State, Nigeria. Methodology and results: The contents of five elements (Cu, Zn, Pb, Cd and Fe) were assayed in Cocoa plantations across Idanre, Owena and Bamikemo in Ondo state. The contamination of the soils was assessed on the basis of geoaccumulation, index, enrichment factor, contamination factor, metal contamination index and pollution load index. The test revealed that all the studied cocoa plantations are highly contaminated with copper while the rest of the heavy metals are most likely to be from natural sources. Conclusion and application of findings: The pollution load index values confirmed that the quality of the cocoa soils studied is deteriorating and this may have severe impact on soil biodiversity and ground water. Result suggests that alternative means of crop protection using biodegradable fungicides should be identified.

Prugarova A. and M. Kovac. 1987. Lead and Cadmium Content in Cocoa Beans. *Nahrung-Food*, 31:635-636.

Reference ID: 21184

Notes: #21184e

Abstract: The choice of cocoa beans as the experimental and sample material for study of the contamination with lead and cadmium was inspired by high Pb and Cd limits in foods made on its basis (cocoa powder, chocolate) as well as by the relatively high proportion of these foods in human nutrition. For Cd, the limits in food products are within the range of $0.01 \text{ mg} \cdot \text{kg}^{-1}$ (milk) to $1.0 \text{ mg} \cdot \text{kg}^{-1}$ (kidneys) whereas the limits for lead range between $0.1 \text{ mg} \cdot \text{kg}^{-1}$ (e.g. milk) and $10.0 \text{ mg} \cdot \text{kg}^{-1}$ (e.g. tea, yeast, crustaceans, molluscs). Limits for Pb and Cd in foods made on cocoa bean basis are given in Table 1 [1].

Comte I., F. Colin, O. Grunberger, J. K. Whalen, R. H. Widodo, and J. P. Caliman. 2015. Watershed-scale assessment of oil palm cultivation impact on water quality and nutrient fluxes: a case study in Sumatra (Indonesia). *Environmental Science And Pollution Research*, 22:7676-7695.

Reference ID: 21185

Notes: #21185e

Abstract: High fertilizer input is necessary to sustain high yields in oil palm agroecosystems, but it may endanger neighboring aquatic ecosystems when excess nutrients are transported to waterways. In this study, the hydrochemical dynamics of groundwater and streams under baseflow conditions were evaluated with bi-monthly measurements for 1 year on 16 watersheds. Hydrochemical measurements were related to the spatial distribution of soil and fertilization practices across a landscape of 100 km^2 , dominated by oil palm cultivation, in Central Sumatra, Indonesia. The low nutrient concentrations recorded in streams throughout the landscape indicated

that the mature oil palm plantations in this study did not contribute to eutrophication of aquatic ecosystems. This was ascribed to high nutrient uptake by oil palm, a rational fertilizer program, and dilution of nutrient concentrations due to heavy rainfall in the study area. Soil type controlled dissolved inorganic N and total P fluxes, with greater losses of N and P from loamy-sand uplands than loamy lowlands. Organic fertilization helped to reduce nutrient fluxes compared to mineral fertilizers. However, when K inputs exceeded the oil palm requirement threshold, high K export occurred during periods when groundwater had a short residence time. For higher nutrient use efficiency in the long term, the field-scale fertilizer management should be complemented with a landscape-scale strategy of fertilizer applications that accounts for soil variability.

Teuscher M., M. Vorlaufer, M. Wollni, U. Brose, Y. Mulyani, and Y. Clough. 2015. Trade-offs between bird diversity and abundance, yields and revenue in smallholder oil palm plantations in Sumatra, Indonesia. *Biological Conservation*, 186:306-318.

Reference ID: 21186

Notes: #21186e

Abstract: Global land-use change has drastic consequences for biodiversity leading to losses of ecological functioning, ecosystem services and human well-being. While species dependent on undisturbed natural habitat are most affected by conversion to agriculture, even populations of disturbance-tolerant species can be endangered in landscapes dominated by high-input mono-cultural cropping systems. This has raised the question of how, and at what cost, a diversity of species can be conserved in such habitats. Focusing on birds of smallholder oil palm-dominated landscapes, we investigated the relationship between the ecological and economic outcomes of remnant or planted trees in smallholder oil palm plantations. The study comprised a household and a field component. We gathered plot specific data on yields, revenue and inputs from 120 households owning productive oil palm plantations in the Jambi Province, Sumatra, Indonesia. Bird diversity and abundance as well as vegetation structure was assessed on the same oil palm plots. We tested the effects of a set of economic and ecological variables on measures of bird diversity, bird abundance, oil palm yield, and total revenue. Our results show that a gain in bird diversity and bird abundance conditional on increases in number of trees comes along with a loss in revenue for farmers indicating that there is a win lose relationship between ecological and economic functions. However, since the relationship is non-linear, costs for bird species gain or gain in bird abundance change depending on the number of trees within an oil palm plantation: in a relatively extensively managed oil palm plantation (high number of trees, low oil palm yields), a further increase in the number of bird species or individuals leads to a relatively high loss in total revenue, whereas in an intensively managed oil palm plantation the same increase in number of bird species results in a smaller loss in revenue. An increase in bird abundance can be fostered at smaller costs when compared to the costs for increasing biodiversity. This suggests that there is room for tree-based enrichment of intensively managed oil palm plantations, where a relatively high increase in bird species richness or bird abundance could be achieved at relatively low cost.

Prescott G. W., D. P. Edwards, and W. A. Foster. 2015. Retaining biodiversity in intensive farmland: epiphyte removal in oil palm plantations does not affect yield. *Ecology and Evolution*, 5:1944-1954.

Reference ID: 21187

Notes: #21187e

Abstract: The expansion of agriculture into tropical forest frontiers is one of the primary drivers of the global extinction crisis, resulting in calls to intensify tropical agriculture to reduce demand for more forest land and thus spare land for nature. Intensification is likely to reduce habitat complexity, with profound consequences for biodiversity within agricultural landscapes. Understanding which features of habitat complexity are essential for maintaining biodiversity and associated ecosystem services within agricultural landscapes without compromising productivity is therefore key to limiting the environmental damage associated with producing food intensively. Here, we focus on oil palm, a rapidly expanding crop in the tropics and subject to frequent calls for increased intensification. One promoted strategy is to remove epiphytes that cover the trunks of oil palms, and we ask whether this treatment affects either biodiversity or yield. We experimentally tested this by removing epiphytes from four-hectare plots and seeing if the biodiversity and production of fruit bunches 2 months and 16 months later differed from equivalent control plots where epiphytes were left uncut. We found a species-rich and taxonomically diverse epiphyte community of 58 species from 31 families. Epiphyte removal did not affect the production of fresh fruit bunches, or the species richness and community composition of birds and ants, although the impact on other components of biodiversity remains unknown. We conclude that as they do not adversely affect palm oil production, the diverse epiphyte flora should be left uncut. Our results underscore the importance of experimentally determining the effects of habitat complexity on yield before introducing intensive methods with no discernible benefits.

Hashim Z., H. Muhamad, V. Subramaniam, and C. Y. May. 2014. Water Footprint: Part 2-FFB Production for Oil Palm Planted in Malaysia. *Journal of Oil Palm Research*, 26:282-291.

Reference ID: 21188

Notes: #21188e

Abstract: Water accounting across the production of fresh fruit bunch (FFB) in the oil palm's life cycle is gaining momentum arising from the importance placed on the need to quantify water footprint (WE). This article quantifies the WE of FFB production from oil palms grown in some areas in Malaysia, from an inventory data gathered from 2009-2012. The WE methodology of Hoekstra et al. (2009) was applied for calculating WE of FFB production. The data for crop evapotranspiration (ET) of 5.5 mm per day (Roslan and Mohd Haniff, 2004) was used to calculate green and blue WF. The results showed that for oil palm, the FFB yield average of 25-year life span was 20.7 t ha⁻¹ yr⁻¹. The FFB production WE was 1166 m³ t⁻¹ FFB (WF_{green} 1055; WF_{blue} 3.56; and WF_{grey} 107 m³ t⁻¹). The results showed that the green WE was higher than the grey or the blue WE as planting of oil palm in Malaysia is without irrigation. Oil palm requires a lot of green water (rain water), but when the amount of rain water is lower than ET, it becomes necessary to determine the water deficit of the soil in the oil palm-growing areas. This is to ensure that any shortcoming of water can be provided through irrigation.

Lee J. S. H., J. Garcia-Ulloa, J. Ghazoul, K. Obidzinski, and L. P. Koh. 2014. Modelling environmental and socio-economic trade-offs associated with land-sparing and land-sharing approaches to oil palm expansion. *Journal of Applied Ecology*, 51:1366-1377.

Reference ID: 21189

Notes: #21189e

Abstract: 1. The effectiveness of land-sharing and land-sparing approaches has been widely debated. Yet, few studies quantify the environmental and socio-economic outcomes of these approaches within a real-world landscape. Indonesia's plans to increase its palm oil production present an opportunity to investigate the potential environmental and socio-economic implications of the land-sharing and sparing approaches.

2. We developed a computer model to simulate the expansion of oil palm agriculture in Sumatra, Indonesia, under four different scenarios distinguishable by the dominance of scheme smallholders or industrial estates: business-as-usual, BAU (25 : 75, scheme smallholders: industrial estates); high-yielding industry dominated, ESTATE (10 : 90); low-yielding smallholder dominated, SMALLHOLDER (40 : 60), high-yielding smallholder dominated, HYBRID (40 : 60; but with improved smallholder yields).

3. Our results reveal several trade-offs associated with varying the proportion of scheme smallholders and productivity of oil palm plantations. The ESTATE scenario (reflecting land-sparing) resulted in lowest environmental costs in terms of forest conversion, greenhouse gas emissions, biodiversity losses and nitrogen fertilizer usage. Additionally, infrastructural development and tax revenues were highest under the land-sparing approach, though fewer jobs were created. The SMALLHOLDER scenario (indicating land-sharing) resulted in highest environmental costs in terms of forest conversion, carbon dioxide emissions and biodiversity losses but involved more households in oil palm agriculture and thus created more employment opportunities. The HYBRID scenario ranked second best in terms of both minimizing forest loss and job creation. However, the drawbacks of this approach included high nitrogen fertilizer consumption, lower infrastructural development and lower tax revenues.

4. Synthesis and applications. From an environmental perspective, it is far more important to implement spatial restrictions on oil palm expansion over forests since increasing the productivity of smallholdings and industrial estates among the four scenarios examined show minimal differences to biodiversity loss and greenhouse gas emissions. The hybrid approach shows that increasing the proportion of scheme smallholders need not come at a great environmental cost for achieving Indonesia's palm oil production target. From a policy perspective, this hybrid approach requires a change in legislation to increase the minimum land area an industrial estate owner must allocate to scheme smallholders (40%), as well as increased support to improve productivity in oil palm smallholdings.

Barnes, A. D., Jochum, M., Mumme, S., Haneda, N. F., Farajallah, A., Widarto, T. H., and Brose, U. Consequences of tropical land use for multitrophic biodiversity and ecosystem functioning. *Nature Communications* 5. 2014.

Reference ID: 21190

Notes: #21190e

Abstract: Our knowledge about land-use impacts on biodiversity and ecosystem functioning is mostly limited to single trophic levels, leaving us uncertain about whole-community biodiversity-ecosystem functioning relationships. We analyse consequences of the globally important land-use transformation from tropical forests to oil palm plantations. Species diversity, density and biomass of invertebrate communities suffer at least 45% decreases from rainforest to oil palm. Combining metabolic and food-web theory, we calculate annual energy fluxes to model impacts of land-use intensification on multitrophic ecosystem functioning. We demonstrate a 51% reduction in energy fluxes from forest to oil palm communities. Species loss

clearly explains variation in energy fluxes; however, this relationship depends on land-use systems and functional feeding guilds, whereby predators are the most heavily affected. Biodiversity decline from forest to oil palm is thus accompanied by even stronger reductions in functionality, threatening to severely limit the functional resilience of communities to cope with future global changes.

Carron M. P., Q. Auriac, D. Snoeck, C. Villenave, E. Blanchart, F. Ribeyre, R. Marichal, M. Darminto, and J. P. Caliman. 2015. Spatial heterogeneity of soil quality around mature oil palms receiving mineral fertilization. *European Journal of Soil Biology*, 66:24-31.

Reference ID: 21191

Notes: #21191e

Abstract: The African oil palm (*Elaeis guineensis* Jacq.) is grown on a total area of 16 million ha; but data on soil quality in mature oil palm plantations are fragmentary and data concerning biota are almost nonexistent. Consequently, no well-tested sampling method is available for soil diagnoses. We studied the spatial heterogeneity of the soil around the palm by measuring comprehensive soil quality in a 24-year-old oil palm plantation. Soil quality and litter were assessed in five zones with different plant cover, and different applications of herbicide or fertilizer. Physical-chemical characteristics, macrofauna, and nematofauna were analysed. A sampling method was developed and adapted to the way the cultivation practices are implemented: sampling by zone and weighting the plot mean by the respective area of each zone. The total density of macrofauna in the litter and in the 0-15 cm soil layer followed a gradient from the harvest pathway (29 ind m⁻²) to the windrow (1003 ind m⁻²). Ants (13-237 ind m⁻²), earthworms (11-120 ind m⁻²), Dermaptera (0-35 ind m⁻²), Coleoptera (3-24 ind m⁻²) and Chilopoda (0-43 ind m⁻²) were the main taxa. The termite population was very poor (3-4 ind m⁻²). The density of nematofauna was also heterogeneous (268-805 ind 100 g⁻¹ of soil). Heterogeneity between zones was also reflected in the density of the functional groups, mainly soil engineers, detritivores and predators for macrofauna and bacterial feeders, and phytoparasites for nematofauna. The weeded circular zone around the palm had the highest soil nutrient content (P, K, Ca, Mg, C-org CEC, base saturation). Its biodiversity was average but it contained the highest density of earthworms and nematofauna. Possible relationships between chemicals and biological groups in the food web are discussed.

Akpo E., T. J. Stomph, D. K. Kossou, A. O. Omore, and P. C. Struik. 2014. Effects of nursery management practices on morphological quality attributes of tree seedlings at planting: The case of oil palm (*Elaeis guineensis* Jacq.). *Forest Ecology and Management*, 324:28-36.

Reference ID: 21192

Notes: #21192e

Abstract: Even though oil palm production is associated with forest clearance and environmental degradation, it is also considered a potential carbon sink. For oil palm to fulfil its potential role in environmental sustainability, high quality seedlings are required. Nursery managers in Benin who produce oil palm seedlings for owners of small farms ignored recommended practices and developed their own. To evaluate the efficacy of their nursery management practices in terms of seedling growth, 2 experiments were conducted. Three polybag sizes (5 L, 8 L, and 15 L) in combination with 4 types of soil substrates and 3 fertiliser treatments were implemented in both experiments in a factorial design. Biomass (shoot, root, shoot-

to-root ratio) and allometric (seedling height, number of leaves, length of most developed leaf, root-collar diameter) variables were measured 8 or 6 months after transplanting.

Polybag size was the main factor determining oil palm seedling growth in both experiments. Applying 10 g fertiliser once a month was harmful to seedling survival with lethal effects in 5 L polybags. Arable soil with animal manure in 8 L polybags without any fertiliser supply sustained seedling growth well; this practice seemed to be the best balance between quality and production cost although 15 L polybags produced the best seedlings. Growth variables were highly correlated. Height and root-collar diameter constitute good candidates to estimate seedling biomass production non-destructively. The treatment effects on total biomass produced were similar for the 2 experiments.

Given the observed large effects of polybag size on seedling growth, our findings suggest that fertiliser addition or substrate selection cannot overrule container size effects; the latter should be considered carefully for (forest and crop) tree seedling production in nurseries.

Anuar E. N., R. Nulit, and A. S. Idris. 2015. Growth Promoting Effects of Endophytic Fungus *Phlebia GanoEF3* on Oil Palm (*Elaeis guineensis*) Seedlings. *International Journal of Agricultural And Biology*, 17:135-141.

Reference ID: 21193

Notes: #21193e

Abstract: Isolation from trunk and root tissues of oil palms by Malaysian Palm Oil Board (MPOB) has found several promising fungi, mainly *Hendersonia GanoEF*, *Amphinema GanoEF2*, and *Phlebia GanoEF3*. The objective of this study was to investigate the potential of *Phlebia GanoEF3* to serve as a biological fertilizer and eventually promote the oil palm seedlings growth. Two types of organic fertilizers; Empty Fruit Bunches (EFB) powder and Real Strong Bioorganic Fertilizer (RSBF) were incorporated into the formulation to develop biofertilizers containing endophytic fungus *Phlebia GanoEF3*. Five ratios of fertilizer to fungus (10: 50, 20: 40, 30: 30, 40: 20 and 50: 10) for each formulation were prepared and in vitro study and the shelf life of viable cell of *Phlebia GanoEF3* in the formulations during storage were determined. After eight months, the ratio of 30 g of EFB powder to 30 g of *Phlebia GanoEF3* (30: 30 g) and 10 g of RSBF to 50 g of *Phlebia GanoEF3* (10: 50 g) were found to be the suitable ratios for the in vitro study and application in the field. Investigation of endophytic fungus *Phlebia GanoEF3* on the growth of oil palm seedlings in nursery trial showed that seedlings treated with EFB and RSBF organic containing *Phlebia GanoEF3* increased the growth of the seedlings. All growth parameters measured showed significant difference in the mean values between treated and untreated seedlings. These findings showed that *Phlebia GanoEF3* is suitable to be used as biofertilizer for oil palm seedlings.

Offermans A. and P. Glasbergen. 2015. Boundary work in sustainability partnerships: An exploration of the Round Table on Sustainable Palm Oil. *Environmental Science & Policy*, 50:34-45.

Reference ID: 21194

Notes: #21194e

Abstract: Sustainability partnerships have the potential to function as boundary organizations that intertwine stakeholders from different domains of society to jointly

produce knowledge linked to action. However, little is known about the practice of knowledge production in such arrangements. In this paper we develop an analytical framework, based on attributes of the nature of knowledge, the process of knowledge production, and the organization of that process, to analyze the extent to which knowledge processes in partnerships can be understood as joint knowledge production (JKP). The application of the framework to the exemplary case of the Round Table on Sustainable Palm Oil (RSPO) shows that science and scientific knowledge do not necessarily play a dominant role in such a boundary organization. The analysis also shows that an abstract concept like JKP can be operationalized and used to assess characteristic of knowledge production in partnerships. This may provide leverage points to the actors involved to improve their boundary work. The framework can also be used as a dialogue instrument to open-up discussions about, and to reflect upon JKP in boundary organizations.

Austin K. G., P. S. Kasibhatla, D. L. Urban, F. Stolle, and J. Vincent. 2015. Reconciling Oil Palm Expansion and Climate Change Mitigation in Kalimantan, Indonesia. *Plos One*, 10.

Reference ID: 21195

Notes: #21195e

Abstract: Our society faces the pressing challenge of increasing agricultural production while minimizing negative consequences on ecosystems and the global climate. Indonesia, which has pledged to reduce greenhouse gas (GHG) emissions from deforestation while doubling production of several major agricultural commodities, exemplifies this challenge. Here we focus on palm oil, the world's most abundant vegetable oil and a commodity that has contributed significantly to Indonesia's economy. Most oil palm expansion in the country has occurred at the expense of forests, resulting in significant GHG emissions. We examine the extent to which land management policies can resolve the apparently conflicting goals of oil palm expansion and GHG mitigation in Kalimantan, a major oil palm growing region of Indonesia. Using a logistic regression model to predict the locations of new oil palm between 2010 and 2020 we evaluate the impacts of six alternative policy scenarios on future emissions. We estimate net emissions of 128.4-211.4 MtCO₂ yr⁻¹ under business as usual expansion of oil palm plantations. The impact of diverting new plantations to low carbon stock land depends on the design of the policy. We estimate that emissions can be reduced by 9-10% by extending the current moratorium on new concessions in primary forests and peat lands, 35% by limiting expansion on all peat and forestlands, 46% by limiting expansion to areas with moderate carbon stocks, and 55-60% by limiting expansion to areas with low carbon stocks. Our results suggest that these policies would reduce oil palm profits only moderately but would vary greatly in terms of cost-effectiveness of emissions reductions. We conclude that a carefully designed and implemented oil palm expansion plan can contribute significantly towards Indonesia's national emissions mitigation goal, while allowing oil palm area to double.

Scriven S. A., J. A. Hodgson, C. J. McClean, and J. K. Hill. 2015. Protected areas in Borneo may fail to conserve tropical forest biodiversity under climate change. *Biological Conservation*, 184:414-423.

Reference ID: 21196

Notes: #21196e

Abstract: Protected areas (PAs) are key for conserving rainforest species, but many PAs are becoming increasingly isolated within agricultural landscapes, which may

have detrimental consequences for the forest biota they contain. We examined the vulnerability of PA networks to climate change by examining connectivity of PAs along elevation gradients. We used the PA network on Borneo as a model system, and examined changes in the spatial distribution of climate conditions in future. A large proportion of PAs will not contain analogous climates in future (based on temperature projections for 2061-2080), potentially requiring organisms to move to cooler PAs at higher elevation, if they are to track climate changes. For the highest warming scenario (RCP8.5), few (11-12.5%; 27-30/240) PAs were sufficiently topographically diverse for analogous climate conditions (present-day equivalent or cooler) to remain in situ. For the remaining 87.5-89% (210-213/240) of PAs, which were often situated at low elevation, analogous climate will only be available in higher elevation PAs. However, over half (60-82%) of all PAs on Borneo are too isolated for poor dispersers (<1 km per generation) to reach cooler PAs, because there is a lack of connecting forest habitat. Even under the lowest warming scenario (RCP2.6), analogous climate conditions will disappear from 61% (146/240) of PAs, and a large proportion of these are too isolated for poor dispersers to reach cooler PAs. Our results suggest that low elevation PAs are particularly vulnerable to climate change, and management to improve linkage of PAs along elevation gradients should be a conservation priority.

Eilenberg M. 2015. Shades of green and REDD: Local and global contestations over the value of forest versus plantation development on the Indonesian forest frontier. *Asia Pacific Viewpoint*, 56:48-61.

Reference ID: 21197

Notes: #21197e

Abstract: In a time of increasing land enclosures sparked by large-scale environmental initiatives and agricultural expansion, this paper examines local and global contestations over the value of forest on an Indonesian forest frontier. Engaging with recent debates on carbon forestry, the paper problematises the emerging initiatives of Reducing Emissions from Deforestation and Forest Degradation' known as REDD+ in the province of West Kalimantan, Indonesia. The paper argues that the general rush to implement REDD+ without intimate knowledge of the political landscape of resource struggle is in danger of generating new enclosures of land that may be easily appropriated by local elites, thus excluding less fortunate sections of local society. The paper shows how divergent interpretations of REDD+ are triggering land disputes, and how powerful actors readily appropriate REDD+ discourses as a tool to support divergent claims of land ownership. Government and villagers, through overlapping and contradictory engagements, negotiate REDD+ initiatives with global environmental actors and private plantation companies. The paper highlights the implications of these local realities for the successes of REDD+. The Kalimantan case highlights some of the dilemmas of carbon mitigation initiatives experienced in frontier regions throughout Southeast Asia, places that have become prime battlefronts of large-scale climate change initiatives and agrarian expansion.