New Entries to IPNI Library as References

Neset T.-S. S. and D. Cordell. 2012. Global phosphorus scarcity: identifying synergies for a sustainable future. J Sci Food Agric, 92:2-6.
Reference ID: 20615
Notes: #20615e
Abstract: Global food production is dependent on constant inputs of phosphorus. In the current system this phosphorus is not predominantly derived from organic recycled waste, but to a large degree from phosphate-rock based mineral fertilisers. However, phosphate rock is a finite resource that cannot be manufactured. Our dependency therefore needs to be addressed from a sustainability perspective in order to ensure global food supplies for a growing global population. The situation is made more urgent by predictions that, for example, the consumption of resource intensive foods and the demand for biomass energy will increase. The scientific and societal debate has so far been focussed on the exact timing of peak phosphorus and on when the total depletion of the global reserves will occur. Even though the timing of these events is important, all dimensions of phosphorus scarcity need to be addressed in a manner which acknowledges linkages to other sustainable development challenges and which takes into consideration the synergies between different sustainability measures. Many sustainable phosphorus measures have positive impacts on other challenges; for example, shifting global diets to more plant-based foods would not only reduce global phosphorus consumption, but also reduce greenhouse gas emissions, reduce nitrogen fertiliser demand and reduce water consumption.

OECD 2013. Economic outlook for Southeast Asia, China and India 2014: Beyond the middle-income trap, OECD Publishing.
Reference ID: 20616
Notes: S 13 #20616e

OECD 2013. Agricultural policy monitoring and evaluation 2013: OECD countries and emerging economies, OECD Publishing.
Reference ID: 20617
Notes: S 13 #20617e

OECD 2013. OECD compendium of agri-environmental indicatros, OECD Publishing.
Reference ID: 20618
Notes: S 13 #20618e

OECD/FAO 2014. OECD-FAO agricultural outlook 2014-2023, OECD Publishing.
Reference ID: 20619
Notes: S 13.1 #20619e

OECD 2014. Climate change, water and afgricultre: Towards resilient systems, OECD Publishing.
Reference ID: 20620
Notes: S 13 #20620e

FAO 2013. FAO statistical yearbook 2013: World food and agriculture, Food and Agriculture Organization of the United Nations, Rome.
Reference ID: 20621
Notes: S 13 #20621e

Cook S., C. H. Lim, S. N. Mohanaraj, Y. M. S. Samosir, C. Donough, T. Oberthür, Y. L. Lim, J. Cock, and S. P. Kam. 2014. Palm oil at the crossroads: the role of Plantation Intelligence to support change, profit and sustainability. The Planter, **90:**563-575.
Reference ID: 20622
Notes: H 8.1.1 #20622e
Abstract: This paper describes a process of Plantation Intelligence – the generation and use of analysis of commercial data held by oil palm companies. Plantation Intelligence consists of a series of insights, developed with partners, which describe the status and trends of key performance indicators. Analysis also describes the productivity of key inputs such as fertilizer and labour. Such insights can be used to guide decisions and to avoid some of the common biases that managers make, especially when under pressure. It is anticipated that Plantation Intelligence will provide greatest value to companies who recognize the need for change and who are able to embed the process in 'normal' management.

Klumper W. and M. Qaim. 2014. A meta-analysis of the impacts of genetically modified crops. Plos One, 9:1-7.
Reference ID: 20623
Notes: #20623e
Abstract: Background: Despite the rapid adoption of genetically modified (GM) crops by farmers in many countries, controversies about this technology continue. Uncertainty about GM crop impacts is one reason for widespread public suspicion. Objective: We carry out a meta-analysis of the agronomic and economic impacts of GM crops to consolidate the evidence. Data Sources: Original studies for inclusion were identified through keyword searches in ISI Web of Knowledge, Google Scholar, EconLit, and AgEcon Search. Study Eligibility Criteria: Studies were included when they build on primary data from farm surveys or field trials anywhere in the world, and when they report impacts of GM soybean, maize, or cotton on crop yields, pesticide use, and/or farmer profits. In total, 147 original studies were included. Synthesis Methods: Analysis of mean impacts and meta-regressions to examine factors that influence outcomes. Results: On average, GM technology adoption has reduced chemical pesticide use by 37%, increased crop yields by 22%, and increased farmer profits by 68%. Yield gains and pesticide reductions are larger for insect-resistant crops than for herbicide-tolerant crops. Yield and profit gains are higher in developing countries than in developed countries. Limitations: Several of the original studies did not report sample sizes and measures of variance. Conclusion: The meta-analysis reveals robust evidence of GM crop benefits for farmers in developed and developing countries. Such evidence may help to gradually increase public trust in this technology.

Bauckhage C. and K. Kersting. 2013. Data mining and pattern recognition in agriculture. Kunstl Intell, 27:324.
Reference ID: 20624
Notes: #20624e
Abstract: Modern communication, sensing, and actuator technologies as well as methods from signal processing, pattern recognition, and data mining are increasingly applied in agriculture. Developments such as increased mobility, wireless networks, new environmental sensors, robots, and the computational cloud put the vision of a sustainable agriculture for anybody, anytime, and anywhere within reach. Yet, precision farming is a fundamentally new domain for computational intelligence and constitutes a truly interdisciplinary venture. Accordingly, researchers and experts of complementary skills have to cooperate in order to develop models and tools for data intensive discovery that allow for operation through users that are not necessarily trained computer scientists.We present approaches and applications that address these challenges and underline the potential of data mining and pattern recognition in agriculture.

IPNI. Better Crops South Asia Vol.8 (2014, No.1). Better Crops - South Asia 8[1], 1-31. 2014. IPNI.
Reference ID: 20625
Notes: #20625e

Carr M. K. V. 2011. The water relations and irrigation requirements of oil palm (*Elaeis guineensis*): A review. Experimental Agriculture, 47:629-652.
Reference ID: 20626
Notes: #20626e
Abstract: The results of research on the water relations and irrigation need of oil palmare collated and summarized in an attempt to link fundamental studies on crop physiology to drought mitigation and irrigation practices. Background information is given on the centres of origin (West Africa) and of production of oil palm (Malaysia and Indonesia), but the crop is now moving into drier regions. The effects of water stress on the development processes of the crop are summarized followed by reviews of its water relations, water use and water productivity. The majority of the recent research published in the international literature has been conducted in Malaysia and in Francophone West Africa. The unique vegetative structure of the palm (stem and leaves) together with the long interval between flower initiation and the harvesting of the mature fruit (ca. three years) means that causal links between environmental factors (especially water) and yield are difficult to establish. The majority of roots are found in the 0-0.6 m soil horizons, but roots can reach depths greater than 5 m and spread laterally up to 25 m from the trunk. The stomata are a sensitive indicator of plant water status and play an important role in controlling water loss. Stomatal conductance and photosynthesis are negatively correlated with the saturation deficit of the air. It is not easy to measure the actual water use of oil palm, the best estimates for mature palms suggesting crop evapotranspiration (ETc) rates of 4-5 mm d-1 in the monsoon months (equivalent to 280-350 l palm-1 d-1). For well-watered mature palms, crop coefficient (Kc) values are in the range 0.8-1.0. Although the susceptibility of oil palm to drought is well recognized, there is a limited amount of reliable data on actual yield responses to irrigation. The best estimates are 20-25 kg fresh fruit bunches ha-1 mm-1 (or a yield loss of about 10% for every 100 mm increase in the soil water deficit). These increases are only realized in the third and subsequent years after the introduction of irrigation and follow an increase

in the number of fruit bunches as a result of an improvement in the sex ratio (female/total inflorescence production) and a reduction in the abortion of immature inflorescences. There is no agreement on the allowable depletion of the available soil water, or on the associated optimum irrigation interval. Drip irrigation has been used successfully on oil palm.

Pittelkow, C. M., Liang, X., Linquist, B. A., van Groenigen, K. J., Lee, J., Lundy, M. E., van Gestel, N., Six, J., Venterea, R. T., and van Kessel, C. Productivity limits and potentials of the principles of conservation agriculture. Nature 000, 1-6. 2014.
Reference ID: 20627
Notes: #20627e

Sidhu M., M. Kurniawan, E. F. Rambe, Z. Sinuraya, A. Aziz, A. Hasyim, and M. Sharma. 2014. Withdrawal; of fertiliser and its impact on the nutrient status, growth and production of previously fertilised oil palm. The Planter, 90:399-417.
Reference ID: 20628
Notes: #20628e
Abstract: A long term NPK factorial fertiliser trial established on a highly leached and infertile soil was converted into a fertiliser withdrawal trial to monitor the residual effects of previous fertiliser applications on the nutrient status, growth and production of 14-year-old oil palm. Of the three major nutrients, nitrogen (N) has the shortest residual effect. A decline in leaf N was recorded two years after fertiliser termination whilst growth parameters such as frond dry weight, petiole cross section and leaf area were affected as early as 12 months after ceasing fertiliser application (MACF). However fresh fruit bunch (FFB) yield only declined in the third year, commencing at 30 MACF. Depletion of N negatively impacted both average bunch weight (ABW) and number of bunches (NOB) harvested, albeit at different time periods. In view of its high soil reserves, residual effect of phosphorus (P) was longer than either nitrogen or potassium. Although the deline in leaf and rachis P content also occured within 24 MACF, FFB yield decline only occured in the fourth year, commensing at 44 MACF. Like N, P withdrawal also had a negative impact on both ABW and NOB harvested. The residual effect of previous potash (K) manuring was found to be intermediate between N and P. In view of the high yields and high K demand of the oil palm in the trial plots, a decline in leaf and rachis K was recorded as early as 12 MACF. This was paralleled by a rapid depletion of soil K reserves within the same short period. Due to the lag-phase between nutrient depletion and yield decline, the latter only occured in the fourth year, commesing at 39 MACF. Unlike N and P, withdrawal of K fertiliser has no negative impact on ABW but significantly reduced NOB harvested. Complete stoppage of all fertilisers (N,P,K) simultaneously, even only for a period of one year, has a negative impact on palm nutrient status, vegetative growth and FFB production. The time frame of palm responses to complete fertiliser withdrawal mirrored those indused by N stoppage rather than those due to P and K termination. However, growth and yield depression was short lived with recovery occuring within 24 months after resumption in manuring. The results indicate that even on highly leached and impoverished soils, it was safe to terminate N, P, K fertiliser applications a minimum of two years prior to replanting. For existing plantings, the long residual effects of previous P and K applications also provided some scope for selective reduction in the latter two fertiliser types, in times of low palm oil prices or financial crisis. However, N inputs cannot be completely stopped even for one year.

Goh K. J., P. H. C. Ng, C. K. Wong, and S. Arif. 2014. Yield potential of oil palm and its attainment in Malaysia. The Planter, 90:503-520.
Reference ID: 20629
Notes: #20629e
Abstract: The potential yield of oil palm estimated at 18.2 tonnes oil per hectare per year has not been breached by the current planting materials. Nevertheless, plant breeders have raised the genetic yield potential (GYP) of oil palm from 8.5 tonnes oil per hectare per year in 1975 to 12.5 tonnes oil per hectare per year in 2000 based on best crosses and from 6 to 8.3 tonnes oil per hectare per year in the same period on family scale. GYP was elevated to about 10 tonnes oil per hectare per year by exploiting the between origin crosses for heterosis such as the three way cross of *Dumpty.Avros.Yangadami* and using semi-clonal seeds for specific combining ability.
GYP cannot be used as the yield target for agronomists and estate management because it is usually a point in space. Instead, the site yield potential (SYP) which accounts for palm age and specific yield limiting factors occuring at the site should be used. The major yield reducing and yield loss factors which increase the yield gap between SYP and actual yield are discussed in the paper. To attain SYP, the problem solving team comprising the planting advisers, agronomists and managers with the support of the directors should correctly diagnosed the problem areas, identify and interpret the causal factors and formulate the strategy and action plan to rectify them quickly. We should resist the temtation to implement in haste untested practices or products without scientific proof or logic hoping to achieve SYP.

Webb M. J. 2010. Development of a fertiliser optimisation technique using multi-nutrient factorial trials and leaf tissue nutrient analysis in commercial oil palm plantations. Pages 40-43.
Reference ID: 20630
Notes: H 8.1.1.11 #20630e
Abstract: Ensuring fertilisers are applied at optimal rates makes economic sense as well as minimising the chance of excess nutrients causing environmental damage. A technique has been developed which uses information from factorial fertiliser trials and nearby commercial plantings of oil palm to determine the optimal economic application rates of three nutrients simultaneously, thus accounting for interactions. The technique is based on a spreadsheet application that can be analysed as often as required in response to climate variation, oil price, and fertiliser costs. It also allows for scenario testing by allowing changes in these costs and prices.

Sabari N. S., S. Harun, and A. Ahmad. 2014. The effect of flood hazard on palm oil yield in Sungai Simpang Kiri Estate.
Reference ID: 20631
Notes: #20631e 13th International Conference on Urban Drainage, Sarawak, Malaysia, 7-12 September 2014
Abstract: Palm oil is one of the important economic resources for Malaysia and the main import materials resource for other countries. By ensuring the stability of the palm oil, government and non-government sectors have conducted various studies ranging from production of seeds and estate management to the process and schedule for palm oil harvest. These studies helped in identification of various factors that affect the optimal production of palm oil, and flood area is one of the factors that influence its production in certain fields. Low landed areas are more likely to be flooded and cover nearby areas in close proximity to rivers and lakes. In this study, the areas of flood were identified. Spatial and non-spatial data were used in this

research. Hydrology and hydraulic software were used for modelling the flood, which was applied to the geographic information system (GIS) to produce the map for affected area, and the effect of flood on the yield of palm oil.

Perdew, J. G. and Shively, G. E. The economics of pest and production management in small-holder cocoa: Lessons from sulawesi. Bulletin of Indonesia Economic Studies Vol.45, No.3, 373-389. 2009.
Reference ID: 20632
Notes: #20632e
Abstract: We examine pest control and production management methods used by farmers in Sulawesi to improve cocoa bean quality and increase income from cocoa. Strategies investigated include those directed at increasing the number and size of cocoa pods, those aimed at reducing hosts for pest transmission, two input-intensive approaches, and the alternative of doing nothing beyond harvesting mature cocoa pods. Using 2005 production data from 600 cocoa farms, we identify factors correlated with adoption of each treatment and, controlling for treatment, isolate factors that influence cocoa yields. To study the conditional profitability of input allocation, we compare observed factor shares with profit-maximising input levels and derive lessons for extension efforts. We conclude that the average increase in private returns arising from more intensive cocoa management appears sufficient to compensate for higher production costs, but that observed extension efforts have not been correlated with higher profits among farmers in the sample.

Sabatier R., K. Wiegand, and K. Meyer. 2013. Production and robustness of a cacao agroecosystem: Effects of two contrasting types of management strategies. Plos One, 8:1-10.
Reference ID: 20633
Notes: #20633e
Abstract: Ecological intensification, i.e. relying on ecological processes to replace chemical inputs, is often presented as the ideal alternative to conventional farming based on an intensive use of chemicals. It is said to both maintain high yield and provide more robustness to the agroecosystem. However few studies compared the two types of management with respect to their consequences for production and robustness toward perturbation. In this study our aim is to assess productive performance and robustness toward diverse perturbations of a Cacao agroecosystem managed with two contrasting groups of strategies: one group of strategies relying on a high level of pesticides and a second relying on low levels of pesticides. We conducted this study using a dynamical model of a Cacao agroecosystem that includes Cacao production dynamics, and dynamics of three insects: a pest (the Cacao Pod Borer, Conopomorpha cramerella) and two characteristic but unspecified beneficial insects (a pollinator of Cacao and a parasitoid of the Cacao Pod Borer). Our results showed two opposite behaviors of the Cacao agroecosystem depending on its management, i.e. an agroecosystem relying on a high input of pesticides and showing low ecosystem functioning and an agroecosystem with low inputs, relying on a high functioning of the ecosystem. From the production point of view, no type of management clearly outclassed the other and their ranking depended on the type of pesticide used. From the robustness point of view, the two types of managements performed differently when subjected to different types of perturbations. Ecologically intensive systems were more robust to pest outbreaks and perturbations related to pesticide characteristics while chemically intensive systems were more robust to Cacao production and management-related

perturbation.

Alvim R. and P. K. R. Nair. 1986. Combination of cacao with other plantation crops: an agroforestry system in Southeast Bahia, Brazil. Agroforestry Systems, 4:3-15.
Reference ID: 20634
Notes: #20634e
Abstract: Brazil accounts for about 20% of the world production of cocoa, and about 95% of cocoa produced in Brazil is from the southeastern part of Bahia State. Traditionally, cacao is grown in monoculture (though under the shade of various other species). But various crop combinations involving cacao have recently been undertaken by the farmers with encouragement from Brazilian government. As a part of the crop diversification programme in the traditional cacao growing areas and their surroundings, extensive areas are being planted to other plantation crops, mainly clove and rubber and, to some extent, coconut too. Crop combinations have been adopted in some of these new plantings and cacao is an important component of most of such combinations. Whereas several other crops are combined with clove trees, cacao is usually the only species grown with mature rubber trees. Young rubber trees are, however, interplanted with a number of other species. Productive coconut areas are found mostly in sandy soils along the coast so that there is little intercropping. However, scattered farms are found where coconuts are underplanted with guarana, black pepper, cacao, cashew, etc. as done commonly in other parts of Northeast Brazil. The paper presents some data on the performance of some of the combinations involving cacao and other plantation crops based on field survey, and discusses the potentials and constraints of extending the system to more areas in the region.

Somarriba E. and J. Beer. 2011. Productivity of *Theobroma cacao* agroforestry systems with timber or legume service shade trees. Agroforestry Systems, **81:**109-121.
Reference ID: 20635
Notes: #20635e
Abstract: Timber production and cocoa yields were studied (initial 10–11years) in two experimental plantations: a Cocoa-Legume system (CL, *Erythrina poeppigiana*, *Gliricidia sepium* or *Inga edulis*), and a Cocoa-Timber system (CT, *Cordia alliodora*, *Tabebuia rosea* or *Terminalia ivorensis,* plus *I. edulis* for inter-site comparisons). These trials had two major goals: (1) to evaluate the use of mono-specific timber shade canopies as an alternative to traditional, mono-specific, legume service shade tree canopies; and (2) to determine the production potential of ten cocoa clonal bi-crosses under these shade tree species. Within each site, shade tree species did not influence dry cocoa bean yield nor pod counts (total number of pods produced, number of healthy pods harvested, pod losses due to monilia [*Moniliophthora roreri*], black pod [*Phytophthora palmivora*] or other causes—birds and squirrels in this study-, and total pod losses). Significant differences were found between cocoa bi-crosses for both cocoa bean yield and pod counts. Sites differed only in terms of total pod losses (43% in CL; 54% in CT) and their causal factors (mainly monilia in CL; both monilia, squirrels and birds in CT). At CT, all timber tree species grew rapidly, reaching 30–34cmdbh, 17–25m total tree height and 97–172m3ha_1 total stem volume (age 10years). Timber species should be promoted for the shade component of cacao plantations given their potential production and the fact that their presence did not negatively affect cocoa yields.

Edwin J. and W. A. Masters. 2005. Genetic improvement and cocoa yields in Ghana. Exp.Agric., 41:491-503.
Reference ID: 20636
Notes: #20636e
Abstract: This paper documents the yield gains attributable to the breeding and distribution of new cocoa varieties in Ghana, using data from a 2002 survey of 192 fields in the country's key cocoa producing regions. We find that planting the more recently-released varieties is associated with at least 42% higher yields, and that genetic improvement accounts for much but not all of the observed correlation between tree age and cocoa yield. Fertilizer use is also very important, being associated with 19% higher cocoa yield per 50 kg bag of fertilizer. We find no evidence that varieties differ in their response to fertilizer, pesticide use or labour, and no evidence of a decline in the yield advantage of new varieties over the 17-year age span observed in the sample.

Bisseleua D. H. B., A. D. Missoup, and S. Vidal. 2009. Biodiversity conservation, ecosystem functioning, and economic incentives under cocoa agroforestry intensification. Conservation Biology, 23:1176-1184.
Reference ID: 20637
Notes: #20637e
Abstract: World chocolate demand is expected to more than double by 2050. Decisions about how to meet this challenge will have profound effects on tropical rainforests and wild species in cocoa-producing countries. Cocoa, 'the chocolate tree', is traditionally produced under a diverse and dense canopy of shade trees that provide habitat for a high diversity of organisms. The current trend to reduce or eliminate shade cover raises concerns about the potential loss of biodiversity. Nevertheless, few studies have assessed the ecological consequences and economic trade-offs under different management options in cocoa plantations. Here we describe the relationships between ant ecology (species richness, community composition, and abundance) and vegetation structure, ecosystem functions, and economic profitability under different land-use management systems in 17 traditional cocoa forest gardens in southern Cameroon. We calculated an index of profitability, based on the net annual income per hectare. We found significant differences associated with the different land-use management systems for species richness and abundance of ants and species richness and density of trees. Ant species richness was significantly higher in floristically and structurally diverse, low-intensity, old cocoa systems than in intensive young systems. Ant species richness was significantly related to tree species richness and density. We found no clear relationship between profitability and biodiversity. Nevertheless, we suggest that improving the income and livelihood of smallholder cocoa farmers will require economic incentives to discourage further intensification and ecologically detrimental loss of shade cover. Certification programs for shade-grown cocoa may provide socioeconomic incentives to slow intensification.

Rosenberg D. E. and T. P. Marcotte. 2005. Land-use system modeling and analysis of shaded cacao production in Belize. Agroforestry Systems, 64:117-129.
Reference ID: 20638
Notes: #20638e
Abstract: Shaded cacao (Theobroma cacao) cultivation is a tropical land-use that has potential to reduce pressure on the forest and provide additional income to smallholder growers. A land-use system (LUS) model was formulated to represent

the economic returns derived from shaded cacao production practiced by smallholders in the Toledo district of Belize. Sixty scenarios were tested to elicit response of net-present-value (NPV), returns to labor, and annual returns to land (ARTL) to individual changes in 10 system parameters. Further scenarios tested the combined interactions between hardwood shade tree type, planting density, time to harvest hardwoods, cacao cultivation practice, and expected output. As a modeling exercise, LUS analysis highlights system components that government agencies, donors, NGOs, extension agents, and smallholders should target with policies, agri-silvi- culture projects, and further research. Results identify more favorable credit, labor-saving technology, better shade-management practices, grafting, and incorporating non-hardwood shade trees and laurel (Cordia alliadora) as interventions that could improve cacao financial performance and encourage adoption. At present, the model cannot predict whether smallholders would respond to recommendations and invest in shaded cacao cultivation in lieu of alternative agricultural land-uses or off-farm employment.

Lueandra N. and J. Andrew. 2007. Competitiveness of cocoa production systems in Trinidad and Tobago. Pages 50-58 Caribbean Agro-Economic Society (CAES).
Reference ID: 20639
Notes: #20639e
Abstract: Trinidad and Tobago produces a fine flavour cocoa that attracts a premium price on the international market. The country has a long and distinguished record in agronomy and production of cocoa and is home to the Cocoa Research Unit, which attracts international notice and funding. However, cocoa production has been on a steady decline over the past few decades. The objective of this study is to assess the competitiveness and comparative advantage of cocoa production in Trinidad and Tobago and to understand the reasons for decline in output within the context of competitiveness. The analyses were conducted over three cocoa production systems - small farm traditional, large farm traditional, and large farm intensive cultivation. The methodology involved data collection and use of the framework of the Policy Analysis Matrix (PAM) to assess competitiveness and comparative advantage. The results indicate that all production systems are profitable, internationally competitive and have comparative advantage. However, the traditional small-farm production system has the least profitability, ompetitiveness and comparative advantage. The results suggest that the low levels of profitability per hectare for the small farms may underlie the declining area and output.

Schroth G. 1999. A review of belowground interactions in agroforestry, focussing on mechanisms and management options. Agroforestry Systems, 43:5-34.
Reference ID: 20640
Notes: #20640e
Abstract: This review summarises current knowledge on root interactions in agroforestry systems, discussing cases from temperate and tropical ecosystems and drawing on experiences from natural plant communities where data from agroforestry systems are lacking. There is an inherent conflict in agroforestry between expected favourable effects of tree root systems, e.g. on soil fertility and nutrient cycling, and competition between tree and crop roots. Root management attempts to optimise root functions and to stimulate facilitative and complementary interactions. It makes use of the plasticity of root systems to respond to environmental factors, including other root systems, with altered growth and physiology. Root management tools include species selection, spacing, nutrient

distribution, and shoot pruning, among others. Root distribution determines potential zones of root interactions in the soil, but are also a result of such interactions. Plants tend to avoid excessive root competition both at the root system level and at the single-root level by spatial segregation. As a consequence, associated plant species develop vertically stratified root systems under certain conditions, leading to complementarity in the use of soil resources. Parameters of root competitiveness, such as root length density, mycorrhization and flexibility in response to water and nutrient patches in the soil, have to be considered for predicting the outcome of interspecific root interactions. The patterns of root activity around individual plants differ between species; knowing these may help to avoid excessive competition and unproductive nutrient losses in agroforestry systems through suitable spacing and fertiliser placement. The possibility of alleviating root competition by supplying limiting growth factors is critically assessed. A wide range of physical, chemical and biological interactions occurs not only in spatial agroforestry, but also in rotational systems. In a final part, the reviewed information is applied to different types of agroforestry systems: associations of trees with annual crops; associations of trees with grasses or perennial fodder and cover crops; associations of different tree and shrub species; and improved fallows.

Aneani F., V. M. Anchirinah, F. Owusu-Ansah, and M. Asamoah. 2012. Adoption of some cocoa production technologies by cocoa farmers in Ghana. Sustainable Agriculture Reseach, 1:103-117.
Reference ID: 20641
Notes: #20641e
Abstract: Adoption of the cocoa (Theobroma cacao) production technologies recommended to cocoa farmers by Cocoa Research Institute of Ghana (CRIG) had been low, eading to yield and production levels below potential. To investigate this issue, a normal socio-economic sample survey of 300 cocoa farmers selected randomly, by a multi-stage sampling technique, from all the cocoa growing regions of Ghana was conducted with a structured questionnaire for the individual interviews. The adoption rates of CRIG-recommended technologies such as control of capsids with insecticides, control of black pod disease with fungicides, weed control manually or with herbicides, planting hybrid cocoa varieties and fertilizer application were 10.3%, 7.5%, 3.7%, 44.0% and 33.0%, respectively. Adoption models indicated that credit, number of cocoa farms owned by the farmer, gender, age of the cocoa farm, migration, cocoa farm size, and cocoa yield affected the adoption decisions of cocoa farmers concerning the CRIG-recommended technologies analyzed in this study.

Ogeh J. S. and R. R. Ipinmoroti. 2013. Micronuturients Assessment of Cocoa, Kola, Cashew and Coffee Plantations for Sustainable Production at Uhinmora, Edo State, Nigeria. J Trop Soils, 18:93-97.
ReferenceID: 20642
Notes: #20642e
Abstract: The micronutrient status of the soils and leaf of cocoa, kola, cashew and coffee plantations to study the soil-plant micronutrient content relationship in the plantation soils for proper management towards optimum production of the crops was investigated at Uhonmora, Edo State, Nigeria. Soil and leaf samples were collected from these plantations and analyzed according to standard laboratory procedures. The soil samples were analyzed for the micronutrients (Cu, Mn, Zn and Fe) and in addition pH, organic carbon, sand, silt and clay contents, while the leaves

were analyzed for only the micronutrient contents. Results indicated that the soils were sandy loam, acidic, low in organic carbon, deficient in Cu and Mn but very high in Fe and Zn contents. This probably resulted in nutrient imbalance in the soils and the deficiency of the nutrients in the crops. The plantations herefore require application of organic manures and micronutrient fertilizers to rectify the inadequate soil organic matter and to supply sufficient amount of Cu and Mn in the soils, to obtain quality fruit yield at optimum level from the plantations.

Bosompem M., J. A. Kwarteng, and E. Ntifo-Siaw. 2011. Towards the Implementation of Precision Agriculture in Cocoa Production in Ghana: Evidence from the Cocoa high Technology Programme in the Eastern region of Ghana. J.Agric.Res.& Dev., 10.
Reference ID: 20643
Notes: #20643e
Abstract: Precision agriculture is defined as an information and technological based farm management system to identify, analyse and manage variability within fields for optimum profitability, sustainability and protections of the land resource. The main goal is to manage and distribute inputs on site- specific basis to maximise long term benefits. Even though Ghana is the second largest producer of cocoa in the world, its average annual yield is abysmal (350 kg/ha) compared to other cocoa producing countries (C™te d'Ivoire=800 kg/ha, Malaysia = 1700 kg/ha).The government of Ghana introduced the Cocoa High Technology Programme (CHTP) with the aim of increasing productivity of cocoa farms. A survey of 200 cocoa farmers, who had adopted the technology in the Eastern Region of Ghana in 2006, was conducted with the aim of estimating how effective cocoa farmers had applied the main components of the CHTP as well as the precision that comes with the programme. The results showed that none of the farmers did soil testing - a precondition for site- specific application - before fertilizer application. Although almost all (99.5%) the farmers applied the fertilizer, they did not use the prescribed ring-method of application that ensures that each cocoa tree has optimal amount of nutrient needed. Barely half (42%) of the farmers applied it at the recommended time. Main reasons given for the farmers' inability to use the precision that came with the CHTP included lack of awareness of the need to perform soil testing, late distribution of fertilizers to farmers and inadequate training of farmers on the precise methods of applying the technologies. The aforesaid constraints, among others, militated against the achievement of the target set by the programme. Several recommendations were made which could make precision agriculture feasible in the cocoa industry in Ghana and other cocoa producing countries.

Maharaj K., T. Indalsingh, D. Ramnath, and A. Cumberbatch. 2003. High density planting of cocoa: the Trinidad and Tobago experience. Pages 171-182 Accra, Ghana.
Reference ID: 20644
Notes: #20644e International Workshop on Cocoa Breeding for Improved production Systems, 19-21 October 2003, Accra, Ghana
Abstract: Cocoa is an important agricultural commodity in Trinidad and Tobago. However annual production of fine or flavour cocoa has declined to 1.5m tonnes in the last five years. High density planting (HDP) was introduced in the 1980's as an alternative technology to traditional systems that are based on low density planting (LDP, normally at 748 plants ha -1). Trials conducted in Trinidad showed higher yields being obtained from three commercial Trinidad Selected Hybrid (TSH) clones,

at 6-8 years after planting, at densities of 2990 trees ha -1 than at 748 and 1495 trees ha -1 . A significant variety x spacing interaction pointed to differences in clone behaviour, with the less vigorous TSH 919 clones performing best at the highest density. Data from other field trials also showed better performance of TSH clones and TSH-derived open-pollinated seedling progenies at HDP in relation to LDP. A successful commercial HDP farm in east Trinidad has achieved yields of 1500 kg ha -1 in its 11 th year of production. The variable cost of production per ha for improved LDP and HDP is US$ 806 and US$1699, respectively, which is indicative of the higher management levels required for HDP. Agronomic factors contributing to productivity on this farm are also examined. Adoption of the HDP system is recommendable based on a higher benefit: cost ratio than for LDP. The performance of Trinidad's cocoa industry can therefore be expected to improve based on the further development of HDP. The reasons that the adoption rate of HDP technology in Trinidad is still very low among small farmers are discussed.

Puentes-Paramo Y., J. Menjivar-Flores, and F. Aranzazu-Hernandez. 2014. Nitrogen, phosphorus and potassium use efficieny in cocoa (*Theobroma cacao* L.). Bioagro, 26:99-106.
Reference ID: 20645
Notes: #20645e
Abstract: The fertilizer management is an important aspect for the crop growth, and an excessive nutrient input may exceed the absorptive capacity of the plant and generate an environmental risk, as well as economic loss to the farmer. herefore, this study aimed to determine the nutrient use efficiency (NUE) of nitrogen, phosphorus and potassium in four cocoa clones (TSH-565, ICS-39, ICS-95 and CCN-51), and its influence on yield. A randomized complete block design with five treatments and four replications were used. The treatments were NPK increases by 25 % (T1), 50 % (T2), 75 % (T3) and 100 % (T4) on the natural level of the soil fertility (TR: control). Differences in agronomic efficiency (AE) for N, P and K were detected ($P^2$0.01); the highest AE was for clone CCN-51 in T1, while for the rest of clones the highest AE took place in T2. With the treatment T4, the four clones had the lowest values. The highest recovery efficiency (RE) of nitrogen and phosphorus was shown by CCN-51 in T1, and by the other clones in T2; however, the highest RE of potassium occurred in T2 for all the clones. The highest yield was for CCN-51 in T1, and in T2 for clones ICS-39, ICS-95 and TSH 565. In general, lower yields were for TR and T4, suggesting that cocoa crop has an appropriate nutrient extraction resulting in good yields, but when the limit is exceeded a nutritional imbalance might occurred.

Zambrano-Pina F. and E. Segovia-Lopez. 2011. The competitivness of the cocoa production system in the north part of Tachira state. Rev.Fac.Agron.(LUZ), 28:566-595.
Reference ID: 20646
Notes: #20646e
Abstract: With the purpose of analyze the competitiveness of the cocoa production in north part of T‡chira State, under the systemic approach and microeconomic competitiveness, was developed a type of research, analytical, non-experimental field with contemporary transactional. Considering a population of 195 producers, by taking a sample of 130 producers and the survey was used as an instrument of data collection. A cluster analysis to identify groups with similar characteristics was applied to the processed data, and multivariate analysis to assess the producer's

behavior in the different groups according to the management of the production process. The results identified three groups (G1, G2 and G3), well differenced by age-related aspects of planting, sowing density, yield, agricultural management and post harvest. In G1, all prunes, 71% performs manual control of pests and diseases and 26% done fertilization; 89% receive further technical assistance. In the G2, only 43% of producers pruning, 26% perform manual control of pests and diseases and 4% applies fertilization, receiving only 26% technical assistance. G3, 78% pruning, 61% control of pests and diseases manual, 12% and 51% fertilized receives technical assistance. The yields were G1: 353.95 kg.ha -1 , G2: 228.72 kg.ha -1 and G3: 265.85 kg.ha -1 . The practical benefit of being performed poorly most common drying. The diagnosis identified a low-tech, high genetic variability and poor post-harvest handling, as main causes for the low competitiveness of cocoa production system in the region.

Broschat T. K. 2009. Palm Nutrition and Fertilization. HortTechnology, 19:690-694.
Reference ID: 20647
Notes: #20647e
Abstract: Palms (Arecaceae) growing in containers have similar nutritional requirements as other tropical ornamental plants and grow well with fertilizers having an elemental ratio of 3N:0.4P:1.7K. However, palms growing in the landscape or field nurseries have very different nutritional requirements from dicotyledonous plants. Whereas nitrogen (N) is the primary limiting nutrient element in container production, potassium (K), manganese (Mn), magnesium (Mg), boron (B), and iron (Fe) deficiencies are more widespread than N deficiency in most landscape soils. Because palms have a single apical meristem, deficiencies of K, Mn, or B can be fatal. In addition to insufficient nutrients in the soil, palm nutrient deficiencies can be caused by high soil pH, certain types of organic matter, deep planting, poor soil aeration, cold soil temperatures, and nutrient imbalances. Correction of nutritional deficiencies in palms can take up to 2 years or longer and therefore prevention of deficiencies by proper fertilization is important. Research has shown that high N:K ratio fertilizers applied directly, or indirectly via application to adjacent turfgrass in a landscape, can exacerbate K and Mg deficiencies in palms, sometimes fatally. For sandy Atlantic coastal plain soils in the southeastern United States, an analysis of 8N-0.9P-10K-4Mg plus micronutrients has been recommended.

Mintz-Habib N. 2013. Malaysian biofuels industry experience: A socio-political analysis of the commercial environment. Energy Policy, 56:88-100.
Reference ID: 20648
Notes: #20648e
Abstract: This study examines the Jatropha adoption process in Sarawak, Malaysia, a land rich in biological and ethnic diversity, but highly impoverished. Attempts to alleviate poverty through oil palm plantation development resulted in internationally condemned destruction of peat lands. Sarawak subsequently turned to the inedible, low-input, exportable, biodiesel feedstock Jatropha. This case study argues that Jatropha is unlikely to make more significant socio-economic contributions than oil palm or other cash crops. The analysis suggests that companies use social capital to aggressively expand their Jatropha business among the native population in order to gain access to native customary lands, which are often underproductive peat lands. Global biofuels sector development dynamics are examined through the lenses of political economics and social, agricultural, and energy studies. The research finds

that farmers' decisions to participate in the biofuels global value chain may result in negative income effects, household food security reduction, and biodiversity loss from peat land destruction. The paper concludes with a proposal for an alternative approach to evaluate both social and financial drivers in order to prevent the negative effects of biofuel-based agribusiness on human and environmental systems.

IPNI. Planters' diary 2015. 2015.
Reference ID: 20649
Notes: S 36 #20649

Siwar C., F. Ahmed, and R. A. Begum. 2013. Climate change, agriculture and food security issues: Malaysian perspective. Journal of Food, Agriculture & Environment, 11:1118-1123.
Reference ID: 20650
Notes: #20650e
Abstract: Climate change is a complex environmental problem that is adversely affecting the different sectors of the economy in both developed and developing world. Malaysia is experiencing rapid changes in climate factors over the past few decades. The mean surface temperature for Malaysia increased with the ranges from 0.6 degrees C to 1.2 degrees C during the period of 40 years (1969-2009). It was projected that the surface temperature would increase from 1.5 degrees C to 2.0 degrees C by 2050. Rainfall and river flows are projected to experience greater fluctuations. Changes in climate factors are likely to affect adversely the agriculture production and consequently food security of the country. This paper aims to focus on the potential threats and effects of climate change on agriculture and food security in Malaysia. The paper reviews currently available information on climate change, agriculture and food security issues in Malaysia. Available literatures demonstrate the potential threat of climate change to the production of grains and export earnings from industrial products. It was reported that changes in climate factors could decrease yields of rice, the main staple food in Malaysia, from 13% to 80%. On the other hand, production of industrial crops, particularly oil palm, rubber and cocoa would decline with a range of 10-30% due to negative impacts of climate variability. Moreover, population of the country is expected to increase in the next few decades which will cause increased domestic demand of food. The country would require to increase significantly the production of food commodities in order to meet increased domestic demand of food. However, it is unlikely that a significant increase in food production will be achieved in the short to medium term due to the limited resources in agriculture sector. This might cause the risk of food crises and consequently threaten food security in the country. Therefore, urgent action is very much needed to preserve agriculture sector and sustain production of food in the face of inevitable climate change.

Koczberski G., G. N. Curry, and V. Bue. 2012. Oil palm, food security and adaptation among smallholder households in Papua New Guinea. Asia Pacific Viewpoint, 53:288-299.
Reference ID: 20651
Notes: #20651e
Abstract: This paper is concerned with food security and access to land for food crop gardening among first and second generation migrant oil palm producers in West New Britain Province, Papua New Guinea. We examine changes in food security

due to the rapid population growth in the presence of growing demand for land for oil palm production. Despite oil palm providing the major source of income for most migrant households, food crop gardening remains a primary livelihood activity, particularly for women, and especially so, during periods of low oil palm prices. Rising population and land pressures pose a threat to household food security and have implications for the supply of food to the rapidly growing urban population in the province. The paper begins by describing how household food security and access to land have changed over the past two decades. Then the paper examines how smallholder households are responding to shortages of garden land through the intensification of land use, intercropping immature oil palm with food crops and seeking access to land beyond the oil palm block. The paper also considers the role that research, agricultural extension and the milling companies can play in supporting strategies to promote food security among smallholders.

Gomiero T., M. G. Paoletti, and D. Pimentel. 2010. Biofuels: Efficiency, Ethics, and Limits to Human Appropriation of Ecosystem Services. J Agric Environ Ethics, 23:403-434.
Reference ID: 20652
Notes: #20652e
Abstract: Biofuels have lately been indicated as a promising source of cheap and sustainable energy. In this paper we argue that some important ethical and environmental issues have also to be addressed: (1) the conflict between biofuels production and global food security, particularly in developing countries, and (2) the limits of the Human Appropriation of ecosystem services and Net Primary Productivity. We warn that large scale conversion of crops, grasslands, natural and semi-natural ecosystem, (such as the conversion of grasslands to cellulosic ethanol production, or plantation of sugar cane and palm oil), may have detrimental social and ecological consequences. Social effects may concern: (1) food security, especially in developing countries, leading to an increase of the price of staple food, (2) transnational corporations and big landowners establishing larger and larger landholdings in conflict with indigenous areas and the subsistence of small farmers. Ecological effects may concern: (1) competition with grazing wild and domesticated animals (e.g., millions of grazing livestock in USA prairies), (2) an excessive appropriation of Net Primary Production from ecosystems, (3) threatening biodiversity preservation and soil fertility. We claim that is it well known how ecological and social issues are strictly interwoven and that large scale biofuels production, by putting high pressure on both fronts, may trigger dangerous feedbacks, also considering the critical fact that 9 billion people are expected to inhabit the planet by 2050. There is a need to conduct serious and deep analysis on the environmental and social impact of large scale biofuels production before important energy policies are launched at global level. Biofuels will not represent an energetic panacea and their role in the overall energy consumption will remain marginal in our present highly energivorous society, while their effect on food security and environment preservation may have detrimental results. We should also have the courage to face two key issues: (1) we cannot keep increasing resources consumption at present pace, and have to change our life style accordingly, and (2) we have to deal with population growth; we cannot expect to have 9-10 billions people inhabiting the earth by 2050, without this representing a major impact on its support system.

Spiertz J. H. J. and F. Ewert. 2009. Crop production and resource use to meet the growing demand for food, feed and fuel: opportunities and constraints. Netherlands Journal of Agricultural Science, 56:281-300.
Reference ID: 20653
Notes: #20653e
Abstract: Global food and feed demands have been projected to double in the 21st century, which will further increase the pressure on the use of land, water and nutrients. At the same time, the political decisions to support renewable energy sources are accelerating the use of biomass, including grain, sugar, oilseed, and lignocellulosic crops for biofuel and power generation. Government directives - incited by climate change, high oil prices and geo-political tensions - promote partial replacement of fossil fuel by biofuels. Prices and availability of commodities used as staple food and feed are becoming already affected by the growing demand for bioenergy. Many implications of this demand for biofuel on the resource base (land, water, biodiversity), environment, rural economy, food prices and social impacts are unknown. The present study reviews and discusses the opportunities and limits of crops and resources for food, feed and biofuel production. There are gaps in our knowledge regarding the global capacity for sustainable plant-based bioenergy production, while maintaining food security; commercial biomass production will compete with food crops for arable land and scarce fresh water resources. The rapidly growing demand for food, feed and fuel will require a combination of further increases in crop yields (ca. 2% per annum) and a doubling or tripling of resource-use efficiencies, especially of nitrogen-use efficiency and water productivity in production systems with high external inputs, over the next 20 to 30 years. Adaptation of cropping systems to climate change and a better tolerance to biotic and abiotic stresses by genetic improvement and by managing diverse cropping systems in a sustainable way will be of key importance. An integrated assessment of resource-use efficiencies, ecological services and economic profitability may guide the choice of crop species and cultivars to be grown in a target environment and region, depending on the added value for specific purposes: food, feed or fuel. To avoid negative impacts on food security, governments should give high priority to 2nd, 3rd and 4th generation technologies for bioenergy.

Escobar J. C., E. S. Lora, O. J. Venturini, E. E. Yanez, and E. F. Castillo. 2009. Biofuels: Environment, technology and food security. Renewable and Sustainable Energy Reviews, 13:1275-1287.
Reference ID: 20654
Notes: #20654e
Abstract: The imminent decline of the world's oil production, its high market prices and environmental impacts have made the production of biofuels to reach unprecedent volumes over the last 10 years. This is why there have been intense debates among international organizations and political leaders in order to discuss the impacts of the biofuel use intensification. Besides assessing the causes of the rise in the demand and production of biofuels, this paper also shows the state of the art of their world's current production. It is also discussed different vegetable raw materials sources and technological paths to produce biofuels, as well as issues regarding production cost and the relation of their economic feasibility with oil international prices. The environmental impacts of programs that encourage biofuel production, farmland land requirements and the impacts on food production are also discussed, considering the life cycle analysis (LCA) as a tool. It is concluded that the rise in the use of biofuels is inevitable and that international cooperation, regulations

and certification mechanisms must be established regarding the use of land, the mitigation of environmental and social impacts caused by biofuel production. It is also mandatory to establish appropriate working conditions and decent remuneration for workers of the biofuels production chain.

Pimentel D., A. Marklein, M. A. Toth, M. N. Karpoff, G. S. Paul, R. McCormack, J. Kriazis, and T. Krueger. 2009. Food Versus Biofuels: Environmental and Economic Costs. Hum Ecol, 37:1-12.
Reference ID: 20655
Notes: #20655e
Abstract: The rapidly growing world population and rising consumption of biofuels intensify demands for both food and biofuels. This exaggerates food and fuel shortages. The use of food crops such as corn grain to produce ethanol raises major nutritional and ethical concerns. Nearly 60% of humans in the world are currently malnourished, so the need for grains and other basic foods is critical. Growing crops for fuel squanders land, water and energy resources vital for the production of food for human consumption. Using corn for ethanol increases the price of US beef, chicken, pork, eggs, breads, cereals, and milk more than 10% to 30%. In addition, Jacques Diouf, Director General of the UN Food and Agriculture Organization, reports that using food grains to produce biofuels is already causing food shortages for the poor of the world. Growing crops for biofuel not only ignores the need to reduce fossil energy and land use, but exacerbates the problem of malnourishment worldwide.

Koh L. P. 2011. Balancing societies' priorities: An ecologist's perspective on sustainable development. Basic and Applied Ecology, 12:389-393.
Reference ID: 20656
Notes: #20656e
Abstract: Rising global demands for water, food and energy are intensifying land-use conflicts, contributing to greenhouse gas emissions, and exacerbating threats to natural ecosystems and wildlife. It is imperative that we develop ways to balance our growing consumptive needs with environmental protection, particularly in the tropics where population growth has been most rapid, the people are poorest, and biodiversity is richest and yet most threatened globally. Environmental and social scientists can help by developing decision-support tools that will enable decision-makers to evaluate the consequences and tradeoffs of pursuing alternative development options in relation to the biophysical, socioeconomic, and technical constraints and considerations within individual societies and landscapes. Ultimately, scientists play a crucial role in helping decision-makers achieve a careful balance of the various priorities within each society, which is needed to ensure sustainable development for the benefit of both humans and the environment.

Tscharntke T., Y. Clough, T. C. Wanger, L. Jackson, I. Motzke, I. Perfecto, J. Vandermeer, and A. Whitbread. 2012. Global food security, biodiversity conservation and the future of agricultural intensification. Biological Conservation, 151:53-59.
Reference ID: 20657
Notes: #20657e
Abstract: Under the current scenario of rapid human population increase, achieving efficient and productive agricultural land use while conserving biodiversity is a global challenge. There is an ongoing debate whether land for nature and for production should be segregated (land sparing) or integrated on the same land (land sharing,

wildlife-friendly farming). While recent studies argue for agricultural intensification in a land sparing approach, we suggest here that it fails to account for real-world complexity. We argue that agriculture practiced under smallholder farmer-dominated landscapes and not large-scale farming, is currently the backbone of global food security in the developing world. Furthermore, contemporary food usage is inefficient with one third wasted and a further third used inefficiently to feed livestock and that conventional intensification causes often overlooked environmental costs. A major argument for wildlife friendly farming and agroecological intensification is that crucial ecosystem services are provided by 'planned' and 'associated' biodiversity, whereas the land sparing concept implies that biodiversity in agroecosystems is functionally negligible. However, loss of biological control can result in dramatic increases of pest densities, pollinator services affect a third of global human food supply, and inappropriate agricultural management can lead to environmental degradation. Hence, the true value of functional biodiversity on the farm is often inadequately acknowledged or understood, while conventional intensification tends to disrupt beneficial functions of biodiversity. In conclusion, linking agricultural intensification with biodiversity conservation and hunger reduction requires well-informed regional and targeted solutions, something which the land sparing vs sharing debate has failed to achieve so far.

Muller A., J. Schmidhuber, J. Hoogeveen, and P. Steduto. 2008. Some insights in the effect of growing bio-energy demand on global food security and natural resources. Water Policy, 10:83-94.
Reference ID: 20658
Notes: #20658e Paper presented at the International Conference: "Linkages between Energy and Water Management for Agriculture in Developing Countries", Hyderabad, India, 28-31 January 2007.
Abstract: Growing crops for biofuels is often criticized because of its direct competition for land for food production. The recent price increases on world food markets are partly a result of this competition. For instance, cereals prices have increased by more than 60% since 2005 and in 2006 sugar prices peaked at a level twice as high as the level of previous years. There are concerns whether these increases will continue and if the world will run out of resources for food production. According to the authors, these concerns are largely unwarranted. For one, higher prices for food also mean that feedstocks are becoming increasingly expensive for bio-energy production and this endogenously limits the amount of feedstocks that will be used in the energy market. In addition, there is no imminent global resource shortage, neither for land nor for water that would support these concerns. Even with an expanding world population there is globally still enough land and water to grow a substantial amount of biomass for both food and bio-energy production. However, there is an uneven distribution of natural resources, resulting in huge regional differences with important areas experiencing major land and water shortages. China and India, for example, account together for more than 35% of the total global population and both have exploited most of the land and water resources available for agriculture. On the other hand, sub-Saharan Africa and South America still have the potential, in terms of suitable land and exploitable water, to expand areas for agricultural production. The growing demand for bio-energy will have a negative and positive effect on food. Higher food prices can increase food insecurity among the urban poor and the rural landless population. On the other hand higher prices and more marketable production can stimulate the agricultural sector and create new opportunities for rural communities. At the national level it can offer development

opportunities for countries with significant resources.

Cassman K. G. and A. J. Liska. 2007. Food and fuel for all: realistic or foolish? Biofuels, Bioproducts and Biorefining, 1:18-23.
Reference ID: 20659
Notes: #20659e
Abstract: In 2005, few would have predicted the current revolution in global agriculture that is being driven by a sudden rise in the price of petroleum and a rapid expansion of global biofuel production from grain, sugar, and oilseed crops. The result has been a convergence of valuation between petroleum and agricultural commodities such that food prices are likely to rise substantially. While countries with adequate resources to support an expansion of biofuel crop production will benefit from this convergence, developing countries and regions that consistently experience food shortages or rely on food imports will face greater food insecurity. To avoid an excessive rise in food prices and increased numbers of undernourished will require a rapid response to improve global targeting of research and development funds to assure an acceleration in food production capacity while protecting natural resources and environmental quality.

Magne A. N., N. E. Nonga, M. Yemefack, and V. Robiglio. 2014. Profitability and implications of cocoa intensification on carbon emissions in Southern Cameroun. Agroforestry Systems, 88:1133-1142.
Reference ID: 20660
Notes: #20660e
Abstract: The present study evaluated profitability of some models of cocoa farms and analyzed the relationship between cocoa yield, income and carbon stored in traditional cocoa agroforests to discuss implications of cocoa intensification on carbon emissions in Cameroun. Surveys on establishment, management practices and marketing were conducted in 49 cocoa farms along a gradient of population density, forest cover and market access, and combined with data on carbon stock and trees species inventories. Traditional cocoa farms were stratified according to rehabilitation practices of farms (no rehabilitation, replacing dead/senescent cocoa plants in the farm or extending the farm by adding young plants around the old plots). Results showed that traditional cocoa agroforests are managed under high trees shade and present high carbon stock levels (average of 64 trees/ha of large tree diameter and about 94 tonC/ha). Management is based on an intensive use of family labor and there is little consistency in the use of inputs (as planting material, fertilizers and pesticides). Profitability analysis using net present value indicated that farms rehabilitated by replacement of cocoa trees were more profitable. Intensified systems are more profitable at the various discount rates considered, with up to 50 % cocoa yield increase but with less tree shade (about 40 trees/ha). Structural and productive parameters of the system showed a high variability and it was not possible to assess a clear relationship between carbon stock, yield, and incomes to clearly delineate tradeoffs. Under persistent poverty conditions and with no major intervention to support inputs purchase, suitable designs for intensification pathways should focus on good practices such as shade management, quality of associated trees, use of improved planting materials released by the research.

Deheuvels O., G. X. Rousseau, G. S. Quiroga, M. D. Franco, R. Cerda, S. J. V. Mendoza, and E. Somarriba. 2014. Biodiversity is affected by changes in management intensity of cocoa-based agroforests. Agroforestry Systems, 88:1081-1099.
Reference ID: 20661
Notes: #20661e
Abstract: In the humid tropics, the rapid rate of deforestation has resulted in a race to protect remaining forest patches that are increasingly isolated within a rapidly expanding agricultural matrix. In these landscapes, a significant area consists of complex agro-forestry systems with high structural and functional plant diversity, providing critical resources for biodiversity conservation, such as food and habitat. Although not a substitute for natural forests, these anthropogenic habitats are gaining increasing conservation value as deforestation progresses. Shaded tree crops, such as cocoa, provide habitats for numerous forest dependent species of high conservation value and play a largely undocumented role in providing other ecological services. Following previous work on the botanical composition and structural complexity of cocoa agroforests in Talamanca (Costa Rica), we assessed if differences in the vegetation composition and structure of 36 cocoa agroforests could affect the wild diversity of small mammals, amphibians, reptiles, soil and litter macro invertebrates and epiphytes found on cocoa trees and associated plants. Results show that Alpha-diversity is not affected by changes in vegetation structure and composition, except for amphibians and epiphytes found on cocoa trees. However, five taxa among eight showed distinct species composition patterns when compared among cocoa-based agroforestry clusters and with forest control. We showed that beta-diversity assessment enhances our understanding of the effect of management intensification on species composition and on habitat quality. The proper design of the shade component in these AFS will certainly play a key role in segregating wild species hosted in these systems and will open a new field of research for the intensification of both cocoa and associated productions in these highly diverse systems.

IPNI. An introduction of IPNI Plantation Intelligence incorporating Estate-Scale-Experimentation. 2014. Penang, Malaysia, IPNI.
Reference ID: 20662
Notes: S 8.1.1 #20622e

Winter, B. Linear models and linear mixed effects models in R with linguistic applications. 1-22. 2013.
Reference ID: 20663
Notes: #20663e
Abstract: This tutorial serves as a quick boot camp to jump-start your own analyses with linear mixed effects models. This text is different from other introductions by being decidedly conceptual; I will focus on why you want to use mixed models and how you should use them. While many introductions to this topic can be very daunting to readers who lake the appropriate statistical background, this text is going to be a softer kind of introduction so, don't panic! The tutorial requires R - so if you haven't installed it yet, go and get it! I also recommend reading tutorial 1 in this series before you go further. You can find it here: http://www.bodowinter.com/tutorial/bw_LME_tutorial1.pdf

IPNI. Better crops with plant food Vol.98 (2014, No.4). Better Crops With Plant Food 98[4], 1-31. 2014. IPNI.
Reference ID: 20664
Notes: #20664e

Boddiger, D. Boosting biofuel crops could threaten food security. 923-924. 9-15-2007. The Lancet.
Reference ID: 20665
Notes: #20665e
Abstract: The USA and Europe have made plans to substantially increase their use of biofuels over the coming years. Although the move might help slow global warming, experts warn that without proper oversight it could increase world hunger and poverty.

Foley J. A., N. Ramankutty, K. A. Brauman, E. S. Cassidy, J. S. Gerber, M. Johnston, N. D. Mueller, C. O'Connell, D. K. Ray, P. C. West, C. Balzer, E. M. Bennett, S. R. Carpenter, J. Hill, C. Monfreda, S. Polasky, J. Rockstrom, J. Sheehan, S. Siebert, D. Tilman, and D. P. M. Zaks. 2011. Solutions for a cultivated planet. Nature, 478:337-342.
Reference ID: 20668
Notes: #20668e
Abstract: Increasing population and consumption are placing unprecedented demands on agriculture and natural resources. Today, approximately a billion people are chronically malnourished while our agricultural systems are concurrently degrading land, water, biodiversity and climate on a global scale. To meet the world's future food security and sustainability needs, food production must grow substantially while, at the same time, agriculture's environmental footprint must shrink dramatically. Here we analyse solutions to this dilemma, showing that tremendous progress could be made by halting agricultural expansion, closing 'yield gaps' on underperforming lands, increasing cropping efficiency, shifting diets and reducing waste. Together, these strategies could double food production while greatly reducing the environmental impacts of agriculture.

Suja G., K. S. John, J. Sreekumar, and T. Srinivas. 2010. Short-duration cassava genotypes for crop diversification in the humid tropics: growth dynamics, biomass, yield and quality. J Sci Food Agric, 90:188-198.
Reference ID: 20669
Notes: #20669e
Abstract: BACKGROUND: Short-duration (6-7 months) cassava provides opportunities to smallholder farmers for effective utilisation of resources such as land, moisture and nutrients as well as diversification of enterprise and income. The variation in biomass production and partitioning, seasonal course of growth indices, yield, quality and nutrient uptake of ten short-duration/early-bulking genotypes of cassava and their impact on nutrient contents in soil in a lowland situation akin to rice fallow were examined in this study. RESULTS: Triploid 2-18 gave the highest yield (38.34 t ha(-1)), followed by triplold 4-2, Sree Vijaya, Sree Jaya and Vellayani Hraswa, which were on a par (30-32 t ha(-1)). Vellayani Hraswa, Sree Vijaya and triploid 4-2 had significantly higher tuberous root dry matter content (370-380 mg g(-1)) and fairly higher starch content (270-280 mg g(-1)). All genotypes except triploid 4-2, triploid 2-18 and H-165 had low cyanogen content (29.2-43.8 mu g g(-1)), well within the tolerable limit. Tuberous root dry matter and total dry matter production,

crop growth rate, tuberous root bulking rate and harvest index at the last phase, number of tuberous roots, mean weight of tuberous roots and nutrient uptake showed significant positive correlations with tuberous root yield. Principal component analysis also showed a similar trend. CONCLUSION: The diploids Sree Vijaya, Sree Jaya, Vellayani Hraswa and Kalpaka are ideal for cultivation in rice fallow for food use owing to their high yield, good cooking quality and low cyanogen content. The triploids are better suited for industrial use owing to their high tuberous root dry biomass production.

El-Sharkawy M. A. and S. M. De Tafur. 2010. Comparative photosynthesis, growth, productivity, and nutrient use efficiency among tall- and short-stemmed rain-fed cassava cultivars. Photosynthetica, 48:173-188.
Reference ID: 20670
Notes: #20670e
Abstract: Field trials under rain-fed conditions at the International Center for Tropical Agriculture (CIAT) in Colombia were conducted to study the comparative leaf photosynthesis, growth, yield, and nutrient use efficiency in two groups of cassava cultivars representing tall (large leaf canopy and shoot biomass) and short (small leaf canopy and shoot biomass) plant types. Using the standard plant density (10,000 plants ha(-1)), tall cultivars produced higher shoot biomass, larger seasonal leaf area indices (LAIs) and greater final storage root yields than the short cultivars. At six months after planting, yields were similar in both plant types with the short ones tending to form and fill storage roots at a much earlier time in their growth stage. Root yield, shoot and total biomass in all cultivars were significantly correlated with seasonal average LAI. Short cultivars maintained lower than optimal LAI for yield. Seasonal P (N), across cultivars, was 12% greater in short types, with maximum values obtained in Brazilian genotypes. This difference in P (N) was attributed to nonstomatal factors (i.e., anatomical/biochemical mesophyll characteristics). Compared with tall cultivars, short ones had 14 to 24 % greater nutrient use efficiency (NUE) in terms of storage root production. The lesser NUE in tall plants was attributed mainly to more total nutrient uptake than in short cultivars. It was concluded that short-stemmed cultivars are superior in producing dry matter in their storage roots per unit nutrient absorbed, making them advantageous for soil fertility conservation while their yields approach those in tall types. It was recommended that breeding programs should focus on selection for more efficient short- to medium-stemmed genotypes since resource-limited cassava farmers rarely apply agrochemicals nor recycle residual parts of the crop back to the soil. Such improved short types were expected to surpass tall types in yields when grown at higher than standard plant population densities (> 10,000 plants ha(-1)) in order to maximize irradiance interception. Below a certain population density (< 10,000 plants ha(-1)), tall cultivars should be planted. Findings were discussed in relation to cultivation and cropping systems strategies for water and nutrient conservation and use efficiencies under stressful environments as well as under predicted water deficits in the tropics caused by trends in global climate change. Cassava is expected to play a major role in food and biofuel production due to its high photosynthetic capacity and its ability to conserve water as compared to major cereal grain crops. The interdisciplinary/interinstitutions research reported here, including an associated release of a drought-tolerant, short-stem cultivar that was eagerly accepted by cassava farmers, reflects well on the productivity of the CIAT international research in Cali, Colombia.

Sommer R., P. L. G. Vlek, T. D. D. Sa, K. Vielhauer, R. F. R. Coelho, and H. Folster. 2004. Nutrient balance of shifting cultivation by burning or mulching in the Eastern Amazon - evidence for subsoil nutrient accumulation. Nutrient Cycling Agroecosystems, 68:257-271.
Reference ID: 20671
Notes: #20671e
Abstract: For over a hundred years shifting cultivation with slash-and-burn land preparation has been the predominant type of land use by smallholders in the Bragantina region of the Brazilian Eastern Amazon. This study contrasts the nutrient balance of slash-and-burn agriculture with a fire-free cultivation. Therefore, one half of a 3.5-year-old (28.7 t DM ha(-1)) and a 7-year-old woody fallow vegetation (46.5 t DM ha(-1)) was burnt and the other half mulched, leaving the biomass as a surface residue. Subsequently, a sequence of maize, beans and cassava was cropped for 1.5 year. Burning the 3.5- and 7-year-old fallow removed 97 and 94% of the C, 98 and 96% of the N, 90 and 63% of the P-stocks, and between 45 and 70% of the cations K, Mg and Ca of the aboveground biomass by volatilization or ash-particle transfer. These losses were avoided with the slash-and-mulch land preparation. Mulching did not increase the losses of nutrients by leaching, despite the high amount of rapidly decomposing surface mulch. Also the length of preceding fallow had no significant influence on leaching losses. At a depth of 3 m, leached nutrients were quantitatively negligible in both treatments. Comparing the nutrient fluxes at soil depths of 0.9 m, 1.8 m and 3 m, the amounts of all mobile nutrients, and also of chloride and sodium were markedly reduced during percolation and must have been retained. It is likely that nutrient retention in the subsoil layer is only temporary, emphasizing the need for a rapid re-establishment of the naturally deeprooting secondary vegetation after abandonment of sites to enable uptake of these nutrients. The overall nutrient balance was highly negative for slash-and-burn. 291 and 403 kg N ha(-1), 21 and 18 kg P ha(-1), and 70 and 132 kg K ha(-1) were removed from the burnt plots with a preceding fallow of 3.5 and 7 years, respectively. A reduced fallow period (3.5 years), which is a common trend in the region, resulted in a higher mean annual rate of nutrient loss averaged over the duration of the cycle than a fallow period of 7 years. Eliminating the burning losses by mulching brought the agricultural system back to an equilibrated or even slightly positive nutrient balance, even after a reduced fallow period. Thus, slash-and-mulch is a viable alternative to maintain agricultural productivity and ecosystem functioning.

El-Sharkawy M. A. and L. F. Cadavid. 2002. Response of cassava to prolonged water stress imposed at different stages of growth. Experimental Agriculture, 38:333-350.
Reference ID: 20672
Notes: #20672e
Abstract: A two-year field trial was conducted to study the effects of prolonged water stress on cassava (Manihot esculenta) productivity, and on nutrient uptake and use efficiency. Four contrasting cultivars were supplied with adequate fertilization and watering, except when water was excluded by covering the soil with plastic sheets for different periods, depending on treatment: from two to six months, four to eight months, or from six to twelve months after planting (early, mid-season and terminal stress respectively). Sequential harvests were made at 2, 4, 6, 8 and 12 months after planting to determine leaf area index and shoot and root biomass. At final harvest, nitrogen, phosphorus, potassium, calcium and magnesium concentrations in shoots and storage roots were determined. During both early and mid-season stress, leaf

area index and shoot and root biomass were significantly smaller than those in the controls across all cultivars. After recovery from stress, leaf area index was greatly enhanced with less dry matter allocated to stems, and root yields approached those in the controls. One cultivar, CMC 40, had greater final root yield under stress treatments. Nutrient concentration in roots and shoots was less in all cultivars with early stress and resulted in higher nutrient use efficiency in all elements for root production. The same trend was observed under mid-season stress, except for nitrogen concentration, which remained unchanged. Terminal stress did not affect leaf area index, but reduced the shoot biomass in all cultivars. Final root yields were smaller than those in the controls except for CMC 40 whose final root yield was greater under stress. Nitrogen concentration was greater in root biomass but less in shoot biomass of all cultivars, resulting in lower nitrogen-use efficiency for root production. Across cultivars, only potassium- and magnesium-use efficiencies were greater than in the controls. CMC 40 was the only cultivar with consistently greater use efficiency of nitrogen, phosphorus, potassium, calcium and magnesium for root production under terminal stress. This higher nutrient use efficiency was due, mainly, to a greater root production rather than to smaller nutrient concentration. This cultivar is suitable as a gene source for improving cassava in order to maximize root production per unit nutrient extracted under stressful environmental conditions.

Ardjasa W. S., H. Ando, K. Kakuda, and M. Kimura. 2002. Fate of basal N and growth of crops cultivated under cassava-based intercropping system with reference to K application rate. Soil Science and Plant Nutrition, 48:365-370.
Reference ID: 20673
Notes: #20673e
Abstract: Cassava is the fourth most important staple food crop in Asia and main crop in the cropping systems used in upland areas. Among staple crops, cassava most abundantly absorbs potassium (K), suggesting that a nutrient disorder might occur among the intercrops. A nutrient disorder in intercrops may affect the fate of applied nitrogen (N) through the growth of intercrops. Strong K-absorption ability of cassava can be potentially antagonistic to other crops. If so, when the soil K level is critical in an intercropping system, K application may result in increased yield through mitigation of the K antagonism among intercrops, accompanied with nutrition improvement of other nutrients. We conducted a field experiment to evaluate the growth of crops and the fate of N fertilizer with reference to the application rate of K in a cassava-based cropping system in South Sumatra. The results obtained were as follows: 1) The dry weight values and yield of cassava, upland rice, and corn without K application were lower than those with K application treatment. However, no significant differences in the dry weight and yield of these crops were observed between K application treatments of standard and double dose. 2) The recovery rate of basal N by upland rice and cassava was positively related to the yield of each crop. Amount of immobilized N in soil applied to upland rice was not affected by the application rate of K. 3) Total recovery rate of basal N applied to upland rice was 2 times higher in the K application treatment than without K application treatment. It appears that K application alleviated the N pollution problem by inducing a high uptake rate of N fertilizer by crops.

Fagbola O., O. Osonubi, and K. Mulongoy. 1998. Contribution of arbuscular mycorrhizal (AM) fungi and hedgerow trees to the yield and nutrient uptake of cassava in an alley-cropping system. Journal of Agricultural Science, 131:79-85.
Reference ID: 20674
Notes: #20674e
Abstract: A field trial on alley-cropping was conducted at the University of Ibadan research farm in the 1990/91 cropping season to assess the contributions of arbuscular mycorrhizal (AM) fungi and hedgerow woody legumes to the yield and nutrient uptake of cassava (Manihot esculenta Crantz) as an intercrop in an infertile soil. The trial also investigated the influence of AM fungi on the interplanting of a nonnodulating woody legume Senna siamea (syn. Cassia siamea) with a nodulating woody legume (Leucaena leucocephala). AM contributions to cassava were greater than the hedgerow contributions, which demonstrated that AM associations are an essential component in the nutrition of cassava. In contrast to cassava, AM inoculation only influenced the leaf dry weight and uptake of nutrients of non-interplanted woody legumes but not the above-ground biomass and P uptake of interplanted woody legumes. However, non-inoculated interplanted Leucaena benefited more from indigenous AM fungi than the competing Senna. The negative contributions to the nutrient uptake (K, Ca and ME) of cassava by hedgerows and the lack of response to AM inoculation in interplanted hedgerow woody legumes could be attributed to root competition among the different plant species growing in close proximity to each other. The present results show that cassava benefits more from AM association than Leucaena which in turn benefits more than Senna in an alley-cropping system.

Putthacharoen S., R. H. Howeler, S. Jantawat, and V. Vichukit. 1998. Nutrient uptake and soil erosion losses in cassava and six other crops in a Psamment in eastern Thailand. Field Crops Research, 57:113-126.
Reference ID: 20675
Notes: #20675e
Abstract: Total nutrient uptake and nutrients removed in harvested plant parts were determined for cassava grown for either root or forage production, maize, sorghum, peanut, mungbean, pineapple and sugarcane. All crops were grown in replicated plots on 7% slope on a sandy loam soil in Sri Racha, Thailand, during a 4 1/2-year period. Erosion losses associated with each crop were also determined by weighing at monthly intervals the soil sediments that had collected in plastic covered channels at the bottom of each plot. Cassava for root production had the lowest total uptake of major nutrients of all crops except mungbean, The amounts of N and P removed in the harvested plant parts were also much lower than those removed by other crops, while the amount of K removed by cassava was similar to other crops but much lower than pineapple or cassava grown for forage. This latter crop had a very high nutrient uptake and removal, especially that of N, K, Ca and Mg. On an annual basis, soil losses due to erosion were highest in cassava grown for roots, followed by cassava for forage, sugarcane, mungbean, sorghum, peanut, maize and pineapple. Thus, when cassava is grown for root production on slopes, it is Likely to cause more erosion than most other crops due to its wide spacing and slow initial canopy development. Cassava farmers should therefore be encouraged to use special management practices that reduce erosion. However, it is unlikely that cassava causes soil degradation by depleting the soil nutrient supply, as N and P removal in the harvested part of the plant was actually lower than, and K removal was similar to that of other crops tested.

Olasantan F. O., H. C. Ezumah, and E. O. Lucas. 1996. Effects of intercropping with maize on the micro-environment, growth and yield of cassava. Agriculture, Ecosystems & Environment, 57:149-158.
Reference ID: 20676
Notes: #20676e
Abstract: The growth environment of cassava intercropped with maize differs from monocultures of cassava, A trial was conducted to determine the effects of intercropping with maize on micro-environment, growth and yield of cassava. Radiant energy reaching the soil surface and maximum diumal soil temperatures were lower with intercropping, with the lowest values being observed in the fertilized plots, Similarly, soil moisture content and earthworm activity were greater with intercropping, with the highest values occurring in fertilized plots. Soil fertility, especially N, was lower in intercropping than in cassava grown alone, with the lowest fertility occurring in non-fertilized mixtures, Intercropping with fertilizer application thus lowered exposure and temperature, and increased soil water and earthworm activity. Inclusion of maize with cassava increased plant height, reduced leaf area index and stem branching and diameter, favoured lodging, delayed bulking of storage roots and decreased nutrient uptake in cassava. The ability of cassava to compensate for impaired early growth after maize harvest depended strongly on soil fertility, especially the level of nitrogen.

Osonubi O., M. O. Atayese, and K. Mulongoy. 1995. The Effect Of Vesicular-Arbuscular Mycorrhizal Inoculation On Nutrient-Uptake And Yield Of Alley-Cropped Cassava In A Degraded Alfisol Of Southwestern Nigeria. Biol Fertil Soils, 20:70-76.
Reference ID: 20677
Notes: #20677e
Abstract: Leaf and root (tuber) nutrient uptake patterns of cassava (Manihot esculenta Crantz) alley-cropped with gliricidia (Gliricidia sepium), leucaena (Leucaena leucocephala), and senna [(Senna (syn. Cassia) siamea] as influenced by vesicular-arbuscular mycorrhizal (VAM) inoculation in a degraded Alfisol were investigated in 3 consecutive years. The cassava plants were mulched with fresh prunings of each hedgerow tree species at 2-month intervals in the second and third years of alley cropping. While VAM inoculation significantly influenced the root uptake of nutrients, the leaf uptake was not affected except for the uptake of P. In most cases, there was no difference in the nutrient concentration between inoculated and uninoculated plants, either in the leaf or in the root, indicating that the productivity of cassava was regulated by the amount of nutrients the roots could absorb. In spite of similar total soil N in all inoculated and uninoculated alley-cropped cassava plots and similar exchangeable soil K contents in inoculated and uninoculated alley-cropped cassava plots with leucaena and senna, greater uptake of N, P, and K and greater concentrations of K were observed in roots of inoculated alley-cropped cassava with gliricidia and leucaena than with senna. These results indicated that greater mineralization and availability of nutrients to cassava roots from prunings of nodulating gliricidia and leucaena than from non-nodulating senna may be important, particularly with efficient VAM inoculation, in these alley-cropping systems. Also, for similar nutrients in the inoculated and uninoculated cassava soils alley-cropped with each hedgerow species, VAM inoculation significantly enhanced cassava root dry weights, indicating that an effective VAM fungus can be an agent of greater nutrient uptake in a competitive environment.

Morris R. A. 1993. Resource Capture And Utilization In Intercropping - Non-Nitrogen Nutrients. Field Crops Research, 34:319-334.
Reference ID: 20678
Notes: #20678e
Abstract: The capture and utilization of P and K, two non-mobile soil resources, were examined by decomposing crop production/unit area into uptake/unit area (capture) and production/unit uptake (utilization efficiency). Resource capture and utilization efficiencies by intercrops were compared to those of sole crops by contrasting intercrop means against the weighted means of sole crops. Weightings were based on the proportion of each species in the intercrop. On average, intercrops took up 43% more P (-4 to 83%) and 35% more K (-10 to 87%) than the sole crops. Where nutrients were not limiting, P and K uptake increased as dry-matter yield increased, evidence that uptake was a function of crop growth rather than conversely. Even where soil P was deficient, uptake by a dominated crop was decided more by factors that determined the outcome of competition than by P availability. The combined root systems, likely to be larger and functional for a longer duration under intercrops than under either sole crop, were postulated to explain the greater capture of non-mobile nutrients like P and K. An enlarged root system provides an expanded root surface area to which non-mobile nutrients can diffuse. For mobile nutrients which move to root surfaces largely by mass flow, shading of the dominated canopy may explain the positive association observed between intercrop dry-matter accumulation and Ca capture. Shading reduces carbon assimilation and transpiration of the understory canopy and, therefore, would reduce mass flow of Ca as well. Competition for P and K by intercropped species, even when nutrient supplies were abundant, was affected by degree of growth concurrency, canopy domination and planting geometry. When a dominating species was harvested much earlier than the dominated species, the uptake rate of the longer-duration crop usually recovered from competition after the first crop was harvested. Exceptions occurred when development of the dominated crop was so badly impaired during concurrent growth that vegetative enlargement was inhibited after harvest of the early species. Uptake rates by pigeon pea and cassava, which are exceptionally long-maturing species that have relatively low daily P and K uptake requirements, appeared capable of fully recovering even on soils in which nutrient availabilities were marginal for other species.

Ewel J. J., ., M. J. Mazzarino, and C. W. Berish. 1991. Tropical Soil Fertility Changes Under Monocultures And Successional Communities Of Different Structure. Ecological Applications, 1:289-302.
Reference ID: 20679
Notes: #20679e
Abstract: For 5 years we monitored the fertility of a volcanic-ash derived Inceptisol at a site in the humid tropics of Costa Rica. After forest felling and burning, we established four treatments in a randomized block design with six blocks: a sequence of monocultures (two crops of maize [Zea mays] followed by cassava [Manihot esculenta], then the tree species Cordia alliodora), successional vegetation, a mimic of successional vegetation that was physiognomically similar to the model but shared no species with it, and a species-enriched version of successional vegetation. In addition, one plot was maintained free of vegetation. Species-rich successional vegetation was effective at maintaining soil fertility, although we observed general trends of soil-nutrient decline beneath all treatments, presumably because of plant uptake. It proved possible to imitate the fertility-maintaining

characteristics of successional vegetation by creating an equally species-rich community of different floristic composition, but the maintenance of fertility was not enhanced by further species enrichment. Successive peaks of nitrate-nitrogen in soil solution, extractable phosphorus, and extractable potassium occurred during the 1st yr, perhaps driven by an early increment of organic matter from postburn debris and roots. Organic matter, total nitrogen, and extractable sulfur were remarkably stable during the 5-yr period. Depletions of cations, decreases in effective cation exchange capacity (CEC(e)), and increases in acid saturation were related to treatment in the following order: bare soil > monocultures > the three diverse, successional communities. In the bare-soil plot, fertility decreased dramatically: there was a net loss of exchangeable cations and inorganic nitrogen, the phosphorus-fixation capacity increased, and acid saturation reached a potentially toxic 86%. At the start of the study, three of the blocks had soil with lower pH, lower CEC(e), and higher acid saturation. During the study this less fertile soil lost proportionally more cations and increased more in acid saturation and phosphorus-fixation capacity. The less fertile soil under monocultures proved exceptionally vulnerable to loss of fertility; after 5 yr under monocultures, for example, acid saturation reached 38% in the more fertile soil and 75% in the less fertile soil. In the species-rich communities, however, changes in soil fertility were far less marked.

Amanullah M. M., K. Vaiyapuri, K. Sathyamoorthi, S. Pazhanivelan, and A. Alagesan. 2007. Nutrient uptake, tuber yield of cassava (Manihot esculenta Crantz.) and soil fertility as influenced by organic manures. Journal of Agronomy, 6:183-187.
Reference ID: 20680
Notes: #20680e
Abstract: Field experiments were conducted to find out the effect of organic manures on the nutrient uptake and soil fertility of cassava at Veterinary College and Research Institute Farm, Namakkal during 2001 and 2002. The popular hybrid of cassava H 226 was tried as test crop. Six organic manurial treatments viz., FYM (25 t ha-1), Poultry manure (10 t ha-1), composted poultry manure (10 t ha-1), FYM (12.5 t ha-1) +poultry manure (5 t ha-1), FYM (12.5 t ha-1)+composted poultry manure (5 t ha-1) along with control (no organic manure) were tried. The study revealed that all the organic manurial treatments had higher uptake of all the nutrients, higher tuber yield and post harvest soil nutrients than control. Composted poultry manure either alone or with FYM recorded higher nutrient uptake, tuber yield and post harvest soil nutrients depleting the soil nutrients, the least. A slightly positive N balance was associated with CPM while all the other manurial treatments had slightly negative balance.

El-Sharkawy M. A. 2006. International research on cassava photosynthesis, productivity, eco-physiology, and responses to environmental stresses in the tropics. Photosynthetica, 44:481-512.
Reference ID: 20681
Notes: #20681e
Abstract: The review sums up research conducted at CIAT within a multidiscipline effort revolving around a strategy for developing improved technologies to increase and sustain cassava productivity, as well as conserving natural resources in the various eco-edaphic zones where the crop is grown, with emphasis on stressful environments. Field research has elucidated several physiological plant mechanisms underlying potentially high productivity under favourable hot-humid environments in the tropics. Most notable is cassava inherent high capacity to assimilate carbon in

near optimum environments that correlates with both biological productivity and root yield across a wide range of germplasm grown in diverse environments. Cassava leaves possess elevated activities of the C_4 phospho*enol*pyruvate carboxylase (PEPC) that also correlate with leaf net photosynthetic rate (P_N) in field-grown plants, indicating the importance of selection for high P_N. Under certain conditions such leaves exhibit an interesting photosynthetic C_3-C_4 intermediate behaviour which may have important implications in future selection efforts. In addition to leaf P_N, yield is correlated with seasonal mean leaf area index (*i.e.* leaf area duration, LAD). Under prolonged water shortages in seasonally dry and semiarid zones, the crop, once established, tolerates stress and produces reasonably well compared to other food crops (*e.g.* in semiarid environments with less than 700 mm of annual rain, improved cultivars can yield over 3 t ha^{-1} oven-dried storage roots). The underlying mechanisms for such tolerance include stomatal sensitivity to atmospheric and edaphic water deficits, coupled with deep rooting capacities that prevent severe leaf dehydration, *i.e.* stress avoidance mechanisms, and reduced leaf canopy with reasonable photosynthesis over the leaf life span. Another stress-mitigating plant trait is the capacity to recover from stress, once water is available, by forming new leaves with even higher P_N, compared to those in nonstressed crops. Under extended stress, reductions are larger in shoot biomass than in storage root, resulting in higher harvest indices. Cassava conserves water by slowly depleting available water from deep soil layers, leading to higher seasonal crop water-use and nutrient-use efficiencies. In dry environments LAD and resistance to pests and diseases are critical for sustainable yields. In semiarid zones the crop survives but requires a second wet cycle to achieve high yields and high dry matter contents in storage roots. Selection and breeding for early bulking and for medium/short-stemmed cultivars is advantageous under semiarid conditions. When grown in cooler zones such as in tropical high altitudes and in low-land sub-tropics, leaf P_N is greatly reduced and growth is slower. Thus, the crop requires longer period for a reasonable productivity. There is a need to select and breed for more cold-tolerant genotypes. Selection of parental materials for tolerance to water stress and infertile soils has resulted in breeding improved germplasm adapted to both favourable and stressful environments.

Cruz J. L., P. R. Mosquim, C. R. Pelacani, W. L. Araujo, and F. M. DaMatta. 2003. Photosynthesis impairment in cassava leaves in response to nitrogen deficiency. Plant and Soil, 257:417-423.
Reference ID: 20682
Notes: #20682e
Abstract: Plants of cassava (*Manihot esculenta* Crantz cv. Cigana Preta) grown in a sand root medium were watered with nutrient solutions containing either 3 m*M* nitrate (low N) or 12 m*M* nitrate (high N). Chlorophyll concentration, chlorophyll *a*/*b* ratio, stomatal conductance, photorespiration rate and net carbon assimilation rate (on an area and a mass basis, but not on a chlorophyll basis) all decreased in low-N plants as compared with high-N ones. By contrast, photosynthetic nitrogen-use efficiency increased in low-N plants. As indicated by chlorophyll *a* fluorescence data, these plants exhibited increases in both excitation pressure on Photosystem II and thermal energy dissipation, with a corresponding decrease in quantum yield of electron transport, when contrasted with high-N plants. This decrease paralleled an unchanged maximal Photosystem II photochemical efficiency, suggesting a down-regulation of the Photosystem II photochemistry. It is proposed that decline in biochemical capacity for carboxylation, rather than stomatal limitation or electron

transport, were the major constraints associated to the reduced photosynthetic rates induced by nitrogen deficiency in cassava plants.

Yeoh H. H. and M. Y. Chew. 1976. Protein content and amino acid composition of cassava leaf. Phytochemistry, 15:1597-1599.
Reference ID: 20683
Notes: #20683e
Abstract: On the basis of leaf dry wt, the protein content of six varieties of cassava varied from 29.3 to 38.6% and the estimated leaf protein production ranged from 242 to 953 kg per ha. On the basis of fr. wt of leaf, the total amino acids ranged from 8.42 to 9.4% while the essential amino acids averaged 4.21% and the sulphur-containing amino acids only 0.25%. The amino acid composition profiles for the six varieties was similar.

Burns A. E., R. M. Gleadow, A. M. Zacarias, C. E. Cuambe, R. E. Miller, and T. R. Cavagnaro. 2012. Variations in the Chemical Composition of Cassava (*Manihot esculenta Crantz*) Leaves and Roots As Affected by Genotypic and Environmental Variation. Agricultural and Food Chemistry, 60:4946-4956.
Reference ID: 20684
Notes: #20684e
Abstract: The purpose of this study was to assess the quality of cassava cultivars, in terms of cyanogenic potential and composition of macro- and micronutrients, sampled from different locations in rural Mozambique. Total cyanide concentrations in fresh cassava tissues were measured using portable cyanide testing kits, and elemental nutrients were later analyzed from dried plant tissue. Variation in cyanogenic potential and nutrient composition occurred both among cultivars and across locations. The majority of cultivars contained >100 ppm total cyanide, fresh weight, and are therefore considered to be dangerously poisonous unless adequately processed before consumption. Leaf cyanogenic and nutrient content varied with plant water status, estimated using carbon isotope discrimination (delta C-13). The colonization of roots of all cultivars by arbuscular mycorrhizal fungi was also quantified and found to be high, indicating that mycorrhizas could play a key role in plant nutrient acquisition in these low-input farming systems.

Awoyinka A. F., V. O. Abegunde, and S. R. A. Adewusi. 1995. Nutrient Content Of Young Cassava Leaves And Assessment Of Their Acceptance As A Green Vegetable In Nigeria. Plant Foods for Human Nutrition, 47:21-28.
Reference ID: 20685
Notes: #20685e
Abstract: Cassava (Manihot esculenta Crantz) leaves contained a high level of crude protein (29.3-32.4% dry weight) compared to a conventional vegetable, Amaranthus (19.6%). Ash was 4.6-6.4% in cassava leaf samples but 13.1% dry weight in Amaranthus. Dietary fibre was very high in all samples (26.9-39% dry weight) while HCN-potential was low (5.1-12.6 mg/100 g dry weight). Tannin was the highest in IITA red cassava leaves (29.7 mg/g) and the lowest in Amaranthus vegetable. In vitro digestibility was very low in oven dried samples (15.6-22.7%). Blanching increased protein content (except Amaranthus) and in vitro protein digestibility but decreased ash, minerals, dietary fibre and tannin, while HCN-potential was unchanged. Grinding reduced both HCN-potential and tannin by 84 and 71% respectively while oven drying only reduced the HCN content marginally. Preference studies showed that the highest percentage of respondents (25.3%) preferred

Amaranthus vegetable, followed by Celosia (17.5%), Talinum (12.4%), garden egg (11.5%), with cassava leaves as the least (0.5%). Organoleptic evaluation rated cassava leaf soup inferior to Amaranthus in terms of appearance, colour and texture but equal in terms of taste and flavour and overall acceptability.

Waddington S. R., X. Li, J. Dixon, G. Hyman, and M. Carmen de Vicente. 2010. Getting the focus right: production constraints for six major food crops in Asian and African farming systems. Food Sec., 2:27-48.
Reference ID: 20686
Notes: #20686e
Abstract: To determine the most important production constraints and associated yield losses for six major food crops in 13 farming systems with high poverty in Sub-Saharan Africa, South Asia and East Asia, surveys were conducted with 672 experts representing a diversity of backgrounds and experience. Respondents reported large gaps between highest achieved crop yield on smallholder farms and average yield on farm. Yield gaps were smallest for rice (about 60% of current average smallholder farm grain yields), mid size for wheat and cassava, and larger (sometimes double current farm yields) for sorghum, cowpea and chickpea. Gaps were also smaller in the high input and yield farming systems of East Asia and largest in the marginal, drier systems, particularly in Sub-Saharan Africa. Four categories of production constraint (abiotic, biotic, management and socio-economic) were considered important contributors to yield gaps. A diversity of specific constraints was reported for the crops in the different systems. The most severe and widespread specific constraints for wheat involved the deficiency, high cost and poor management of N fertilizer, and problems associated with drought stress at grain filling, mid season drought and irrigation management. Those for rice included N fertilizer problems, soil fertility depletion, various leaf, stem and head pests and diseases, weed competition and inadequate water management. Striga and weed competition, soil resource degradation, poor soil fertility management, and drought were the most severe specific constraints for sorghum. Insect pests of pod, leaf, stem and flower and the high cost of their control dominated the constraint set for cowpea. Helicoverpa pod borer, Botrytis grey mould and control costs were the most severe for chickpea. Unsuitable varieties/poor seed, soil infertility and fertilizer constraints were also widespread with the legumes. Marketing problems and lack of finance were concerns for cassava along with weed competition, African cassava mosaic virus and poor varieties/planting materials. The findings can help to inform priority setting for international agricultural research and development activities on important food crops in major farming systems occupying areas of high poverty.

Tittonell P. and K. E. Giller. 2013. When yield gaps are poverty traps: The paradigm of ecological intensification in African smallholder agriculture. Field Crops Research, 143:76-90.
Reference ID: 20687
Notes: #20687e
Abstract: Yield gaps are pervasive in African smallholder agriculture, and are large for almost all crops in all regions. There is consensus that poor soil fertility and nutrient availability are the major biophysical limitations to agricultural production in the continent. We identify two major yield gaps: (1) the gap between actual yields (Y-A) and the water-limited yield potential (Y-w), which is the maximum yield achievable under rainfed conditions without irrigation if soil water capture and storage is optimal and nutrient constraints are released, and (2) The gap between YA, and a locally

attainable yield (Y-L) which corresponds to the water and nutrient-limited yields that can be measured in the most productive fields of resource endowed farmers in a community. Estimates of these two yield gaps are given for major crops, together with a framework for how yield gaps can be estimated in a pragmatic way for different farming systems. The paradigm of ecological intensification which focuses on yield potential, soil quality and precision agriculture is explored for the African context. Our analysis suggests that smallholder farmers are unable to benefit from the current yield gains offered by plant genetic improvement. In particular, continued cropping without sufficient inputs of nutrients and organic matter leads to localised but extensive soil degradation and renders many soils in a non-responsive state. The lack of immediate response to increased inputs of fertiliser and labour in such soils constitutes a chronic poverty trap for many smallholder farmers in Africa. This necessitates a rethink for development policy aimed to improve productivity and address problems of food insecurity.