New Entries to IPNI Library as References

[1] E. Winston, J.O. de Laak, T. Marsh, H. Lempke, O. Aung, T. Nyunt, K. Chapman. (2005). Nutrition & fertiliser management (Chapter 4). pp 1 - 14.
Reference ID: 24327
Note: H 8.1.5.1 #24327
Abstract: Nutrients are recycled within the environment. A 'closed' environment such as a rainforest, recycles its own nutrients and is more or less self-sufficient. however, where plants are grown in a commercial situation, it is necessary to replenish the nutrients that are removed from the system with the coffee beans. Unshaded plants of dwarf, high-yielding varieties such as Catimor, will quickly develop dieback and die if adequate nutrients and water are not added to the soil. Plants with mild to moderate dieback will recover with timely good fertilising, watering and weed management.

[2] MOSTA. (2017). Malaysian Oil Science and Technology MOST Vol 26 No 2 (2017). pp 58 - 119.
Reference ID: 24328
Note: S serial #24328

[3] J. Fry. (2017). Key Factors in Today's Oils and Fats Market. Malaysian Oil Science and Technology MOST. 26(2) pp 58 - 61.
Reference ID: 24329
Note: #24329e > S serial #24328

[4] O.H. Lee. (2017). Recipe for High, Sustainable Oil Palm Yields. Malaysian Oil Science and Technology MOST. 26(2) pp 62 - 65.
Reference ID: 24330
Note: #24330e > S serial #24328
(This paper was presented in MOSTA Oil Palm Best Practices Workshop 2017, 12-14 September 2017, Ipoh, Malaysia)

[5] R. Singh. (2017). Advances in Oil Palm Genomic Research. Malaysian Oil Science and Technology MOST. 26(2) pp 66 - 74.
Reference ID: 24331
Note: #24331e > S serial #24328
(This paper was presented in MOSTA Oil Palm Best Practices Workshop 2017, 12-14 September 2017, Ipoh, Malaysia)
Abstract: The oil palm remains the most productive oil crop planted on only 5-6% of the total world vegetable oil acreage and yet accounts for 45% of edible oil produced worldwide. It remains the backbone of the agriculture industry in Malaysia and Indonesia.

[6] C.J. Teo, S.Y. Chin, C.K. Wong, C.C. Tan, K.J. Goh. (2017). Planting Materials for High Sustainable Oil Palm Yields. Malaysian Oil Science and Technology MOST. 26(2) pp 75 - 82.
Reference ID: 24332
Note: #24332e > S serial #24328

(This paper was presented in MOSTA Oil Palm Best Practices Workshop 2017, 12-14 September 2017, Ipoh, Malaysia)
Abstract: A definition of High and Sustainable may be as follows - "High Yield and remain high without depleting natural resources, profit and human energy". It is challenging to achieve sustainable high yields nowadays. The scope of this presentation will cover: 1. What are the challenges for high, sustainable oil palm yields? 2. What are the remedies offered by planting materials? 3. What germplasm and breeding lines are available? 4. How do breeders handle this challenge?

[7] Y.M. Choo. (2017). Progress Towards Reducing Contaminants: Setting New Targets for the Industry (Standards & Specifications). Malaysian Oil Science and Technology MOST. 26(2) pp 83 - 86.
Reference ID: 24333
Note: #24333e > S serial #24328
(This paper was presented in MOSTA Oil Palm Best Practices Workshop 2017, 12-14 September 2017, Ipoh, Malaysia)
Abstract: The Malaysian Oil Palm Industry is a very well regulated industry. There are numerous laws in place to ensure the well-being of the oil palm industry. This includes those for the production of palm oil which adheres to quality specifications and protects consumers.

[8] M.R. Chandran. (2017). New Targets for Quality Improvement of Palm Oil. Malaysian Oil Science and Technology MOST. 26(2) pp 87 - 92.
Reference ID: 24334
Note: #24334e > S serial #24328
(This paper was presented in MOSTA Oil Palm Best Practices Workshop 2017, 12-14 September 2017, Ipoh, Malaysia)
Abstract: On the centennial of the oil palm, it may be appropriate to recall palm's illustrious history to the present day where new quality targets are being called for. The Rantau Panjang Avenue Palms - from Henri Fauconnier's collection of seeds from Sumatra in 1911-1912 is shown in Figs. 1 and 2, where magnificent palms of over 100 years can still be seen. Fig. 3 shows the Sumatran Dura Deli oil palm (103 years not out) planted in 1914 by Henri Fauconnier in Rantau Panjang, Selangor - Like a Rolex watch, it does not only tell time, it also tells history. Historical photographs of H Fauconnier, his bungalow and Maison de Palme in Rantau Panjang (Figs. 4 & 5)

[9] S. Topcu, C. Kirda, D.L. Bjorneberg, R.E. Sojka. (2005). Irrigation: Environmental Effects & Methods. pp 267 - 280.
Reference ID: 24335
Note: H 7.2 #24335
Abstract: The delta plains of the Euphrates and the Tigris rivers in Mesopotamia, and the Nile in Egypt have witnessed numerous civilizations. With the early practice of irrigated agriculture, these soils have offered a prosperous life to the people of the region.

[10] A. Rival. (2018). Achieving sustainable cultivation of oil palm: Vol 1: Introduction, breeding and cultivation techniques. Secondary Achieving sustainable cultivation of oil palm: Vol 1: Introduction, breeding and cultivation techniques. Burleigh Dodds Science Publishing Limited. United Kingdom. pp 1 - 290.
Reference ID: 24336
Note: S 8.1.1 #24336

[11] A. Rival. (2018). Achieving sustainable cultivation of oil palm: Vol 2: Diseases, pests, quality and sustainability. Secondary Achieving sustainable cultivation of oil palm: Vol 2: Diseases, pests, quality and sustainability. Burleigh Dodds Science Publishing Limited. United Kingdom. pp 1 - 441.
Reference ID: 24337
Note: S 8.1.1 #24337

[12] P.-M. Bosc, C. Gaillard. (2018). Understanding/categorising smallholders in oil palm cultivation. pp 361 - 382.
Reference ID: 24338
Note: #24338e > S 8.1.1 #24337

[13] J.I. Sanz, M. Mosquera, J.A. Beltrán. (2018). Closing yield gaps for small- and medium- scale oil palm producers: improving cultivation practices. pp 383 - 405.
Reference ID: 24339
Note: #24339e > S 8.1.1 #24337

[14] P. Rott. (2018). Achieving sustainable cultivation of sugarcane: Volume 1: Cultivation techniques, quality and sustainability. Secondary Achieving sustainable cultivation of sugarcane: Volume 1: Cultivation techniques, quality and sustainability. Burleigh Dodds Science Publishing Limited. United Kingdom. pp 1 - 340.
Reference ID: 24340
Note: S 8.3.1 #24340

[15] D. Snoeck, L. Koko, J. Joffre, P. Bastide, P. Jagoret. (2016). Cacao Nutrition and Fertilization. pp 155 - 202.
Reference ID: 24341
Note: #24341e
Abstract: Cocoa is globally the third agricultural commodity traded in terms of value. The cocoa world production is relatively stable since 2010 amounting to around 4.5 million tonnes. Eight countries account for 90% of the cocoa production, of which four West African countries. Under traditional cultivation practices, cocoa yields are poor with an average of ten fruits per cacao (*Theobroma cacao* L.), even though it has a potential to yield more than 100 fruits. As for most tree crops, the yields are depending on many factors, of which the more important are planting material, climate, cultural practices, and soil. Cacao is cultivated on many types of soil, and in various conditions, from agroforestry systems to full sun. Soil degradation and low soil fertility are among the main causes of low cocoa productivity. However, despite this inherent low fertility, most of the cocoa farmers do not use fertilizer because they are not well informed of the agricultural and fertilizers issues.
Here, we first review why fertilizers are used and how to optimize their effects, particularly farming practices and soil fertility management in full sun or shaded plantations. Second, we describe soil diagnosis and the foliar diagnosis, the two complementary approaches that were developed to assess the nutritional needs of cacao. The soil diagnosis provides a means to improve soil nutrient availabilities, while foliar diagnosis provides information on the cacao health. Third, we review the methods used to design fertilizer formulae and doses, and how they are calculated. Fertilizer inputs and mode of application are determined from the local conditions and farming practices. Fourth, we review the effects of nutrients on the characteristics of cacao (tree) and cocoa (product). Finally, some current issues are discussed, such as the use of advising a single formula for a whole region or country and how to develop

adoption of fertilizer by the cocoa farmers.

[16] X. Ma, M. Zarebanadkouki, Y. Kuzyakov, E. Blagodatskaya, J. Pausch, B.S. Razavi. (2018). Spatial patterns of enzyme activities in the rhizosphere: Effects of root hairs and root radius. Soil Biology and Biochemistry. 118 pp 69 - 78.
Reference ID: 24342
Note: #24342e
Abstract: The importance of root hairs and root radius for exudation and nutrient acquisition by plants is known mainly from nutrient solution studies. The in situ effects of root hairs and root radius on the spatial distribution of enzyme activity in the rhizosphere of various plants are unknown. Four plants with contrasting root morphology (maize, wheat, lentil and lupine) were chosen to test the effects of root hairs and root radius on the spatial distribution of β-glucosidase, cellobiohydrolase, leucine aminopeptidase and acid phosphatase. We combined zymography with enzyme kinetics to evaluate the effects of root hairs on the rhizosphere extent and on substrate turnover. The extent of enzyme activity in the rhizosphere of four plants ranged from 0.55 to 2 mm. The extent of β-glucosidase was 1.5 times broader (1.2mm versus 0.8 mm) and the substrate turnover was 2-fold faster around wheat root regions with hairs than hairless locations. The rhizosphere extent relative to root radius and the enzyme activity per root surface area were plant and enzyme specific: the rhizosphere extent was 1.5–2 times broader and the enzyme activity was 2–8-fold higher in wheat (with thin roots and long root hairs) compared to maize, lentil and lupine. The rhizosphere extent of acid phosphatase (1.1–2.0 mm) was 1.5–2-fold broader than that of other enzymes (0.5–1.0 mm). For the first time, we showed that the rhizosphere extent relative to root radius was 20–100% broader and enzyme activity per surface area was 4–7-fold higher around thin roots (wheat) than around thick roots (maize). Moreover, the rhizosphere extent relative to root radius was 10–30% broader and enzyme activity per root area was 2–7 times higher around roots with long and dense hairs (lupine) than around roots with short and sparse hairs (lentil). We conclude that root hairs and root radius shape the rhizosphere: root hairs contributed mainly to the rhizosphere extent, while root radius more strongly affected the enzyme activity per root surface area.

[17] M. Holz, M. Zarebanadkouki, Y. Kuzyakov, J. Pausch, A. Carminati. (2017). Root hairs increase rhizosphere extension and carbon input to soil. Annals of Botany. 00 pp 1 - 9.
Reference ID: 24343
Note: #24343e
Abstract:
• *Background and Aims* Although it is commonly accepted that root exudation enhances plant–microbial interactions in the rhizosphere, experimental data on the spatial distribution of exudates are scarce. Our hypothesis was that root hairs exude organic substances to enlarge the rhizosphere farther from the root surface.
• *Methods* Barley (*Hordeum vulgare* 'Pallas' – wild type) and its root-hairless mutant (brb) were grown in rhizoboxes and labelled with $^{14}CO_2$. A filter paper was placed on the soil surface to capture, image and quantify root exudates.
• *Key Results* Plants with root hairs allocated more carbon (C) to roots (wild type: 13 %; brb: 8 % of assimilated ^{14}C) and to rhizosheaths (wild type: 1.2 %; brb: 0.2 %), while hairless plants allocated more C to shoots (wild type: 65 %; brb: 75 %). Root hairs increased the radial rhizosphere extension three-fold, from 0.5 to 1.5 mm. Total exudation on filter paper was three times greater for wild type plants compared to the

hairless mutant.
• *Conclusion* Root hairs increase exudation and spatial rhizosphere extension, which probably enhance rhizosphere interactions and nutrient cycling in larger soil volumes. Root hairs may therefore be beneficial to plants under nutrient-limiting conditions. The greater C allocation below ground in the presence of root hairs may additionally foster C sequestration.

[18] A. Thoumazeau, F. Gay, P. Alonso, N. Suvannang, A. Phongjinda, P. Panklang, T. Chevallier, C. Bessou, A. Brauman. (2017). SituResp®: A time- and cost-effective method to assess basal soil respiration in the field. Applied Soil Ecology. pp 1 - 9.
Reference ID: 24344
Note: #24344e
Abstract: The soil microbial activity is a key parameter in numerous studies aiming to assess soil quality in agricultural plots. Basal Soil Respiration (BSR) has been extensively used as an indicator of this soil microbial activity. However, available methods to measure BSR remain time- and labor- consuming and must be performed in the laboratory which may lead to result distortion due to the needed soil pre-treatments. The SituResp® method was developed to assess BSR in a time and cost-effective way. This method was adapted from a laboratory methodology, the MicroResp™ method, in order to be implemented in the field on fresh soil samples. It is based on the color change of a pH-sensitive gel in reaction to the CO_2 concentration change in the headspace of a soil sample over the 24-h incubation. This study presents the calibration and validation of the SituResp® method in laboratory conditions, and a comparison in the field with the Solvita® tool, a comparable method used by agricultural scientists and advisors. The results of the calibration showed a high correlation between the air CO_2 concentration and the absorbance variation of the gel at 570 nm (R^2 = 0.95). The validation against the titration alkali-trap method, on 21 soil samples, showed a strong correlation between the two methods (R^2 = 0.90). In the field test on 9 agricultural-plots, the SituResp® method yielded similar results to the Solvita® tool. The SituResp® method is therefore a reliable method for performing a cheap, rapid but efficient assessment of soil microbial activity in the field which could be included in soil quality monitoring.

[19] T. Jensen. 2018. Plant Nutrition Today - Spring 2018 Issue 1 No 5: 4R Plant Nutrition and Farm Net Profits. (5). pp 1 - 2.
Reference ID: 24345
Note: #24345e
Abstract: Farmers want to manage their farms so that they are sustainable, and the key indicators of farm sustainability are its Social, Environmental, and Economic goals and outcomes. Individual farms vary in size. But all farms need to be managed so that they contribute to society, help look after the environment, and function economically so the farm is profitable and contributes to the local economy.

[20] R. Mikkelsen. 2018. Plant Nutrition Today - Spring 2018 Issue 1 No 4: Ugly Pictures Help to Grow Beautiful Potatoes. (1). pp 1 - 2.
Reference ID: 24346
Note: #24346e
Abstract: Potatoes are one of the most important crops in the human diet. They are grown worldwide, with China being the largest potato-producing country, followed by India and Russia. There are hundreds of potato varieties, representing a wide range of colors, shapes, sizes, flavors, and cooking properties.

[21] Y. Huang, B. Guenet, P. Ciais, I.A. Janssens, J.L. Soong, Y. Wang, D. Goll, E. Blagodatskaya, Y. Huang. (2018). ORCHIMIC (v1.0), a microbe-driven model for soil organic matter decomposition designed for large-scale applications. Geoscientific Model Development. pp 1 - 48.
Reference ID: 24347
Note: #24347e
Abstract: The role of soil microorganisms in regulating soil organic matter (SOM) decomposition is of primary importance in the carbon cycle, and in particular in the context of global change. Modelling soil microbial community dynamics to simulate its impact on soil gaseous carbon (C) emissions and nitrogen (N) mineralization at large spatial scales is a recent research field with the potential to improve predictions of SOM responses to global climate change. We here present a SOM model called ORCHIMIC whose input data that are consistent with those of global vegetation models. The model simulates decomposition of SOM by explicitly accounting for enzyme production and distinguishing three different microbial functional groups: fresh organic matter (FOM) specialists, SOM specialists, and generalists, while implicitly also accounting for microbes that do not produce extracellular enzymes, i.e. cheaters. This ORCHIMIC model and two other organic matter decomposition models, CENTURY (based on first order kinetics and representative for the structure of most current global soil carbon models) and PRIM (with FOM accelerating the decomposition rate of SOM) were calibrated to reproduce the observed respiration fluxes from FOM and SOM and their possible interactions from incubation experiments of Blagodatskaya et al. (2014). Among the three models, ORCHIMIC was the only one that captured well both the temporal dynamics of the respiratory fluxes and the magnitude of the priming effect observed during the incubation experiment. ORCHIMIC also reproduced well the temporal dynamics of microbial biomass. We then applied different idealized changes to the model input data, i.e. a 5 K stepwise increase of temperature and/or a doubling of plant litter inputs. Under 5 K warming, ORCHIMIC predicted a 0.002 K-1 decrease in the C use efficiency (defined as the ratio of C allocated to microbial growth to the sum of C allocated to growth and respiration) and a 3 % loss of SOC. Under the double litter input scenario, ORCHIMIC predicted a doubling of microbial biomass, while SOC stock increased by less than 1 % due to the priming effect. This limited increase in SOC stock contrasted with the proportional increase in SOC stock as modelled by the conventional SOC decomposition model (CENTURY), which cannot reproduce the priming effect. If temperature increased by 5 K and litter input is doubled, the model predicted almost the same loss of SOC as when only temperature was increased. These tests suggest that the responses of SOC stock to warming and increasing input may differ a lot from those simulated by conventional SOC decomposition models, when microbial dynamics is included. The next step is to incorporate the ORCHIMIC model into a global vegetation model to perform simulations for representative sites and future scenarios.

[22] L.S. Woittiez, M. Slingerland, R. Rafik, K.E. Giller. (2018). Nutritional imbalance in smallholder oil palm plantations in Indonesia. Nutrient Cycling in Agroecosystems. pp 1 - 14.
Reference ID: 24348
Note: #24348e
Abstract: In Indonesia more than 40% of the area under oil palm is owned by smallholders. The productivity in smallholder plantations is usually less than in large plantations, and limited fertiliser applications may be one of the key reasons. We

investigated the use of fertilisers by >300 smallholder farmers in Sumatra and Kalimantan, some of whom were involved in training programmes aimed at yield improvement. In our sample, the total applications of N were largest (166 kg ha^{-1} $year^{-1}$), followed by K (122 kg) and P (56 kg). The applications of K were insufficient to compensate for the off-take with a production of 20 tonne fruit bunches ha^{-1} $year^{-1}$, while N applications were excessive. On average, farmers applied 1130 kg fertiliser ha^{-1} $year^{-1}$, and relied strongly on subsidised fertilisers, especially NPK Ponska (66%) and urea (39%). The average costs for fertiliser application were USD 225 ha^{-1} $year^{-1}$. Trained farmers applied significantly more P in one research area, but for the other nutrients and research areas, there was no significant difference between trained and untrained farmers. Plantation size and nutrient application were weakly correlated in some areas, but not in the sample as a whole. Previously reported nutrient application rates were mostly less than our findings indicated, suggesting that actual nutrient limitations may be more severe. To overcome nutrient limitations and enhance nutrient use efficiency, we recommend that fertilisers are used in the correct balance; a ground cover vegetation is maintained to protect against erosion; and the application of empty fruit bunches is encouraged.

[23] A. Nurcahyo, E. Meijaard. (2018). Inspire lead authors from global south. Nature. 555 pp 443 - 443.
Reference ID: 24349
Note: #24349e
Abstract: Dyna Rochmyaningsih argues that the position of authors from the 'global south' on papers with Western scientists could be unfairly affected by their limited access to funding (Nature 553, 251; 2018), citing our paper on a new species of orangutan (*Pongo tapanuliensis*) in Indonesia as an example. In that case, however, an Indonesian (A.N.) is one of 4 lead authors, and listing of the 37 co-authors was decided on the basis of contribution rather than funding. Nevertheless, such collaborative standards are rare.

[24] H.R. Mount. (2018). Obtaining Soil Information Needed for Site-Specific Management Decisions. Site-Specific Management Guidelines. pp 1 - 4.
Reference ID: 24350
Note: #24350e
Abstract: County soil surveys contain a compendium of information about soil and climatic conditions within a region. The soil surveys are available from local Natural Resources Conservation Service (NRCS) offices. Most are in the process of being digitized. Boundaries of different soils are usually drawn on an aerial photograph. Most soil surveys are Order 2, with scales of 1:12,000 to 1:31,680 and a minimum size delineation of 1.5 to 10 acres. Order 2 soil surveys were not developed for site-specific management, and research evaluating the ability to use them for site-specific management has been mixed. They can be personalized by developing a new map based on the Order 2 soil survey as well as experiences, visual observations, and measured values.

[25] V. Naipal, P. Ciais, Y. Wang, R. Lauerwald, B. Guenet, K. Van Oost. (2018). Global soil organic carbon removal by water erosion under climate change and land use change during 1850-2005 AD. Biogeosciences. pp 1 - 33.
Reference ID: 24351
Note: #24351e
Abstract: The onset and expansion of agriculture has accelerated soil erosion by

rainfall and runoff substantially, mobilizing vast quantities of soil organic carbon (SOC) globally. Studies show that at timescales of decennia to millennia this mobilized SOC can significantly alter previously estimated carbon emissions from land use change (LUC). However, a full understanding of the impact of erosion on land-atmosphere carbon exchange is still missing. The aim of our study is to better constrain the terrestrial carbon fluxes by developing methods compatible with Earth System Models (ESMs) in order to explicitly represent the links between soil erosion by rainfall and runoff and carbon dynamics. For this we use an emulator that represents the carbon cycle of a land surface model, in combination with the Revised Universal Soil Loss Equation model. We applied this modeling framework at the global scale to evaluate the effects of potential soil erosion (soil removal only) in the presence of other perturbations of the carbon cycle: elevated atmospheric CO_2, climate variability, and LUC. We found that over the period 1850-2005 AD acceleration of soil erosion leads to a total potential SOC removal flux of 100 Pg C of which 80% occurs on agricultural, pasture and natural grass lands. Including soil erosion in the SOC-dynamics scheme results in a doubling of the cumulative loss of SOC over 1850 – 2005 due to the combined effects of climate variability, increasing atmospheric CO_2 and LUC. This additional erosional loss decreases the cumulative global carbon sink on land by 5 Pg for this specific period, with the largest effects found for the tropics, where deforestation and agricultural expansion increased soil erosion rates significantly. We also show that the potential effects of soil erosion on the global SOC stocks cannot be ignored when compared to the effects of climate change or land use change on the carbon cycle. We conclude that it is necessary to include soil erosion in assessments of LUC and evaluations of the terrestrial carbon cycle.

[26] G. Aubert. (1978). Soil Survey: Different Types and Categories. Soil Resource Inventories and Development Planning. pp 17 - 25.
Reference ID: 24352
Note: #24352e
Abstract: Soil is a natural object, and as such, it is an indispensable object of study, both as an entity itself and to understand the action of its formative factors in order to determine its genesis and evolution, its place in a natural and rational classification, and its global distribution.
Since soil is one of the fundamental components of terrestrial ecosystems, we must therefore attempt to ascertain how soil interacts with them. These ecosystems are often transformed directly or indirectly by man into agro-ecosystems which furnish food, fiber, and other products such as textiles, wood, oil, etc. The study of soil types must therefore be performed with the goal of determining their possible adaptation to these utilizations.
Soil survey, the field and subsequent laboratory study of soils, is based on grouping individual soils into units defined by their characteristics, properties, and evolution, elements which permit the expression of their specificity, the role they play in ecosystems, and their possibilities for utilization. Mapping is performed to show the spatial distribution of these defined units.

[27] International Fertilizer Association, IFA. (2018). The Fertilizer Industry Submission to the Consultation on the Koronivia Joint Work on Agriculture of the SBSTA. pp 1 - 9.
Reference ID: 24353
Note: #24353e
Abstract:

- Fertilizers are essential for achieving global food security. When considering GHG emissions from fertilizers it is important to focus on GHG emissions per unit of output of agricultural crops grown with the assistance of fertilizers in order not to jeopardize agricultural productivity and by extension food security;
- Farmers can adapt to climate change by using fertilizers according to Best Management Practices that strengthen their crops' resilience and make the best use of resources like water;
- Fertilizer Best Management Practices can also reduce GHG emissions from fertilizer application, prevent deforestation and increase soil carbon sequestration, thus playing an essential role in the agricultural sector's climate change mitigation potential;
- Mineral and organic nutrient sources are complementary: mineral fertilizer have a higher nutrient content than organic sources, a well-defined composition and are readily available to crops. Organic nutrient sources are rich in organic matter and contribute to improve soil properties. Integrated Plant Nutrient Management takes advantage of this synergy.

[28] M. Holz, M. Zarebanadkouki, A. Kaestner, Y. Kuzyakov, A. Carminati. (2017). Rhizodeposition under drought is controlled by root growth rate and rhizosphere water content. Plant Soil. pp 1 - 15.
Reference ID: 24354
Note: #24354e
Abstract:
Aims Rhizodeposition is an important energy source for soil microorganisms. It is therefore crucial to estimate the distribution of root derived carbon (C) in soil and how it changes with soil water content.
Methods We tested how drought affects exudate distribution in the rhizosphere by coupling $^{14}CO_2$ labelling of plants and phosphor imaging to estimate C allocation in roots. Rhizosphere water content was visualized by neutron radiography. A numerical model was employed to predict the exudate release and its spatiotemporal distribution along and around growing roots.
Results Dry and wet plants allocated similar amounts of ^{14}C into roots but root elongation decreased by 48% in dry soil leading to reduced longitudinal rhizosphere extension. Rhizosphere water content was identical (31%) independent of drought, presumably because of the high water retention by mucilage. The model predicted that the increase in rhizosphere water content will enhance diffusion of exudates especially in dry soil and increase their microbial decomposition.
Conclusion Root growth and rhizosphere water content play an important role in C release by roots and in shaping the profiles of root exudates in the rhizosphere. The release of mucilage may be a plant strategy to maintain fast diffusion of exudates and high microbial activity even under water limitation.

[29] Global Coffee Platform, GCP. (2017). Brazil. A Quick Scan on Improving the Economic Viability of Coffee Farming. Global Coffee Platform (GCP).
Reference ID: 24355
Note: H 8.1.5 #24355e (note: in folder Global Coffee Platform)

[30] Global Coffee Platform, GCP. (2017). Colombia. A Quick Scan on Improving the Economic Viability of Coffee Farming. Global Coffee Platform (GCP).
Reference ID: 24356
Note: H 8.1.5 #24356e (note: in folder Global Coffee Platform)

[31] Global Coffee Platform, GCP. (2017). Ethiopia. A Quick Scan on Improving the Economic Viability of Coffee Farming. Global Coffee Platform (GCP).
Reference ID: 24357
Note: H 8.1.5 #24357e (note: in folder Global Coffee Platform)

[32] Global Coffee Platform, GCP. (2017). The Future of Coffee. A Quick Scan on Improving the Economic Viability of Coffee Farming. Global Coffee Platform (GCP).
Reference ID: 24358
Note: #24358e (note: in folder Global Coffee Platform)

[33] Global Coffee Platform, GCP. (2017). Honduras. A Quick Scan on Improving the Economic Viability of Coffee Farming. Good Coffee Platform (GCP).
Reference ID: 24359
Note: H 8.1.5 #24359e (note: in folder Global Coffee Platform)

[34] Global Coffee Platform, GCP. (2017). Indonesia. A Quick Scan on Improving the Economic Viability of Coffee Farming. Good Coffee Platform (GCP).
Reference ID: 24360
Note: H 8.1.5 #24360e (note: in folder Global Coffee Platform)

[35] Global Coffee Platform, GCP. (2017). Kenya. A Quick Scan on Improving the Economic Viability of Coffee Farming. Global Coffee Platform (GCP).
Reference ID: 24361
Note: H 8.1.5 #24361e (note: in folder Global Coffee Platform)

[36] Global Coffee Platform, GCP. (2017). Nicaragua. A Quick Scan on Improving the Economic Viability of Coffee Farming. Global Coffee Platform (GCP).
Reference ID: 24362
Note: H 8.1.5 #24362e (note: in folder Global Coffee Platform)

[37] Global Coffee Platform, GCP. (2017). Tanzania. A Quick Scan on Improving the Economic Viability of Coffee Farming. Global Coffee Platform (GCP).
Reference ID: 24363
Note: H 8.1.5 #24363e (note: in folder Global Coffee Platform)

[38] Global Coffee Platform, GCP. (2017). Uganda. A Quick Scan on Improving the Economic Viability of Coffee Farming. Global Coffee Platform (GCP).
Reference ID: 24364
Note: H 8.1.5 #24364e (note: in folder Global Coffee Platform)

[39] Global Coffee Platform, GCP. (2017). Vietnam. A Quick Scan on Improving the Economic Viability of Coffee Farming. Global Coffee Platform (GCP).
Reference ID: 24365
Note: H 8.1.5 #24365e (note: in folder Global Coffee Platform)

[40] H. Adam, M. Collin, F. Richaud, T. Beule, D. Cros, A. Omore, L. Nodichao, B. Nouy, J.W. Tregear. (2011). Environmental regulation of sex determination in oil palm: current knowledge and insights from other species. Annals of Botany. United Kingdom. pp 1529 - 1537.
Reference ID: 24366
Note: #24366e

Abstract:
† Background The African oil palm (*Elaeis guineensis*) is a monoecious species of the palm subfamily Arecoideae. It may be qualified as 'temporally dioecious' in that it produces functionally unisexual male and female inflorescences in an alternating cycle on the same plant, resulting in an allogamous mode of reproduction. The 'sex ratio' of an oil palm stand is influenced by both genetic and environmental factors. In particular, the enhancement of male inflorescence production in response to water stress has been well documented.
† Scope This paper presents a review of our current understanding of the sex determination process in oil palm and discusses possible insights that can be gained from other species. Although some informative phenological studies have been carried out, nothing is as yet known about the genetic basis of sex determination in oil palm, nor the mechanisms by which this process is regulated. Nevertheless new genomics-based techniques, when combined with field studies and biochemical and molecular cytological-based approaches, should provide a new understanding of the complex processes governing oil palm sex determination in the foreseeable future. Current hypotheses and strategies for future research are discussed.

[41] K. Allen, M.D. Corre, A. Tjoa, E. Veldkamp. (2015). Soil Nitrogen-Cycling Responses to Conversion of Lowland Forests to Oil Palm and Rubber Plantations in Sumatra, Indonesia. Plos One. 10(7) pp 1 - 21.
Reference ID: 24367
Note: #24367e
Abstract: Rapid deforestation in Sumatra, Indonesia is presently occurring due to the expansion of palm oil and rubber production, fueled by an increasing global demand. Our study aimed to assess changes in soil-N cycling rates with conversion of forest to oil palm (*Elaeis guineensis*) and rubber (*Hevea brasiliensis*) plantations. In Jambi Province, Sumatra, Indonesia, we selected two soil landscapes – loam and clay Acrisol soils – each with four land-use types: lowland forest and forest with regenerating rubber (hereafter, "jungle rubber") as reference land uses, and rubber and oil palm as converted land uses. Gross soil-N cycling rates were measured using the 15N pool dilution technique with in-situ incubation of soil cores. In the loam Acrisol soil, where fertility was low, microbial biomass, gross N mineralization and NH_4+ immobilization were also low and no significant changes were detected with land-use conversion. The clay Acrisol soil which had higher initial fertility based on the reference land uses (i.e. higher pH, organic C, total N, effective cation exchange capacity (ECEC) and base saturation) (P_0.05–0.09) had larger microbial biomass and NH_4+ transformation rates (P_0.05) compared to the loam Acrisol soil. Conversion of forest and jungle rubber to rubber and oil palm in the clay Acrisol soil decreased soil fertility which, in turn, reduced microbial biomass and consequently decreased NH_4+ transformation rates (P<0.05–0.09). This was further attested by the correlation of gross N mineralization and microbial biomass N with ECEC, organic C, total N (R=0.51–0. 76; P<0.05) and C:N ratio (R=-0.71 – -0.75, P<0.05). Our findings suggest that the larger the initial soil fertility and N availability, the larger the reductions upon land-use conversion. Because soil N availability was dependent on microbial biomass, management practices in converted oil palm and rubber plantations
should focus on enriching microbial biomass.

[42] M. Brockhaus, K. Obidzinski, A. Dermawan, Y. Laumonier, C. Luttrell. (2012). An overview of forest and land allocation policies in Indonesia: Is the current framework sufficient to meet the needs of REDD+? Forest Policy and Economics. 18 pp 30 - 37.
Reference ID: 24368
Note: #24368e
Abstract: The global community is negotiating an international REDD+ mechanism, and recent multilateral and bilateral arrangements indicate Indonesia may receive a significant share of financial resources attached to this mechanism. These financial incentives may potentially alter the country's economic landscape. However, current forest and land allocation policies and politics support economic activities that promote the exploitation of forest assets. More recently, global needs for energy and food have increased pressure on forest land. The REDD+ mechanism is designed to reverse this situation and create opportunities for necessary reforms both inside and outside the forestry sector. In this paper, we take a political economy perspective to analyze Indonesia's policies on the allocation of forest land (kawasan hutan) and, related to this, assess the changes in forest land allocation that are needed to enable REDD+ to compete with other sectors. This paper shows that there are numerous challenges to create a “space” for REDD+, many of which are rooted in the political economy of forests that shapes the nature and process of the land allocation system. The questions of where, on which type of forest land, at what scale and based on which procedures remain key for REDD+ and its capability to compete with other objectives within the current forest land allocation framework.

[43] A. Daher, H. Adam, N. Chabrillange, M. Collin, Mohamed.N., J.W. Tregear, F. Aberlenc-Bertossi. (2010). Cell cycle arrest characterizes the transition from a bisexual floral bud to a unisexual flower in *Phoenix dactylifera*. Annals of Botany. 106 pp 255 - 266.
Reference ID: 24369
Note: #24369e
Abstract:
† Background and Aims Phoenix dactylifera (date palm) is a dioecious species displaying strong dimorphism between pistillate and staminate flowers. The mechanisms involved in the development of unisexual flowers are as yet unknown.
† Methods This paper describes the results of inflorescence and flower development studies using different histological and molecular cytological approaches. Nuclear integrity and cell division patterns in reproductive organs were investigated through DAPI staining and in situ hybridization using a histone H4 gene probe.
† Key Results The earliest sex-related difference in flower buds is observed at an otherwise ‘bisexual’ stage, at which the number of cells in the gynoecium of pistillate flowers is higher than in their staminate counterparts. In the pistillate flower, staminodes (sterile stamens) display precocious arrest of development followed by cell differentiation. In the staminate flower, pistillodes (sterile gynoecium) undergo some degree of differentiation and their development ceases shortly after the ovule has been initiated. Staminode and pistillode cells exhibit nuclear integrity although they did not show any accumulation of histone H4 gene transcripts.
†Conclusions These results strongly suggest that the developmental arrest of sterile sex organs and the subsequent unisexuality of date palm flowers result from a cessation of cell division and precocious cell differentiation rather than from cell death.

[44] P. Dixon, H. van Meijl, M. Rimmer, L. Shutes, A. Tabeau. (2016). RED versus REDD: Biofuel policy versus forest conservation. Economic Modelling. 52 pp 366 - 374.
Reference ID: 24370
Note: #24370e
Abstract: We examine the interplay between Renewable Energy Directives (RED) and the United Nations Programme to Reduce Emissions from Deforestation and Forest Degradation (REDD) using a scenario approach with a recursive–dynamic global computable general equilibrium model. A methodological issue addressed in the paper is the specification of the supply of agricultural land in the face of restrictions over its availability, as arises under REDD. By giving magnitudes to the effects of REDD and RED, our simulations provide a defense against environmental skeptics who, in the absence of such estimates, can dismiss these policies as being exorbitantly expensive. Although REDD and RED are in tension with respect to land use, the paper shows that they could be implemented simultaneously without significant global problems for food supply. The paper does however pinpoint some regional problems. Implementation of RED and REDD would cause large increases in food prices in Indonesia and Southern Africa. The methodology used in this paper, if implemented at a more detailed level, could be the basis of working out compensation packages that would be needed to make pervasive RED and REDD policies politically feasible.

[45] T.H. Fairhurst, W. Griffiths, C Donough, C. Witt, D. McLaughlin, K.E. Giller. (2010). Identification and elimination of yield gaps in oil palm plantations in Indonesia. AGRO 2010. Montpellier, France. ESA.
Reference ID: 24371
Note: #24371e (Note: Proceedings Notes is entered as #19205e)

[46] L.A. Frazao, K. Paustian, C.E.P. Cerri, C.C. Cerri. (2012). Soil carbon stocks and changes after oil palm introduction in the Brazilian Amazon. GCB Bioenergy. 2012 pp 1 - 7.
Reference ID: 24372
Note: #24372e
Abstract: As oil palm has been considered one of the most favorable oilseeds for biodiesel production in Brazil, it is important to understand how cultivation of this perennial crop will affect the dynamics of soil organic carbon (SOC) in the long term. The aim of this study was to evaluate the changes in soil C stocks after the conversion of forest and pasture into oil palm production in the Amazon Region. Soil samples were collected in March 2008 and September 2009 in five areas: native forest (NARF), pasture cultivated for 55 years (PAST), and oil palm cultivated for 4 (OP-4), 8 (OP-8) and 25 years (OP-25), respectively. Soils were sampled in March 2008 to evaluate the spatial variability of SOC and nitrogen (N) contents in relation to the spacing between trees. In September 2009, soils were sampled to evaluate the soil C stocks in the avenues (inter rows) and frond piles, and to compare the total C stocks with natural forest and pasture system. Soil C contents were 22–38% higher in the area nearest the oil palm base (0.6 m) than the average across the inter row (0–4.5 m from the tree), indicating that the increment in soil organic matter (SOM) must have been largely derived from root material. The soil C stocks under palm frond piles were 9–26% higher than in the inter rows, due to inputs of SOM by pruned palm fronds. The soil carbon stocks in oil palm areas, after adjustments for differences in bulk density and clay content across treatments, were 35–46% lower than pasture soil C stocks, but

were 0–18% higher than the native forest soil C content. The results found here may be used to improve the life cycle assessment of biodiesel derived from palm oil.

[47] O. Hospes. (2014). Marking the success or end of global multi-stakeholder governance? The rise of national sustainability standards in Indonesia and Brazil for palm oil and soy. Agriculture and Human Values. 31(3) pp 425 - 437.
Reference ID: 24373
Note: #24373e
Abstract: The RSPO and RTRS are global private partnerships that have been set up by business and civil society actors from the North to curb de-forestation and to promote sustainable production of palm oil or soy in the South. This article is about the launch of new national standards in Indonesia and Brazil that are look-alikes of the global standards but have been set up and supported by government or business actors from the South. The two main questions of this article are: do the new national standards in Indonesia and Brazil provide a fundamental challenge to the RSPO and RTRS, or do they demonstrate the successful diffusion and adoption of global private rules into national contexts? Do the new national standards help or undermine the RSPO and RTRS in their efforts to reduce de-forestation? Combining the theoretical notions of proto-institution and rival governance network, a comparative analysis is offered of the launch of the new national standards in Indonesia and Brazil. The conclusion is that, whilst the RSPO and RTRS have served as models for the general design and principles of the national standards, they really differ from the global standards in terms of normative contents: the national standards offer more room to palm oil plantations and large-scale soy producers to expand production at the expense of forests and other high conservation areas. Governments and producer associations in Indonesia and Brazil have not launched national standards to implement the RSPO or RTRS but to challenge these interventions from the North.

[48] ISP. (2017). The Planter Vol 93 No 1099 October 2017. 93 pp 691 - 746.
Reference ID: 24374
Note: S serial #24374

[49] H.S. Ooi, K. Subramaniam. (2017). Increasing the Capacity of the Power House of a Palm Oil Mill. The Planter. 93(1099) pp 699 - 713.
Reference ID: 24375
Note: #24375e > S serial #24374
Abstract: The new regulations of the Department of Environment (DOE) have created the need to increase the power generated at the mill. According to the Clean Air Regulations 2014, the boiler emission levels for existing mills must be less than 150mg per m3 particulate matters in the flue gases by 2019. For the mills which are located close to population centres, such as in Sandakan, Sabah, the treated POME (palm oil mill effluent) at the final discharge must be below 20 ppm (parts per million) in biological oxygen demand (BOD). In addition, the treated POME must be used for land application.

[50] Z.A. Zainal Aminuddin, M.P. Zambri, K.I. Ismail. (2017). Evolution of Resource Management in Oil Palm. The Planter. 93(1099) pp 719 - 727.
Reference ID: 24376
Note: #24376e > S serial #24374
Abstract: Good resource management is the key to obtaining high productivity and efficiency in oil palm plantations. Factors that must be considered include land

selection, planting material, technical management, harvesting and environment. If all these critical factors affecting the sustainability of oil palm plantations are well managed and integrated with each other, the palm oil industry would effectively be addressing many of the issues that are currently hindering its progress towards being a more stable and viable industry in the future.

[51] J.N. Wintgens. (2012). Coffee: Growing, Processing, Sustainable Production - A Guidebook for Growers, Processors, Traders and Researchers. Secondary Coffee: Growing, Processing, Sustainable Production - A Guidebook for Growers, Processors, Traders and Researchers. Wiley-VCH Gmbh & Co. United Kingdom. pp 1 - 983.
Reference ID: 24377
Note: S 8.1.5 #24377

[52] IPNI. 2017. Research With Impact - Improving Forage Production in Russia with Proper Fertilization. RUS 8. pp 1 - 1.
Reference ID: 24378
Note: #24378e
Abstract: Annual and perennial grasses and legumes are important forage crops in Russia, occupying almost 20% of the total cultivated land. Insufficient fertilization and poor-quality seed has led to low productivity of forage grasses and poor silage quality. Russia currently imports a significant amount of milk products and the desire to build the domestic dairy industry has prompted the need to boost the production of high quality forage.

[53] T. Mielke. (2017). Global Supply, Demand and Price Outlook for Vegetable Oils as well as for Palm Oil. POC 2017: Palm & Lauric Oils Price Outlook Conference & Exhibition: 100 Years of Palm Oil in Malaysia: More Sustainable Through Bursa Palm Oil Futures. pp 1 - 5.
Reference ID: 24379
Note: #24379e (Note: this is a summary of a lecture from POC 2017, KL #23530)
Abstract: World consumption of oils & fats has been very strong with an average annual growth of 6.4 Mn T in the most recent 5 years, of which 1.6 Mn T used for the production of biofuels and 4.8 Mn T for other purposes (mainly for food). Biodiesel consumption accounts for approx. 15% of world consumption of all 17 oils & fats.
During the past 25 years world production of 17 oils &fats increased by more than 150%. Palm oil accounted for most of the increase and now accounts for 30% of world production

[54] D. Morley. (2015). RSPO, the global standard for sustainable palm oil. AgroFOOD Industry Hi Tech. pp 29 - 30.
Reference ID: 24380
Note: #24380e
Abstract: RSPO is a multi-stakeholder association founded to provide a sustainable solution in palm oil cultivation. Oil palm cultivation is among the main factors causing deforestation in South East Asia, but it also guarantees four-to-ten times better yields than other oleaginous crops and provides 40% of the supply of vegetal fats around the world. That’s why certified sustainable palm oil is the solution. RSPO is the global standard in palm oil sustainable cultivation, and today the 20% of the global production is certified sustainable. RSPO, aiming to transform the whole market, has set for Europe the target of 100% certified sustainable palm oil use by 2020.

[55] P. Murugesan. (2017). Oil palm (*Elaeis guineensis*) genetic resources for abiotic stress tolerance: A review. Indian Journal of Agricultural Sciences. 8(5) pp 571 - 579.
Reference ID: 24381
Note: #24381e
Abstract: Oil palm (*Elaeis guineensis* Jacq.) once grown widely in forests and adjoining areas was subsequently domesticated as a plantation crops. Global oil palm area has quintupled from 1990 and it is grown in an area of 17 million ha with a palm oil production of 59.42 million tonnes. Oil yield is dependent not only on genotypes but also on environmental factors. The growth of common oil palm varieties is suppressed at temperatures below 15°C. Oil palm is a drought tolerant crop as it is surviving in locations with a dry season of several months. Nevertheless water deficit stress reduces the palm fresh fruit bunch yield to less than 5 tonnes/ ha along with significant reduction (up to 26.30%) in vegetative growth. Excess soil moisture and continuous water logging are detrimental to oil palm fresh fruit bunch production. The important parameters, viz. the root biomass, potential root extraction ratio (PRER), rate of stomatal conductance and photosynthesis can be used for screening oil palm genotypes for drought tolerance. The progenies of Bamenda × Ekona and Tanzania × Ekona hybrids had drought tolerance and produced 40-42 tonnes of fresh fruit bunch during initial three years. The progenies of crosses between Deli × Yangambi (NIFOR, Nigeria), Bamenda × Ekona (ASD Costa Rica), Tanzania × Ekona and IRHO7010 were reported to adapt to prolonged drought conditions in Nigeria, Costa Rica and Colombia, respectively. Cameroon and Tanzanian genetic sources had cold tolerance and hybrids of Dami Deli × Cameroon /Tanzania crosses and Amazon (variety) are available with Agricultural Services Development, Costa Rica. *Elaeis oleifera* has inherent characteristics to tolerate drought and water stagnation, pest and disease resistance and exhibits slow vertical growth. ASD Costa Rica had developed compact palm utilising the genetic resources of *E. oleifera*. Varieties with short leaves and slow vertical growth are most preferred traits in oil palm industry to increase the productivity per unit area as they can be planted at high density. Information on early maturing varieties, dwarfness, rapid and quality planting material production technologies in relation to abiotic stress tolerance for oil palm are scanty.

[56] H.B. Ngalle, J.M. Bell, G.F.N. Ebongue, L. Nyobe, F.C. Ngangnou, G.N. Ntsomboh. (2013). Morphogenesis of Oil Palm Fruit (*Elaeis guineensis* Jacq.) in Mesocarp and Endocarp Development. Journal of Life Sciences. 7(2) pp 153 - 158.
Reference ID: 24382
Note: #24382e
Abstract: This work aims to study the development of the pericarp of the fruit of *Elaeis guineensis* Jacq. var. dura. The thickness, the water and the oil contents of its tissues are evaluated every two weeks, from pollination to the maturity of the fruit. The development of the oil palm fruit takes 5.5 months. The endocarp reaches its maximum thickness at the 70th DPP (day post-pollination), with a water content of 72%. It then starts its dehydration, while sclerifying. It therefore isolates the seed at start and later protects it. The mesocarp is visible at anthesis and its water content is close to 92%. From the 100th DPP, it begins a continuous dehydration associated, from the 130th DPP, with an active lipids biosynthesis. Ultimately, the pericarp of the oil palm fruit fulfills both functions, namely to protect the seed by early sclerification of the endocarp and ensure the dissemination of the species by the high oil content of the mesocarp. A comparative anatomy of the pericarp tissues of the three genotypes of *E. guineensis* Jacq., during the first three weeks of fruit development, will enhance the understanding of the primary effect of sh gene.

[57] P. Pacheco, S. Gnych, A. Dermawan, H. Komarudin, B. Okarda. (2017). The palm oil global value chain: Implications for economic growth and social and environmental sustainability. Working Paper 220. Indonesia. pp 1 - 55.
Reference ID: 24383
Note: #24383e

[58] C. Phosri, A. Rodriguez, I.R. Sanders, P. Jeffries. (2010). The role of mycorrhizas in more sustainable oil palm cultivation. Agriculture, Ecosystems & Environment. 135 pp 187 - 193.
Reference ID: 24384
Note: #24384e
Abstract: Oil palm is a significant and developing crop in many developing countries. The introduction of oil palm puts pressure on natural resources because it is often planted in cleared-cut land that previously supported other crops or was forested. This has led to environmental concerns which require attention. Hence it is important that new plantations are managed in a sustainable way to reduce the impact of oil palm cultivation on ecosystems whilst maximising yield and productivity to farmers. The application of arbuscular mycorrhizal fungi (AMF) technology is one option that can benefit both agronomic plant health and ecosystems. AMF have the potential to increase conventional agricultural productivity and are crucial for the sustainable functioning of agricultural ecosystems. This paper provides an insight into how AMF application might benefit oil palm cultivation through more sustainable management and the practical use of AMF for oil palm plantations.

[59] R.Y. Priyati, R. Tyers. (2016). Price Relationships in Vegetable Oil and Energy Markets. Discussion Paper 16.11. Australia. pp 1 - 48.
Reference ID: 24385
Note: #24385e
(Presented at Annual Australasian Development Economics Workshop Deakin University, 9-10 June 2016)
Abstract: The markets for vegetable oils have expanded significantly in recent decades in association with the diversification in their use across final consumption as food, industrial inputs and fuels. International markets for such products remain critically important for several developing countries yet they have become more integrated globally and volatility has increased as financial determinants of demand have become more prominent. This paper reviews these developments in vegetable oil and energy markets and tests for changes in their level of integration over time. It further examines the dependence of prices in these markets on financial volatility and overall economic performance, offering scenarios for vegetable oil market behaviour in response to low energy prices, tighter monetary policy and strong demand in importing regions. The results are particularly strong in response to changes in interest rates, supporting the perspective that financial determinants of demand have strengthened.

[60] N.K. Fageria, V.C. Baligar. (1997). Phosphorus-Use Efficiency by Corn Genotypes. Journal of Plant Nutrition. 20(10) pp 1267 - 1277.
Reference ID: 24386
Note: #24386e
Abstract: Phosphorus (P) deficiency is a principal yield-limiting factor for annual crop production in acid soils of temperate as well as tropical regions. The objective of this study was to screen nine corn *(Zea mays* L.) genotypes at low (0 mg P kg^{-1}), medium

(75 mg P kg^{-1}), and high (150 mg P kg^{-1}) levels of P applied in an Oxisol. Plant height, root length, shoot dry weight, root dry weight, shoot-root ratio, P concentration in shoot and root, P uptake in root and shoot, and P-use efficiency parameters were significantly (P<0.01) influenced by P treatments. Significant genotype differences were found in plant height, shoot and root dry weight, P uptake in root and shoot, and P-use efficiency. Based on dry matter production and P-use efficiency, genotypes were classified as efficient and responsive, efficient and nonresponsive, nonefficient and responsive, and nonefficient and nonresponsive.

[61] A. Dobermann, K.G. Cassman. (2005). Cereal area and nitrogen use efficiency are driver of future nitrogen fertilizer consumption. Science in China Series C: Life Sciences. 48(Special Issue) pp 745 - 758.
Reference ID: 24387
Note: #24387e
Abstract: At a global scale, cereal yields and fertilizer N consumption have increased in a near-linear fashion during the past 40 years and are highly correlated with one another. However, large differences exist in historical trends of N fertilizer usage and nitrogen use efficiency (NUE) among regions, countries, and crops. The reasons for these differences must be understood to estimate future N fertilizer requirements. Global nitrogen needs will depend on: (i) changes in cropped cereal area and the associated yield increases required to meet increasing cereal demand from population and income growth, and (ii) changes in NUE at the farm level. Our analysis indicates that the anticipated 38% increase in global cereal demand by 2025 can be met by a 30% increase in N use on cereals, provided that the steady decline in cereal harvest area is halted and the yield response to applied N can be increased by 20%. If losses of cereal cropping area continue at the rate of the past 20 years (-0.33% yr^{-1}) and NUE cannot be increased substantially, a 60% increase in global N use on cereals would be required to meet cereal demand. This would have major environmental implications. Interventions to increase NUE and reduce N losses to the environment must be accomplished at the farm- or field-scale through a combination of improved technologies and carefully crafted local policies that contribute to the adoption of improved N management; uniform regional or national directives are unlikely to be effective at both sustaining yield increases and improving NUE. Examples from several countries show that increases in NUE at rates of 1% yr^{-1} or more can be achieved if adequate investments are made in research and extension. Failure to arrest the decrease in cereal crop area and to improve NUE in the world's most important agricultural systems will likely cause severe damage to environmental services at local, regional, and global scales due to a large increase in reactive N load in the environment.

[62] N.K. Fageria, V.C. Baligar. (1999). Phosphorus-use Efficiency in Wheat Genotypes. Journal of Plant Nutrition. 22(2) pp 331 - 340.
Reference ID: 24388
Note: #24388e
Abstract: Phosphorus (P) deficiency is one of the principal yield-limiting factors in Oxisols in various parts of the world. The objective of this study was to evaluate 15 wheat genotypes for P-use efficiency. The genotypes were evaluated in an Oxisol at zero ("low" P), 75 mg P kg^{-1} ("medium" P), and 150 mg P kg^{-1} ("high" P). Shoot weight and P uptake in shoot were the most sensitive plant parameters to P deficiency. Significant (P<0.01) genotypic differences in P-use efficiency were found. Phosphorus-use efficiency is represented as mgs of dry matter of root and shoot per

mg of P accumulated in root and shoot. On the basis of P-use efficiency, genotypes were classified as efficient and responsive (ER), efficient and nonresponsive (ENR), nonefficient and responsive (NER), and nonefficient and nonresponsive (NENR). From a practical point of view, genotypes which produce high shoot dry matter in a low level of P and respond well to added P are the most desirable because they are able to express their high yield potential in a wide range of P environment. Genotypes BR10, CPAC89128, and NL459 fall into this group. These are often referred to as widely adapted genotypes, in contrast with other genotypes which can be referred to as more specifically adapted genotypes.

[63] N.K. Fageria, R.J. Wright, V.C. Baligar. (1988). Rice cultivar evaluation for phosphorus use efficiency. Plant and Soil. 111 pp 105 - 109.
Reference ID: 24389
Note: #24389e
Abstract: Phosphorus deficiency is one of the most growth-limiting factors in acid soils in various parts of the world. The objective of this study was to screen 25 rice cultivars (*Oryza sativa* L.) at low, medium, and high levels of soil P. Number of tillers, root length, plant height, root dry weight and shoot dry weight were related to tissue P concentrations, P uptake and P-use efficiency. Shoot weight was found to be the plant parameter most sensitive to P deficiency. Significant cultivar differences in P use efficiency were found. Phosphorus use efficiency was higher in roots than shoots and decreased with increasing levels of soil P. Positive correlations were found among growth parameters such as plant height, tillers, root and shoot weight, and P content of roots and shoots. These results indicate selection of rice cultivars for satisfactory performance under low P availability can be carried out using shoot and root dry weight as criteria.

[64] N. Rajanaidu, M.M. Ainul, A. Kushairi, A. Din. (2013). Historical Review of Oil Palm Breeding for the Past 50 Years. International Seminar On Breeding For Sustainability in Oil Palm. Kuala Lumpur. pp 1 - 19.
Reference ID: 24390
Note: #24390e
Abstract: The development of oil palm breeding in Malaysia from 1960- 2010 is covered in this paper. Discovery of the inheritance of shell and DXP, crop diversification policy of the Government, formation of Federal Land Development Authority (FELDA), and availability of funds from World Bank to finance oil palm industry provided much the impetus for accelerated growth. Prior to 1960, the Department of Agriculture of Malaysia and the private sector (Guthrie, Harrisons and Crosfield (H&C), Socfin, United Plantations (UP)) have introduced the basic oil palm breeding material from Indonesia and Africa. The Deli duras from Marihat Baris, Elmina including dumpy E206, importation AVROS pollen by H&C and Department of Agriculture (DOA), DOA pisifera 27B & 29/36, Guthire URT (Deli and Congo) formed the foundational breeding materials available in the country. A number of breeding materials exchange programmes were initiated in Malaysia i.e. Cooperative Breeding Scheme (CBS) in 1956, Oil Palm Genetic Laboratory (OPGL) in 1963 and Sabah Breeding programme (SBP) in 1964. In early stages DOA, Guthrie, H&C, Socfin, Felda, Pamol (Unilever) and Dunlops were actively involved in oil palm breeding and seed production. In 1979, Palm Oil Research Institute of Malaysia (PORIM) was formed. A large oil palm (guineensis and oleifera) germplasm was collected in Africa and Central/South America. The first collection was made in 1973 under Malaysian Agricultural Research and Development Industry (MARDI) and the last collection was

in 2010 in Angola. In 1983, Socfin breeding programme and seed production was closed down. Meanwhile the Pamol (Sabah & Kluang) and Dunlops oil palm breeding programme were merged into IOI. The Sime Darby, Guthrie, H&C (Golden Hope) breeding programmes were consolidated into a single entity under Sime Darby. Meanwhile a number of new seed producers such as Applied Agriculture Resources Sdn. Bhd. (AAR), Borneo Samudera, Sarawak Plantation Agriculture Development Sdn. Bhd. (SPAD), NALFIN Planting Material Sdn.Bhd. (NALFIN), RISDA Semaian Landskap Sdn. Bhd. (RISDA), Federal Land Consolidation and Rehabilitation (FELCRA), Genting Plantations Berhad (GENTING), DOA Sabah, Malaysian Palm Oil Board (MPOB), IJM Plantations Berhad (IJM), Sasaran Ehsan Utama Sdn. Bhd. (SEU), PPNJ and KULIM Sdn. Bhd. (KULIM) have started seed production programme largely by obtaining advanced breeding materials from MPOB and also the leasing mother palms and sourcing pollen from MPOB. Most of seed producers use ex- Chemara Deli duras as female parents. AVROS, dumpy AVROS, Yangambi, dumpy Yangambi, dumpy Yangambi X AVROS, Calabar, Ekona sources are used as pisiferas for seed production and breeding. Recently hybrid duras (Deli duras X Nigerian duras) and Nigerian population 12 pisiferas are being tested as new parental materials. With the introduction of pollinating weevils from Cameroons to Malaysia in 1981, there was a spike in the dura contamination in the oil palm DXP planting materials. Several quality control measures were taken by oil palm breeders to minimize the contamination. Currently the dura contamination is less than 1% in DXP planting material.

Oil palm tissue culture programme was started in early eighties in Malaysia. Current production is about 5 million ramets compared to 120 million of DXP seeds. Meanwhile, tissue culture floral abnormalities had cast a certain level of risk in planting oil palm clones. MPOB and members of the industry have invested heavily to discover the DNA markers which can be used to identify and discard abnormal plantlets in the nursery and before field planting.

There is a potential application of tissue culture technique to multiply parental palms (which have been progeny-tested) to produce semi- and bi- clonal seeds. A number of companies such as AAR, UP and FELDA Agricultural Services Sdn. Bhd. (FASSB) have since been marketing semi-clonal seeds.

Internationally, there is a big demand for Malaysian oil palm planting materials. This is due to various quality control measures Malaysia has implemented and they include SIRIM standards for mother palms, progeny tested material and inspection of facilities by SIRIM officers. Seed producers need MPOB licence to operate. MPOB samples DXP seeds produced by various companies (once in 5 years) and evaluate the materials for performance compliance and contamination checks independently.

Malaysian oil palm breeders have contributed much to the science of oil palm breeding by publishing papers in areas of breeding methods, best linear unbiased prediction (BLUP), experimental designs, genotype X environment (GXE) interaction, molecular breeding and disease tolerance.

With the discovery of shell gene at the molecular level and following publishing the oil palm genome sequence data, we expect further integration of conventional and molecular breeding techniques.

In the past, the field of oil palm breeding had attracted students with PhD to carry out research. Now, the top students select the field of biotechnology and very few opt to study quantitative genetics. We hope this trend will reverse in the future.

[65] J.H. Schmidt. (2015). Life Cycle Assessment of Five Vegetable Oils. Journal of Cleaner Production. 87 pp 130 - 138.
Reference ID: 24391
Note: #24391e
Abstract: The purpose of this study is to evaluate and compare the environmental performance of five different vegetable oils, including the relevant market responses induced by the oils' by-products. The oils under study are palm oil, soybean oil, rapeseed oil, sunflower oil and peanut oil. These oils are to a large extent substitutable and they are among the largest oils in terms of global production. Besides evaluating the environmental performance of each oil individually, the effect of reducing each one of the oils and replacing it with a mix of the others is also evaluated. The life cycle inventory is carried out using a consequential approach, which implies that co-product allocation is avoided by use of substitution, and that marginal market mixes are generally applied. The environmental performance is evaluated by focussing on global warming, land use and water consumption. With respect to global warming, rapeseed oil and sunflower oil are the best performing, followed by soybean oil and palm oil, and with peanut oil as the least good performing. For land use, palm oil and soybean oil are the oils associated with the smallest contribution, followed by rapeseed oil, and with sunflower oil and peanut oil as the oils with the largest net occupation of land. When focussing on water consumption (using the water stress index), sunflower oil had the smallest impact, followed by rapeseed oil, palm oil and soybean oil, and with peanut oil as the oil with the largest contribution.

[66] H.F. Teh, B.K. Neoh, M.P.L. Hong, J.Y.S. Low, T.L.M. Ng, N. Ithnin, Y.M. Thang, M. Mohamed, F.T. Chew, H. Mohd. Yusof, H. Kulaveerasingam, D.R. Appleton. (2013). Differential Metabolite Profiles during Fruit Development in High-Yielding Oil Palm Mesocarp. Plos One. 8(4) pp 1 - 10.
Reference ID: 24392
Note: #24392e
Abstract: To better understand lipid biosynthesis in oil palm mesocarp, in particular the differences in gene regulation leading to and including de novo fatty acid biosynthesis, a multi-platform metabolomics technology was used to profile mesocarp metabolites during six critical stages of fruit development in comparatively high- and low-yielding oil palm populations. Significantly higher amino acid levels preceding lipid biosynthesis and nucleosides during lipid biosynthesis were observed in a higher yielding commercial palm population. Levels of metabolites involved in glycolysis revealed interesting divergence of flux towards glycerol-3-phosphate, while carbon utilization differences in the TCA cycle were proven by an increase in malic acid/citric acid ratio. Apart from insights into the regulation of enhanced lipid production in oil palm, these results provide potentially useful metabolite yield markers and genes of interest for use in breeding programmes.

[67] W. Verheye. (2010). Growth and Production of Oil Palm. pp 1 - 10.
Reference ID: 24393
Note: #24393e

[68] R.E. Jezeer, M.J. Santos, R.G.A. Boot, M. Junginger, P.A. Verweji. (2018). Effects of shade and input management on economic performance of small-scale Peruvian coffee systems. Agricultural Systems. 162 pp 179 - 190.
Reference ID: 24394
Note: #24394e

Abstract: Tropical agroforestry systems provide a number of ecosystem services that might help sustain the production of multiple crops, improve farmers' livelihoods and conserve biodiversity. A major drawback of agroforestry coffee systems is the perceived lower economic performance compared to high-input monoculture coffee systems, which is driving worldwide intensification practices of coffee systems. However, comprehensive cost-benefit analyses of small-scale coffee plantations are scarce. Consequently, there is a need to improve our understanding of the economic performance of coffee systems under different shade and input management practices. We provide a comprehensive economic analysis of Arabica coffee farming practices where we compare productivity, costs, net income and benefit-cost ratio (BCR) of 162 small-scale, Peruvian coffee plantations under different shade and input management practices along an elevation gradient. By using a cluster analysis, three shade and three input classes (low, medium and high) were defined. We found similar economic performance for all shade classes, but reduced net income and BCR in the High-Input class. More specifically, there was no difference in net income or BCR between low, medium and high shade classes. The High-Input class had significantly lower net income and BCR, mainly due to increased costs of (hired) labour, land, and fertilizer and fungicides; costs which were not fully compensated for by higher coffee yields. Coffee yield decreased with elevation, whereas gate coffee price and quality, as well as shade levels, increased with elevation. Additional revenues from timber could increase farmers' income and overall economic performance of shaded plantations in the future. Our analysis provides evidence that for small-scale coffee production, agroforestry systems perform equally well or better than unshaded plantations with high input levels, reinforcing the theory that good economic performance can coincide with conservation of biodiversity and associated ecosystem services. Additional comprehensive and transparent economic analyses for other geographic regions are needed to be able to draw generalizable conclusions for smallholder coffee farming worldwide. We advise that future economic performance studies simultaneously address the effects of shade and input management on economic performance indicators and take biophysical variation into account.

[69] Anonymous. (2018). InfoSawit Vol XII No 3 Maret 2018. 12 pp 1 - 56.
Reference ID: 24395
Note: #24395e

[70] Anonymous. (2018). InfoSawit Vol XII No 4 April 2018. 12 pp 1 - 56.
Reference ID: 24396
Note: #24396e

[71] T. Oberthur, C.R. Donough, H. Sugianto, K. Indrasuara, T. Dolong, G. Abdurrohim. (2018). Keberhasilan Intensifikasi Perkebunan Kelapa Sawit Dengan Best Management Practices: Dampak Terhadap Tandan Buah Segar Dan Hasil Minyak. (Bagian 1 dari 4: Latar Belakang Intensifikasi Hasil Dan Bmp & Pendekatan Dan Kerangka Analisis Data). Infosawit. 12(3) pp 48 - 51.
Reference ID: 24397
Note: #24397e > #24395e (Note: this is part 1 in 4 series)(part 2 is #24398, part 3 is #24421)
Abstract: Hasil minyak yang dicapai di Indonesia dan Malaysia terus menurun jauh di bawah tingkat potensi dengan rata-rata hasil minyak nasional jarang melebihi 4t/ha. Namun, pada tingkat grup (sekitar 150.000 ha), rata-rata produksi minyak 6t/ha telah dilaporkan. Ini menunjukkan selisih hasil yang besar.

[72] T. Oberthur, C.R. Donough, H. Sugianto, K. Indrasuara, T. Dolong, G. Abdurrohim. (2018). Keberhasilan Intensifikasi Perkebunan Kelapa Sawit Dengan BMP: Dampak Terhadap Tandan Buah Segar Dan Hasil Minyak (Bagian 2 dari 4: Hasil dan Diskusi). Infosawit. 12(4) pp 48 - 53.
Reference ID: 24398
Note: #24398e > #24396e (note: this is part 2 of 4 series)(part 1 is #24397, part 3 is #24421)

[73] P. Imbach, E. Fung, L. Hannah, C.E. Navarro-Racines, D.W. Roubik, T.H. Ricketts, C.A. Harvey, C.I. Donatti, P. Läderach, B. Locatelli, P.R. Roehrdanz. (2017). Coupling of pollination services and coffee suitability under climate change. PNAS. pp 1 - 5.
Reference ID: 24399
Note: #24399e
Abstract: Climate change will cause geographic range shifts for pollinators and major crops, with global implications for food security and rural livelihoods. However, little is known about the potential for coupled impacts of climate change on pollinators and crops. Coffee production exemplifies this issue, because large losses in areas suitable for coffee production have been projected due to climate change and because coffee production is dependent on bee pollination. We modeled the potential distributions of coffee and coffee pollinators under current and future climates in Latin America to understand whether future coffee-suitable areas will also be suitable for pollinators. Our results suggest that coffee-suitable areas will be reduced 73–88% by 2050 across warming scenarios, a decline 46–76% greater than estimated by global assessments. Mean bee richness will decline 8–18% within future coffee-suitable areas, but all are predicted to contain at least 5 bee species, and 46–59% of future coffee-suitable areas will contain 10 or more species. In our models, coffee suitability and bee richness each increase (i.e., positive coupling) in 10–22% of future coffee-suitable areas. Diminished coffee suitability and bee richness (i.e., negative coupling), however, occur in 34–51% of other areas. Finally, in 31–33% of the future coffee distribution areas, bee richness decreases and coffee suitability increases. Assessing coupled effects of climate change on crop suitability and pollination can help target appropriate management practices, including forest conservation, shade adjustment, crop rotation, or status quo, in different regions.

[74] L. Meylan, C. Gary, C. Allinne, J. Ortiz, L. Jackson, B. Rapidel. (2017). Evaluating the effect of shade trees on provision of ecosystem services in intensively managed coffee plantations. Agriculture, Ecosystems & Environment. 245 pp 32 - 42.
Reference ID: 24400
Note: #24400e
Abstract: Intensively managed cropping systems with emphasis on productivity of the main crop can benefit from additional ecosystem services brought by integration of trees in the system − but potential drawbacks must also be accounted for. In an on-farm study, we used a variety of plant, soil and water- related variables to assess the effect of *Erythrina* spp. and *Musa* spp. on the provision of ecosystem services in productive, high-quality Coffea arabica plantations in Costa Rica. We found 1) no significant effect of shade trees on coffee production overall; 2) evidence that shade trees do affect flowering and subsequent cherry development, with effects strongly dependent on climate and annual variations in coffee plant physiology; 3) *Erythrina* shade trees significantly increased soil litter and relative infiltration rate of water in the soil, both linked to soil conservation and decrease in erosion; 4) even in highly fertilized

environments, *Erythrina* trees do fix N which was taken up by adjacent coffee plants. The lack of significant negative effect of shade trees on overall coffee yield and the observation of the provision of other useful services was not unexpected, because of 1) the low density of shade trees in the study site (100–350 trees/ha pruned twice a year on average) and 2) the sensitivity of coffee yields to other interacting effects such as climate, pests and diseases and physiological variations in the plant. Pending further long-term research into the factors affecting coffee yield, we find shade trees provide sufficient ecosystem services to justify their integration in even intensively managed plantations.

[75] F.A.S. Xavier, E.F. Almeida, I.M. Cardoso, E. de Sá Mendonça. (2011). Soil phosphorus distribution in sequentially extracted fractions in tropical coffee-agroecosystems in the Atlantic Forest biome, Southeastern Brazil. Nutrient Cycling in Agroecosystems. 89(1) pp 31 - 44.
Reference ID: 24401
Note: H 8.1.5 #24401
Abstract: Phosphorus (P) deficiency is one of the most important constraints to food production, particularly in tropical Oxisols. This study aimed to characterize the inorganic and organic P (Pi and Po) fractions in the soil in three smallholding coffee cultivation fields managed under either agroforestry (AGF) or full sun (FSC) agroecosystems. The work was carried out in areas situated at the municipalities of Divino and Araponga in the Zona da Mata in the state of Minas Gerais, southeastern Brazil. Soil P forms including H_2O–Pi; $NaHCO_3$–Pi,Po; NaOH–Pi,Po; diluted HCl–Pi; concentrate HCl–Pi,Po and Residual-P were sequentially extracted in samples from 0 to 5 and 5 to 10-cm soil layers. Together, H_2O–Pi and $NaHCO_3$–Pi accounted on average for only 4% of soil total P in the cultivated soils. $HCl_{conc.}$-Pi ranged from 142.8 to 372.4 mg kg^{-1} being the predominant Pi fraction. AGF systems promoted an increment of 8% in the $NaHCO_3$–Po fraction in relation to the FSC systems in the upper soil layer. The AGF systems increased $HCl_{conc.}$-Po pool in relation to the FSC systems in Divino and Araponga(I) soils, indicating that agroforestry is an important management strategy to increase bioavailable P and for the maintenance of organic P pool. The distribution of inorganic and organic P pools varied among the different study sites, showing that P cycling depends on the inherent characteristic of each agroecosystem. The availability of P to plants in coffee-agroforestry fields is directly associated with the cycling of the organic P pool.

[76] S.S. Khalajabadi. (2011). Coffee Crops Response to Nitrogen on Direct Sunlight and Semi-Shadow and its Relationship with the Soil's Organic Matter: RESPUESTA DE CAFETALES AL SOL Y BAJO SEMISOMBRA A NITRÓGENO Y SU RELACIÓN CON LA MATERIA ORGÁNICA DEL SUELO. Revista Facultad Nacional de Agronomia Medellin. 64(1) pp 5781 - 5791.
Reference ID: 24402
Note: H 8.1.5.1 #24402
Resumen: La materia orgánica del suelo (MO) puede llegar a ser una fuente importante de nitrógeno (N) para las plantas. Mediante el desarrollo de esta investigación se evaluó la respuesta de cafetales a plena exposición solar y bajo semisombra al suministro de N y su relación con la MO. Para ello se seleccionaron 20 plantaciones al sol y 12 con semisombra en 25 municipios de Colombia, contrastantes en su contenido de MO (desde 4 hasta 28%). Se evaluaron dos tratamientos, uno con N, P, K y Mg y el otro sin N, el cual se aplicó en dosis de 240 kg ha^{-1} $año^{-1}$ como urea. En los cafetales al sol el efecto de la carencia de N sobre la

producción se manifestó a partir del segundo año y se aumentó gradualmente, hasta alcanzar reducciones cercanas al 50% en el cuarto año; bajo semisombra se registró un comportamiento similar pero de menor magnitud. En ambos sistemas de producción, el comportamiento del rendimiento relativo en función del contenido de materia orgánica, se ajustó a un modelo cuadrático, con punto de inflexión en el 18% de la variable independiente. El suministro de N disminuyó el pH del suelo y aumentó las pérdidas de K+ en los dos sistemas; en los cafetales al sol se incrementaron los contenidos foliares de N, Mg y Mn por el efecto del N, mientras que las concentraciones de P, K, Cu y B disminuyeron. En las plantaciones desarrolladas bajo semisombra la fertilización nitrogenada sólo aumentó el contenido foliar del Mn y redujo el B.

Abstract: Soil's organic matter (OM) can be an important source of nitrogen (N) for plants. Through the development of this investigation the response of coffee in full sunlight and under light shade to the supply of N and its relationship to OM was evaluated. For this, 20 plantations exposed to direct sunlight and 12 under semi–shade were selected in 25 municipalities in Colombia, with different content of OM (from 4 to 28%). Two treatments were evaluated, one with N, P, K and Mg and the other without N, which was applied in doses of 240 kg ha^{-1} yr^{-1} as urea. In the sunlight exposed plantations, the effect of N deficiency on production was expressed from the second year and gradually increased. It reached close to 50% reductions in four years. The plantation under semi–shade registered a similar pattern but of lesser magnitude. The relationship between OM and relative yield was adjusted to a quadratic model, whose behaviour was similar for both systems, with an average inflection point of 18%. The supply of N decreased the soil's pH and increased loss of K+ in the two systems. In sunlight-exposed coffee plantations the foliar contents of N, Mg and Mn increased by the effect of N, while the concentrations of P, K, Cu and B decreased. The N fertilization of the semi–shade plantations only increased the leaf content of Mn and reduced the B.

[77] A. Salamanca-Jimenez, T. Doane, W.R. Horwath. (2016). Performance of Coffee Seedlings as Affected by Soil Moisture and Nitrogen Application. pp 221 - 244.
Reference ID: 24403
Note: H 8.1.5.1 #24403
Abstract: Nitrogen (N) and soil moisture are the most important factors controlling yield in Colombian coffee crops. Since long-term productivity is contingent on robust early growth, it is imperative to study these factors in seedlings in order to ensure maximum yield potential of mature trees. A greenhouse experiment with four soil water and four N levels was used to determine how these two important variables affect quantifiable parameters representing seedling performance. Shoot biomass, the most obvious indicator of performance, was increased by both higher soil moisture and higher N application, although root biomass increased with N application only in wetter soils and in general the root to shoot ratio diminished with increasing N application. Like shoot biomass, leaf N content and N derived from fertilizer (Ndff) also increased with increasing N application, with relatively more leaf N recovered from fertilizer as soil moisture increased. Evapotranspiration (EVPT) responded to soil moisture, whereas water use efficiency, in terms of shoot mass produced per unit of evapotranspired water, responded dramatically to N level but was not affected by soil moisture. The strong effect of N application on water use efficiency was affirmed by the higher 13C/12C ratios and stem water potentials of plants grown under higher N levels, indicating greater water stress in these plants. All of these responses were

associated with changes in photosynthesis as a result of acclimation to the imposed conditions. Consideration of these results will facilitate new recommendations for maximizing growth of coffee seedlings by increasing water and N use efficiency while reducing the economic and environmental impacts attributed to N fertilizers.

[78] G.P. Maro, J.P. Mrema, B.M. Msanya, B.H. Janssen, J.M. Teri. (2014). Developing a Coffee Yield Prediction and Integrated Soil Fertility Management Recommendation Model for Northern Tanzania. International Journal of Plant & Soil Science. 3(4) pp 380 - 396.
Reference ID: 24404
Note: H 8.1.5.1 #24404e
Abstract: The aim of this study was to develop a simple and quantitative system for coffee yield estimation and nutrient input advice, so as to address the problem of declining annual coffee production in Tanzania (particularly in its Northern coffee zone), which is related to declining soil fertility. The study was conducted between 2010 and 2013 at TaCRI Lyamungu, with source data taken from Hai and Lushoto districts, Northern Tanzania. An earlier model QUEFTS, developed for maize but under similar conditions as those of Arabica coffee (Coffea arabica) in the study areas was used as a benchmark. Secondary fertilizer trial data were used in model calibration for coffee, while adding two more steps related to balanced nutrition and the economics of integrated soil fertility management (ISFM). Primary soil analytical data and calculated yields on basis of tree number were used for model testing. The result was a new model which we hereby call SAFERNAC (Soil Analysis for Fertility Evaluation and Recommendation on Nutrient Application to Coffee). The model consists of three modules: SOIL (the soil properties of interest), PLANT (all the crop and crop management parameters such as physiological nutrient use efficiency, plant density, maximum yields per tree) and INPUT (nutrient inputs – organic and inorganic). It consists of two subsequent parts – a baseline approach (no input) for coffee land evaluation; and an integrated soil fertility management (ISFM) approach that involves application of nutrient inputs, for ISFM planning and design of fertilizer experiments. The model was checked for accuracy of the adjusted equations, and found to be capable of reproducing the actual yields by 80-100%. The new model is a useful tool for use in coffee farms.

[79] L.S. Woittiez, S. Turhina, D. Deccy, M. Slingerland, M. Van Noordwijk, K.E. Giller. (2018). Fertiliser Application Practices and Nutrient Deficiencies in Smallholder Oil Palm Plantations in Indonesia. Experimental Agriculture. pp 1 - 17.
Reference ID: 24405
Note: #24405e (Supplementary paper available in folder)
Abstract: Oil palm has become an important source of revenue for smallholders in Indonesia, but productivity of smallholder plantations is generally poor. Nutrient limitations have been suggested as an important agronomic constraint to yield. Our research aimed to quantify fertiliser use, soil and tissue nutrient status, and palm growth and yield in a sample of independent smallholder plantations. We selected 49 plantations in Indonesia in two provinces with contrasting soils. For all plantations, we obtained self-reported fertiliser use and yield data, collected soil and tissue samples, and analysed vegetative growth. More than 170 kg N ha^{-1} $year^{-1}$ was applied in one site, and P was applied in excess of recommended quantities in both sites, but on average farmers applied less than 100 kg K ha^{-1} $year^{-1}$. Soils in the palm circle were poor in N, P and K in 29, 40 and 82% of the plantations, and deficiencies were measured in 57, 61 and 80% of the leaflet samples, respectively. We found statistically

significant correlations between tissue nutrient concentrations and vegetative growth, but a large part of the variation in the data remained unaccounted for. Single leaf area was reduced in>80% of the plantations. Average yields were estimated to be 50–70% of the water-limited potential. Our results demonstrate that widespread nutrient imbalances and deficiencies, especially potassium and phosphorus, occur in smallholder oil palm plantations, due to inadequate and unbalanced fertiliser application practices. These deficiencies may be an important underlying cause of the overall poor productivity, which threatens the economic and environmental sustainability of the smallholder sector.

[80] W. Li, H. Fu, L.L. yu, A. Cracknell. (2017). Deep Learning Based Oil Palm Tree Detection and Counting for High-Resolution Remote Sensing Images. Remote Sensing. 9(22) pp 1 - 13.
Reference ID: 24406
Note: #24406e
Abstract: Oil palm trees are important economic crops in Malaysia and other tropical areas. The number of oil palm trees in a plantation area is important information for predicting the yield of palm oil, monitoring the growing situation of palm trees and maximizing their productivity, etc. In this paper, we propose a deep learning based framework for oil palm tree detection and counting using high-resolution remote sensing images for Malaysia. Unlike previous palm tree detection studies, the trees in our study area are more crowded and their crowns often overlap. We use a number of manually interpreted samples to train and optimize the convolutional neural network (CNN), and predict labels for all the samples in an image dataset collected through the sliding window technique. Then, we merge the predicted palm coordinates corresponding to the same palm tree into one palm coordinate and obtain the final palm tree detection results. Based on our proposed method, more than 96% of the oil palm trees in our study area can be detected correctly when compared with the manually interpreted ground truth, and this is higher than the accuracies of the other three tree detection methods used in this study.

[81] J.I.R. Edreira, K.G. Cassman, Z. Hochman, M.K. van Ittersum, L. van Bussel, L. Claessens, P. Grassini. (2018). Beyond the plot: technology extrapolation domains for scaling out agronomic science. Environmental Research Letters. 13 pp 1 - 9.
Reference ID: 24407
Note: #24407e
Abstract: Ensuring an adequate food supply in systems that protect environmental quality and conserve natural resources requires productive and resource-efficient cropping systems on existing farmland. Meeting this challenge will be difficult without a robust spatial framework that facilitates rapid evaluation and scaling-out of currently available and emerging technologies. Here we develop a global spatial framework to delineate ‘technology extrapolation domains’ based on key climate and soil factors that govern crop yields and yield stability in rainfed crop production. The proposed framework adequately represents the spatial pattern of crop yields and stability when evaluated over the data-rich US Corn Belt. It also facilitates evaluation of cropping system performance across continents, which can improve efficiency of agricultural research that seeks to intensify production on existing farmland. Populating this biophysical spatial framework with appropriate socio-economic attributes provides the potential to amplify the return on investments in agricultural research and development by improving the effectiveness of research prioritization and impact assessment.

[82] J.R. Vijiandran, M.H.A. Husni, C.B.S. Teh, A.R. Zaharah, A. Xaviar. (2017). Nutrient Losses Through Runoff from Several Types of Fertilisers Under Mature Oil Palm. Malaysian Journal of Soil Science. 21 pp 113 - 121.
Reference ID: 24408
Note: #24408e
Abstract: This study was conducted to understand the effects of fertiliser type (straights, compounds and controlled-release fertilisers) on N, P, K and Mg losses by surface runoff. The study was conducted in a mature oil palm field using three 20 m by 6 m erosion plots containing two palms per plot with the soil type being Typic Kandiudults and slopes ranging from 5.5° to 7.5°. Nutrient losses were measured in the eroded sediment and runoff water for every rainfall event over a period of 24 months. Nutrient losses were higher in the runoff water than in the eroded sediments. Broadcast application of controlled-release fertilisers and its slow dissolving nature made it prone to washing down the slope. Hence, higher nutrient losses were observed in the controlled-release fertilisers compared to other treatments. Compound fertilisers showed lower total losses for N (4.96%), K (3.95%) and Mg (0.65%) compared to straight fertilisers. Lower P losses were observed in the straights compared to the compound fertilisers due to higher percentage of soluble P in the compound fertilisers. Controlled- release fertilisers recorded high nutrient losses in the sediments caused by the washout Except for nitrogen, controlled-release fertilisers recorded higher losses for P (56.56%), K (19.83%) and Mg (10.36%) compared to straight fertilisers. Nitrogen losses were 18.15% lower in the controlled-release fertilisers compared to straights. Compound fertilisers showed lowest losses for N and K compared to straight fertilisers. Based on the data, it is postulated that compound fertilisers can lead to better nutrient uptake compared to straight fertilisers. However, this hypothesis needs to be tested through field experiments measuring nutrient uptake and its effect on oil palm productivity.

[83] BC Insight. (2018). Fertilizer International Number 483 March/April 2018. 483 pp 1 - 39.
Reference ID: 24409
Note: #24409e

[84] O.M. Bensaeed, A.M. Shariff, A.B. Mahmud, H. Shafri, M. Alfatni. (2014). Oil palm fruit grading using a hyperspectral device and machine learning algorithm. 7th IGRSM International Remote Sensing & GIS Conference and Exhibition. pp 1 - 23.
Reference ID: 24410
Note: #24410e
Abstract: In this paper, a hyperspectral-based system was introduced to detect the ripeness of oil palm fresh fruit bunches (FFB). The FFBs were scanned using a hyperspectral device, and reflectance was recorded at different wavelengths. A total of 469 fruits from oil palm FFBs (nigrescens, virescens, oleifera) were categorized as overripe, ripe, and underripe. Fruit attributes in the visible and near infrared (400 nm to1000 nm) wavelength range regions were measured. Artificial neural network (ANN), classified the different wavelength regions on oil palm fruit through pixel-wise processing. The developed ANN model successfully classified oil palm fruits into the three ripeness categories (ripe, underripe, and overripe). The accuracy achieved by our approach was compared against that of the conventional system employing manual classification based on the observations of a human grader. Our classification approach had an accuracy of more than 95% for all three types of oil palm fruits. The research findings will help increase the quality harvesting and grading efficiency of

FFBs.

[85] M.S.M. Alfatni, A.R.M. Shariff, M.Z. Abdullah, M.H. Marhaban, S.B. Shafie, M.D. Bamiruddin, O.M.B. Saaed. (2014). Oil palm fresh fruit bunch ripeness classification based on rulebased expert system of ROI image processing technique results. 7th IGRSM International Remote Sensing & GIS Conference and Exhibition. IOP Publishing. pp 1 - 9.
Reference ID: 24411
Note: #24411e
Abstract: There is a processing need for a fast, easy and accurate classification system for oil palm fruit ripeness. Such a system will be invaluable to farmers and plantation managers who need to sell their oil palm fresh fruit bunch (FFB) for the mill as this will avoid disputes. In this paper, a new approach was developed under the name of expert rules-based system based on the image processing techniques results of the three different oil palm FFB region of interests (ROIs), namely; ROI1 (300x300 pixels), ROI2 (50x50 pixels) and ROI3 (100x100 pixels). The results show that the best rule-based ROIs for statistical colour feature extraction with k-nearest neighbors (KNN) classifier at 94% were chosen as well as the ROIs that indicated results higher than the rule-based outcome, such as the ROIs of statistical colour feature extraction with artificial neural network (ANN) classifier at 94%, were selected for further FFB ripeness inspection system.

[86] S. Cook, M. Lacoste, F. Evans, M. Ridout, M. Gibberd, T. Oberthür. (2018). An On-Farm Experimental philosophy for farmer-centric digital innovation. 14th International Conference on Precision Agriculture. Canada. pp 1 - 9.
Reference ID: 24412
Note: #24412e
Abstract: In this paper, we review learnings gained from early On-Farm Experiments (OFE) conducted in the broadacre Australian grain industry from the 1990s to the present day. Although the initiative was originally centered around the possibilities of new data and analytics in precision agriculture, we discovered that OFEs could represent a platform for engaging farmers around digital technologies and innovation. Insight from interacting closely with farmers and advisors leads us to argue for a change in the ways we approach OFE research. Acknowledging that conditions have changed and drawing from business and social sciences, we suggest that OFE approaches today should develop aspects related to skill development, value generation and value sharing, the social dimension of change, and a renewed focus on farmer-centric research to better bridge industry requirements and scientist inputs.

[87] M. Pushparani, A. Sagaya, S. Ravan. (2018). Big Data Analytics using Weight Estimation Algorithm for Oil Palm Plantation Domain. International Journal of Advances in Soft Computing and Its Application. 10(1) pp 71 - 89.
Reference ID: 24413
Note: #24413e
Abstract: Malaysia and Indonesia are the largest producers and exporters of palm oil and palm oil products in the region and in the world. Both country plays a significant role in contributing to global economy growth. There is always a constant demand for palm oil and its products. In order to cope with demand there are many measure and initiatives taken, managing operation is one of the way to address demands. On the other hand, big data analytics is one of the technology that is assisting many domains. The more data in hand the more accurate information and this would enable plantation

stakeholders to make better decisions at any given point of time. This research focus on an approach towards big data analytics using weight estimation algorithm to assist in managing plantation operation effectively. This research emphasis on big data analytics as one of the approach to improve the operational efficiency by ensuring abundance of data in various forms and in various location made available in a single place thus empowering plantation stakeholder to make decisions with the accurate information. The weight estimation algorithm is used in a portable gadget to estimate the weight of the yield at the estate and any discrepancies are addressed with-in the manageable time. With the collected data, analysis is performed at plantation site and headquarters. The weight estimation algorithm is a combination of data collection, estimation of load and ensuring that data is available online on a real-time basis. Data analytics with the captured data will assist in effective decision making that attributes to reduced cost outages within a reduced time. The aim of this research is to create a big data analytics framework using weight estimation algorithm to capture data from various source and making it available on time for better decision making within the plantation estate and the mill.

[88] N. Sabri, Z. Ibrahim, S. Syahlan, N. Jamil, N.N.A. Mangshor. (2017). Palm Oil Fresh Fruit Bunch Ripeness Grading Identification Using Color Features. Journal of Fundamental and Applied Sciences. (Special Issue) pp 1 - 17.
Reference ID: 24414
Note: #24414e
Abstract: This research investigates the ripeness grading identification of the palm oil FFB using color features that are color histogram, color moment and color correlogram. Palm oil is harvested during the optimum stage of its ripeness since it improves the FFB oil quality and quantity. Harvesting wrong bunches decreases the oil extraction rate of the palm. A preliminary research on the palm oil FFB grading identification is conducted. Each ripeness stage has its own unique color. A study on color features is investigated. A new dataset of images of FFB is constructed. A comparative study between Support Vector Machine (SVM) and Naïve Bayes classifiers has been performed using the values of color histogram, color moment and color correlogram. The results of the experiments indicate that color moment with SVM produce a higher palm oil FFB ripeness grading identification accuracy compared to color histogram and color correlogram.

[89] M. Nababan, Y. Laia, D. Sitanggang, O. Sihombing, E. Indra, S. Siregar, W. Purba, R. Mancur. (2018). The diagnose of oil palm disease using Naive Bayes Method based on Expert System Technology. Journal of Physics. 1007(Conference Series) pp 1 - 6.
Reference ID: 24415
Note: #24415e
Abstract: Expert system is dealt with system that used computer-based human intelligence to overcome particular problem which is commonly conducted by an expert. Frequent problem faced by the farmers of oil palm is the difficulty in defining the type of plant disease. As a result, the delay treatment of plant disease brings out the declining of farm products. An application system is needed to deal with the obstacles and diagnosing the type of oil palm plant disease. The researcher designed an intelligence-based application with input-output plan which is able to diagnose the type of oil palm plant disease by applying naive bayes method. Based on the research result by conducting bayes method with recognized symptom, diagnose of oil palm plant disease could be accomplished. The data of symptoms found are leaves turned

yellow 0.4, dead leaves 0.4, black and brown color among the veins of leaves 0.5, young and old fruit with whole space 0.4, and decay of bunches is 0.3. The roots are tender in the amount of 0.5, and damage on sheath is 0.3. Through the chosen symptoms as mentioned above, the value of bayes is 80% with the type of disease is rotten bunch.

[90] Q.B. Kwong, C.K. Teh, A.L. Ong, F.T. Chew, S. Mayes, H. Kulaveerasingam, M. Tammi, S.H. Yeoh, D.R. Appleton, J.A. Harikrishna. (2017). Evaluation of methods and marker Systems in Genomic Selection of oil palm (*Elaeis guineensis* Jacq.). BMC Genetics. 18(107) pp 1 - 9.
Reference ID: 24416
Note: #24416e
Abstract:
Background: Genomic selection (GS) uses genome-wide markers as an attempt to accelerate genetic gain in breeding programs of both animals and plants. This approach is particularly useful for perennial crops such as oil palm, which have long breeding cycles, and for which the optimal method for GS is still under debate. In this study, we evaluated the effect of different marker systems and modeling methods for implementing GS in an introgressed dura family derived from a Deli dura x Nigerian dura (Deli x Nigerian) with 112 individuals. This family is an important breeding source for developing new mother palms for superior oil yield and bunch characters. The traits of interest selected for this study were fruit-to-bunch (F/B), shell-to-fruit (S/F), kernel-to-fruit (K/F), mesocarp-to-fruit (M/F), oil per palm (O/P) and oil-to-dry mesocarp (O/DM). The marker systems evaluated were simple sequence repeats (SSRs) and single nucleotide polymorphisms (SNPs). RR-BLUP, Bayesian A, B, Cπ, LASSO, Ridge Regression and two machine learning methods (SVM and Random Forest) were used to evaluate GS accuracy of the traits.
Results: The kinship coefficient between individuals in this family ranged from 0.35 to 0.62. S/F and O/DM had the highest genomic heritability, whereas F/B and O/P had the lowest. The accuracies using 135 SSRs were low, with accuracies of the traits around 0.20. The average accuracy of machine learning methods was 0.24, as compared to 0.20 achieved by other methods. The trait with the highest mean accuracy was F/B (0.28), while the lowest were both M/F and O/P (0.18). By using whole genomic SNPs, the accuracies for all traits, especially for O/DM (0.43), S/F (0.39) and M/F (0.30) were improved. The average accuracy of machine learning methods was 0.32, compared to 0.31 achieved by other methods.
Conclusion: Due to high genomic resolution, the use of whole-genome SNPs improved the efficiency of GS dramatically for oil palm and is recommended for dura breeding programs. Machine learning slightly outperformed other methods, but required parameters optimization for GS implementation.

[91] T. Oberthür, A.M. Tin. (2018). Supporting responsible and profitable use of fertilizer nutrients in Myanmar. Fertilizer Focus. (May/June 2018) pp 56 - 61.
Reference ID: 24417
Note: #24417e
Abstract: Since 2013, Canpotex and IPNI have been engaged in Myanmar to introduce concepts and principles of responsible crop nutrition. This was initially achieved through a series of seminars dedicated to agricultural decision-makers in government, universities and crop associations. Subsequently, commodity-specific field handbooks were produced in Burmese language to further disseminate basic crop nutrition knowledge among fertilizer dealers and farmers. As part of this

engagement, in 2017, we conducted an assessment of opportunities for responsible fertilizer market development. The assessment was informed by secondary land use and production statistics and, deep field intelligence, generated using a participatory approach adapted by IPNI to the local conditions.

[92] Argus FMB. (2018). Fertilizer Focus May/June 2018. May/June 2018 pp 1 - 70.
Reference ID: 24418
Note: #24418e

[93] IPNI. (2018). Better Crops With Plant Food Vol. 102 (2018, No. 2). 102 pp 1 - 38.
Reference ID: 24419
Note: #24419e

[94] L. Luar, M. Pampolino, A. Ocampo, A. Valdez, D.F. Cordora, T. Oberthür. (2018). Cassava Response to Fertilizer Application. Better Crops With Plant Food. 102(2) pp 11 - 13.
Reference ID: 24420
Note: #24420e > #24419e
Abstract: Continuous cassava cultivation without fertilizer application will lead to soil nutrient depletion and cause yield losses over time. Fertilizer recommendations based on the principles of 4R Nutrient Stewardship will help cassava farmers reap the benefits of their investment in fertilizer.

[95] T. Oberthur, C.R. Donough, H. Sugianto, K. Indrasuara, T. Dolong, G. Abdurrohim. (2018). Keberhasilan Intensifikasi Perkebunan Kelapa Sawit Dengan Best Management Practices: Dampak Terhadap Tandan Buah Segar Dan Hasil Minyak. (Bagian 3 dari 4: Kesimpulan Untuk Industri). Infosawit. 12(5) pp 48 - 51.
Reference ID: 24421
Note: #24421e > #24422e (Note: this is part 3 of 4) (part 1 is #24397, part 2 is #24398)

[96] Anonymous. (2018). InfoSawit Vol XII No 5 Mei 2018. 12 pp 1 - 56.
Reference ID: 24422
Note: #24422e

[97] E. Wafula, S. Zingore, G.N. Chemining'wa. (2018). Soil Fertility Management for Soybean Intensification in Western Kenya. Better Crops With Plant Food. 102(2) pp 3 - 5.
Reference ID: 24423
Note: #24423e > #24419e
Abstract: Large soybean yield gaps on smallholder farms in Kenya are associated with multiple soil constraints, including nutrient depletion, low organic matter, and soil acidity. Integrated nutrient management practices are necessary to increase productivity, particularly on degraded course-textured soils.

[98] J.M. Enrico, F. García, M. Stewart, E. Francisco, G. Balboa, I. Ciampitti, F. Salvagiotti. (2018). Integrating Crop and Fertilization Management Strategies for Soybean in the Central Pampas - Continuing Series: Nutrient Decision Support for Soybean Systems - Part 4. Better Crops With Plant Food. 102(2) pp 6 - 10.
Reference ID: 24424
Note: #24424e > #24419e
Abstract: Changes to specific crop management practices increased both biomass and seed yield. Seed yield improvements were mostly achieved through greater production of biomass and number of seeds. These effects were further enhanced under more intensive fertilizer management. Processes occurring at seed set (R2 to R5) and pod filling period (R5 to R7) were the most affected. Optimizing the growing conditions within these stages is critical when looking for higher yields. Increased yields under more intensive strategies were associated with higher uptake of N, P, and S.

[99] S. Li, P. He. (2018). Identifying Yield and Nutrient Gaps for Potato Production in Northwest China. Better Crops With Plant Food. 102(2) pp 14 - 16.
Reference ID: 24425
Note: #24425e > #24419e
Abstract: A yield and nutrient gap analysis for potato helps to evaluate the yield-limiting nutrient factors within northwestern China, and identifies the solutions to improving tuber yields to realistically attainable levels.

[100] R. Mahesh, B. Patil, H.A. Archana. (2018). Subsurface Drip Fertigation: A Tool for Practicing 4R Nutrient Stewardship in Sugarcane. Better Crops With Plant Food. 102(2) pp 17 - 20.
Reference ID: 24426
Note: #24426e >> #24419e
Abstract: Subsurface drip fertigation, an advanced method for co-application of water and nutrients following the principles of 4R Nutrient Stewardship (right source, rate, time, and place), has the capability to deliver nutrients uniformly within the effective root volume zone where most of the active roots are concentrated.
When adopted in the sugarcane fields of Tamil Nadu, this system demonstrated an overall increase in cane yield of 62 t/ha while improving nutrient use efficiency and farm net income.

[101] Mark Reiter Catherine Fleming-Wimer, Rory Maguire, and Steve Phillips. (2018). Long-Term Impacts of Poultry Litter on Soil pH and Phosphorus. Better Crops With Plant Food. 102(2) pp 21 - 23.
Reference ID: 24427
Note: #24427e > #24419e
Abstract: Common N–based rates for poultry litter (PL) application in the mid-Atlantic region were tested over nine years to track changes in soil profile pH and P concentration. A common in-house best management practice of modifying P solubility by lowering PL pH with alum did little to prevent P build-up over time and did not reduce plant available P that would limit growth.

[102] R. Mikkelsen. (2018). Quality: Potassium Management is Critical for Horticultural Crops. Better Crops With Plant Food. 102(2) pp 24 - 26.
Reference ID: 24428
Note: #24428e > #24419e

Abstract: Potassium is essential for the growth of all plants, but particular attention has been placed on its role in improving the quality of horticultural crops because of their high value and short shelf-life. Parameters of quality are expressed differently in each plant species, but the fundamental role of K for promoting quality is consistently and widely reported. This brief review examines the role of K in producing quality food that meets consumer demands and preferences.

[103] T.M. Maaz, R. Omonode, T. Vyn. (2018). Can Lower Nitrogen Balances and Greater Recovery by Corn Reduce N_2O Emissions? Part 1. Better Crops With Plant Food. 102(2) pp 27 - 30.
Reference ID: 24429
Note: #24429e > #24419e

[104] R. Noland, M.S. Wells, H. Peterson. (2018). Enhancing Cover Crop Nitrogen Uptake with Improved Establishment. Better Crops With Plant Food. 102(2) pp 31 - 34.
Reference ID: 24430
Note: #24430e > #24419e
Abstract: In the north central part of the US Midwest, the growing season often offers only a small opportunity for cover crop growth in the corn-soybean cropping system. In Minnesota fields, we show that with planting techniques that produce good seed to soil contact, along with choice of a species that will grow to produce at least 390 kg DM/ha, cover crops can effectively take up residual N to reduce risk of nitrate loss.

[105] IPI. (2018). e-ifc No 52 March 2018. 52 pp 1 - 40.
Reference ID: 24431
Note: #24431e

[106] A.C.C. Bernardi, G.B. de Souza, F. Vale. (2018). Polyhalite Compared to KCl and Gypsum in Alfalfa Fertilization. e-ifc. March 2018 pp 3 - 9.
Reference ID: 24432
Note: #24432e > #24431e
Abstract: Poor acidic soils significantly challenge potassium (K) availability for crop production in Brazil. Therefore, huge amounts of K fertilizers, mostly KCl, are applied yearly. Nevertheless, KCl agronomic efficiency in those soil is often insufficient, hence alternative K donors are sought. In the present study, polyhalite, a natural mineral with potential as a multi-nutrient (11.7, 19, 3.6, and 12.1% of K, sulfur (S), magnesium (Mg), and calcium (Ca), respectively) fertilizer, was examined in a pot-grown (local topsoil) alfalfa (Medicago sativa L.) experiment vs. KCl together with gypsum. Four K application rates (equivalent to 0, 50, 100, and 200 kg K_2O ha^{-1}) were tested with seven fertilizer combinations: KCl; KCl + gypsum1; KCl + gypsum2; polyhalite + KCl (1:7); polyhalite + KCl (1:1); polyhalite + KCl (7:1); and polyhalite. The results of seven successive harvests indicated that K application was essential to obtain considerable plant biomass in a K-rate dependent pattern. Polyhalite application, in combination with KCl or exclusively, gave rise to significantly higher biomass yields than KCl application, with or without gypsum. Polyhalite significantly enhanced K, S, Ca, and Mg uptake, particularly when applied alone at the highest dose. Indications of K-Mg or Cl-S competition seen under KCl application diminished under polyhalite. In conclusion, under the terms of a pot-grown experiment, polyhalite appeared as a promising alternative among K fertilizers for alfalfa grown on Brazilian acidic soils. Polyhalite may be considered as a replacement to KCl as a K source, as well as a

donor of Ca, Mg, and S. Broad scale field experiments are required, however, to further confirm this conclusion under practical terms.

[107] Y.L. Liao, Y.H. Lu, J. Xie, Z.P. Yang, X. Zhou, J. Nie. (2018). Effects of Long-Term Application of K Fertilizer and Rice Straw on Yields, Crop K Uptake, and Soil K Supply Capacity in Double Rice Cropping Systems on Reddish Paddy Soils. e-ifc. 52(March) pp 10 - 19.
Reference ID: 24433
Note: #24433e > #24431e
Abstract: The effect of potassium (K) application through mineral fertilizer or rice straw (RS) on rice yield, crop K uptake, and soil K supply capacity were studied in a long-term fertilization experiment (1981-2012) under an intensive double rice cropping system. The application of combined mineral K and soil-embedded RS significantly increased rice grain and straw yields. Potassium uptake significantly increased following consistent application of mineral K, RS, or both. The average annual amount of crop K uptake was in the order of: mineral NPK+RS > NPK > NP+RS > CK > NP. Long-term absence of K application led to a deficit in available, slowly-available, and total topsoil K. Long-term K application through mineral fertilizer and RS not only increased topsoil illite content, but also transformed poor-crystallized illite into well-crystallized illite. In-vitro K saturation treatments demonstrated the increased X-ray diffraction peak area of illite versus the declining vermiculite/chlorite peak. Soil K quantity/intensity (Q/I) parameters indicate an improved soil K capacity following long-term K application. It appears that two contradictory processes occurred in the reddish paddy soil, when applied with K releasing materials. The first is the enrichment of the soil solution with K+ ions and its positive consequences on the clay composition and on K saturation of clay minerals, mostly illite. While mineral K application boosts the soil solution with K at the beginning of the crop cycle, the degrading RS provides a consistent K supply thereafter. The conflicting process is the declining soil pH, with its negative effect on clay mineral structure and its affinity to K and other cations. So far, the positive effects dominate, demonstrating significant influences on crop performance as well as soil fertility. However, the mechanisms involved in the long-term K status in paddy soils are very complex, with many interactive factors, most of which are still obscure. Apparently, RS can successfully replace much of the mineral fertilizer, however, the particular sensitivity of the paddy soil system to soil pH must be taken into account.

[108] E.W. Gikonyo, S.K. Kimani, C.N. (Kibunja, A.O. Esilaba, L.W. Mbuthia. (2018). Rice Response to Potassium Fertilization in Mwea, Kenya. e-ifc. 52(March) pp 20 - 31.
Reference ID: 24434
Note: #24434e > #24431e
Abstract: In Kenya, the importance of potassium (K) fertilization to enhance crop yields for food security and income generation cannot be disregarded. The present study aimed to evaluate rice responses to different rates of Muriate of Potash (MOP) fertilizer, thus establishing the fertilizer recommendation for maximum rice yields and further identifying the best K fertilizer resource for maximum rice yields. The two most popular rice varieties, Basmati 370 and BW 196, were used. Five different K rates were examined: 0, 40, 80, 120 and 160 kg K_2O ha^{-1}. In addition, three K fertilizers were tested: MOP, Sulphate of Potash (SOP), and NPK-17-17-17 (SSS), all applied at 80 kg K_2O ha^{-1}. Experimental design was a split plot design with fertilizer rates as main plots and rice varieties as the sub-plots in experiment 1, while in experiment 2

fertilizer types were the main plots and varieties were the sub plots. These experiments were conducted in parallel in four locations in the Mwea Irrigation Scheme: Karaba, Tebere, Thiba, and Wamumu. Results revealed significant differences in plant height, tillering, total biomass, grain yield, and harvest index in most instances. These differences were associated with location, cultivar, and K application rates. Generally, grain yields were modest, ranging from 2.0 to 5.5 Mg ha^{-1} for Basmati 370, and from 2.0 to 10.0 Mg ha^{-1} for BW 196. Crop response to K application rate was quite small and limited, in most cases, to 40-80 kg K_2O ha^{-1}. No significant effect was observed for the K fertilizer type. Soil tests indicated severe soil acidity and K shortage at most locations. The restrained yields and relatively poor response to K rates points to fundamental challenges requiring solutions (e.g. soil acidity and water availability) before K fertilization is taken care of. However, splitting K dose during the season may improve K availability when required and crop K uptake, thus supporting better rice yields and income.

[109] R. Härdter. (2018). The role of magnesium ... in maximizing crop yields, enhancing quality and improving crop tolerance to stress conditions. Fertilizer Focus May/June 2018. May/June 2018 pp 62 - 65.
Reference ID: 24435
Note: #24435e > #24418e
Abstract: With the intensification of plant production, driven by a large population with growing food demands and very limited available land resources for agricultural use, the question whether current soil fertility management practices are sufficient to meet these demands in a sustainable way is persistent. It is not only global food production that went through an unprecedented growth during the last decade, but also fertilizer nutrient consumption, which fuelled this development.

[110] ISP. (2018). The Planter Vol 94 No 1102 January 2018. 94 pp 1 - 64.
Reference ID: 24436
Note: S serial #24436

[111] K.C. Sim, A.S.H. Tan, K.J. Wong, T.S. Chuah. (2018). Efficacy of MSMA Based Premix Herbicides on Control of Goosegrass (*Eleusine indica*) that Evolved Resistance across Glyphosate, Glufosinate and Fluazifop. The Planter. 94(1102) pp 13 - 24.
Reference ID: 24437
Note: #24437e > S serial #24436
Abstract: *Eleusine indica*, commonly known as goosegrass, is an annual noxious grassy weed which has a wide tolerance to environmental stresses. In Malaysia, infestation of goosegrass at immature oil palm and rubber plantations, orchards and vegetable fields has caused a significant loss in crop yields. Currently, this weed species has developed resistance to four groups of herbicides including glyphosate, glufosinate, paraquat or/and fluazifop. This study aimed to determine efficacy of MSMA based premix herbicides on control of the resistant biotypes of mature goosegrass (RG).

[112] R. Abd Majid. (2018). Fine-Tuning of Field Design During Replanting to Enhance the Yield Potential and Mechanised Operations: Holistic Considerations. The Planter. 94(1102) pp 25 - 43.
Reference ID: 24438
Note: #24438e > S serial #24436
(reproduced from 13th ISP National Seminar 2017 Book, "100 Years of Oil Palm: Suring Forward".)
Abstract: Most companies in Semenanjung Malaysia has embarked on replanting into the third generation while in Sabah and Sarawak they are now into the second generation. Unfortunately most had not taken the opportunity to adopt the available GIS/GPS technologies in the planning work to address the two major issues which are yield stagnation and mechanised operations. Many had merely replaced the old palms with new ones without giving much consideration to address related issues such as yield enhancement, Ganoderma infection and reducing the very heavy dependency on human labour with mechanisation.

[113] I.E. Henson. (2006). Modelling the Impact of Some Oil Palm Crop Management Options. Secondary Modelling the Impact of Some Oil Palm Crop Management Options. MPOB. Kuala Lumpur. pp 1 - 79.
Reference ID: 24439
Note: #24439e
Abstract: One use of crop growth simulation models is to aid formulation of crop management decisions. The mechanistic model, OPRODSIM (Oil Palm Production Simulator), includes several options to explore the possible outcomes of such decisions. These are: i) time of year of planting, ii) initial planting density, iii) methods of underplanting, iv) ablation, v) frond pruning, vi) stand thinning, vii) irrigation and viii) varying crop cycle length (palm age at replanting). The model also facilitates a simple assessment of crop loss due to certain pests and diseases. The consequences of planting time depend on site rainfall pattern, but date of planting was found to have surprisingly little effect on annual yield at a dry site averaged over 10 or more years. However, simulating the long-term effects of initial growth check s resulting from poor planting conditions proved difficult, and this aspect of the model is in need of improving. The model was able to simulate several observed effects of planting density, such as the relatively small response of vegetative, compared with bunch, production and the existence of an optimum leaf area index (LAI) and total biomass for yield. There were, however, considerable differences between these relations when comparing the two methods of simulating vegetative biomass production (VBP) and it was concluded that use of the standard method (which derives VBP from LAI) is not appropriate for simulating extremes of planting density. Various effects of under-planting were reproduced satisfactorily and the yield gains and losses resulting from different under-planting treatments accorded well with experimental data. Simulation of ablation (inflorescence disbudding) resulted in a stimulation of vegetative growth during the disbudding period followed by a small increase in yield in the year after ablation ceased, similar to field observations. However, the longer term effects on cumulative yield were not reproduced. With respect to frond pruning, the model allows considerable manipulation of frond number over and above that resulting from routine pruning carried out during bunch harvesting. As in practice, excessive pruning was detrimental to yield. However, the model generally predicted lower yield from over-pruned palms than observed in trials. Several reasons for this discrepancy are discussed and one means of partially correcting it was tested. The pruning option was also used, with modifications, to simulate the effects of defoliation by insect pests.

Thinning of the stand, either as a planned event following high density planting, or as an ad hoc response to yield depression due to over-vigorous vegetative growth, or as a consequence of palm loss due to disease, was also evaluated. However, the effects on yield of different planting arrangements which result from thinning, and the irregular stands resulting from disease attacks, need to be better understood and modelled. The irrigation option, available with simulation of soil water balance, was upgraded to include two methods for varying irrigation frequency and amount. The simulated yield responses to irrigation were in several respects similar to those observed, though some of the modeled results are still in need of testing in the field. Finally, the model was used to compare the effects of planting cycle length on cumulative yield and thus, to estimate an optimum age for re-planting. This was found to depend both on stand vigour (as reflected by frond size) and planting density. Thus far, the analyses consider yield alone. However, extension of the model's capabilities to include cost assessments of the various strategies is envisaged.

[114] I.E. Henson. (2006). Modelling the Impact of Climatic and Climate-Related Factors on Oil Palm Growth and Productivity. Secondary Modelling the Impact of Climatic and Climate-Related Factors on Oil Palm Growth and Productivity. MPOB. Kuala Lumpur. pp 1 - 43.
Reference ID: 24440
Note: #24440e
Abstract: Accounting for the effects of climate is an important aspect of crop simulation modelling. Climatic factors such as radiation, temperature, humidity, rainfall and wind have both direct and indirect effects on crop growth. The main indirect effects occur through changes in soil water supply and evaporative demand. In the oil palm productivity model OPRODSIM (Oil Palm Production Simulator), an attempt is made to simulate the effects of these factors on oil palm growth and yield, using the best available information. The model uses independent climate data sets, specific to major Malaysian oil palm environments. Currently, four representative climatic conditions are provided, with a further option for the user to employ his own data set if available. The model can be used to evaluate each climatic element individually or in combination with others. It includes a standard soil water balance routine that calculates soil water deficit and evapotranspiration. Potential evapotranspiration and atmospheric vapour pressure deficit, if not provided as inputs, are also calculated. The information is used to assess probable effects on both vegetative and reproductive growth of oil palm. Options to change rainfall and explore the effects of the water holding capacity of the soil are included. The model also considers the consequences for yield of climate modifying factors such as haze, El Niño and global warming.

[115] I.E. Henson, K.C. Chang. (2007). Modelling the Oil Palm Nutrient Demand, Nutrient Turnover and Nutrient Balance. Secondary Modelling the Oil Palm Nutrient Demand, Nutrient Turnover and Nutrient Balance. MPOB. Kuala Lumpur. pp 1 - 72.
Reference ID: 24441
Note: #24441e
Abstract: OPRODSIM (Oil Palm Production Simulator) is a source-based model that simulates fresh fruit bunch (FFB) yield based on the assimilate remaining after the requirements of vegetative growth have been met. In its initial form, the model assumes that nutrient supply is non-limiting.
In this report, the 'demands' for the major nutrients (nitrogen, phosphorus and potassium) needed to achieve 'satisfactory' yields of oil palm are considered, and equations to calculate these are incorporated in an updated version of the model. A

nutrient balance is developed that takes account of nutrient uptake and storage in permanent biomass, nutrient export in FFB, nutrient turnover within the plantation, nutrient inputs by rain, legume covers and mill by-products, and nutrient losses by leaching and other processes. Some uncertainties are identified such as the fate of nutrients in cut frond bases and decaying male inflorescences.
Nutrient budgets are presented and the results are compared with those from field experiment

[116] I.E. Henson. (2007). Modelling the effects of physiological and morphological characters on oil palm growth and productivity Oil Palm Bulletin. 54 pp 1 - 26.
Reference ID: 24442
Note: #24442e
Abstract: The model OPRODSIM is a mechanistic simulation model of oil palm growth and yield, the output of which depends crucially on the values assigned to various physiological and morphological characters. In this article, the effects of manipulating these values are explored and related to what is known concerning the magnitude of their natural variation.
The main physiological and morphological variables in crop growth simulation models include leaf photosynthetic characteristics such as the initial light-use (quantum) efficiency (a) and the photosynthetic rate at light saturation (AMAX), the canopy structural features affecting the capture of radiation, summarized in terms of the radiation extinction coefficient (k), the partitioning of assimilates between the various organs, and morphological attributes, which either influence or are the outcome of, underlying physiological processes. In relation to its morphology, the specific leaf area (m^2 kg^{-1} dry weight) of the fronds of oil palm is of interest as this may affect the efficiency of light capture in relation to dry matter allocation. Other aspects of palm growth considered in the model are frond expansion rate, frond production rate (determined as the emergence rate which influences not only the allocation of dry matter to fronds but also the production of inflorescences that are located in the frond axils), the rate of increase in height of the trunk (which has practical implications in terms of ease of harvesting of bunches), the rate of root biomass turnover (possibly a source of wasteful assimilate use) and the bunch development time (time from anthesis to ripening), which affects standing biomass and maintenance respiration requirements. Assimilate storage and frond turnover are also briefly discussed.
The effects of varying each of these parameters is examined and a sensitivity analysis undertaken where appropriate, to determine the relative importance of each. The results are compared with those of previous studies.

Abstrak: Model OPRODSIM ialah satu model simulasi mekanistik tumbesaran dan hasil sawit, di mana outputnya sangat bergantung pada nilai yang diberi kepada pelbagai ciri-ciri fisiologi dan morfologi. Dalam artikel ini, kesan manipulasi nilai ini ditinjau dan dikaitkan dengan apa yang diketahui mengenai kesan perbezaan semula jadi.
Ciri-ciri utama fisiologi dan morfologi dalam simulasi tumbesaran pokok termasuk ciri-ciri daun fotosintesis seperti kecekapan jumlah penggunaan cahaya awal (a) dan kadar ketepuan cahaya fotosintesis (AMAX), sifat struktur kanopi yang mempengaruhi penangkapan sinaran cahaya, diringkaskan dalam bentuk pekali kepupusan sinaran cahaya (k), pembahagian bahan serapan antara pelbagai organ, dan sifat morfologi sama ada mempengaruhi atau sebagai kesan proses fisiologi asas. Berkenaan dengan morfologi, luas daun spesifik (m^2 kg^{-1} berat kering) pelepah sawit sangat menarik kerana boleh memberi kesan kepada kecekapan penangkapan cahaya

dalam hubungan pembahagian bahan kering. Aspek lain dalam tumbesaran sawit yang diberi pertimbangan dalam model ini ialah kadar pengembangan pelepah, kadar pengeluaran pelepah (ditentukan sebagai kadar pengeluaran di mana bukan sahaja mempengaruhi pembahagian bahan kering kepada pelepah tetapi juga pengeluaran jambak bunga yang terletak di celah pelepah), kadar pertambahan ketinggian batang (di mana akan memberi kesan penuaian tandan), kadar pengeluaran akar (kemungkinan sumber pembaziran kegunaan bahan serapan) dan masa pembentukan tandan (masa dari bunga mengorak sehingga masak), di mana memberi kesan biojisim tegak dan keperluan pernafasan).
Kesan pelbagai parameter ini diteliti dan analisis sensitiviti dijalankan di mana sesuai untuk menentukan kepentingan setiap satu parameter secara relatif. Keputusannya dibandingkan dengan kajian sebelum ini

[117] T. Rhebergen, C Donough, H. Sugianto. (2018). Pocket Guide: Oil Palm 4R Series - Volume One: Leaf Sampling Unit. Secondary Pocket Guide: Oil Palm 4R Series - Volume One: Leaf Sampling Unit. Oxford Graphic Printers Pte Ltd. Singapore. pp 1 - 22.
Reference ID: 24443
Note: S 8.1.1. #24443

[118] T. Rhebergen, C Donough, H. Sugianto. (2018). Pocket Guide: Oil Palm 4R Series - Volume Two: Soil Sampling. Secondary Pocket Guide: Oil Palm 4R Series - Volume Two: Soil Sampling. Oxford Graphic Printers Pte Ltd. Singapore. pp 1 - 28.
Reference ID: 24444
Note: S 8.1.1. #24444

[119] T. Rhebergen, C Donough, H. Sugianto. (2018). Pocket Guide: Oil Palm 4R Series - Volume Three: Plant Sampling. Secondary Pocket Guide: Oil Palm 4R Series - Volume Three: Plant Sampling. Oxford Graphic Printers Pte Ltd. Singapore. pp 1 - 32.
Reference ID: 24445
Note: S 8.1.1. #24445

[120] T. Rhebergen, C Donough, H. Sugianto. (2018). Pocket Guide: Oil Palm 4R Series - Volume Four: Growth Measurements. Secondary Pocket Guide: Oil Palm 4R Series - Volume Four: Growth Measurements. Oxford Graphic Printers Pte Ltd. Singapore. pp 1 - 40.
Reference ID: 24446
Note: S 8.1.1. #24446

[121] I.E. Henson. (2010). Oil Palm: Ecophysiology of Growth and Production. pp 253 - 286.
Reference ID: 24447
Note: #24447e
Abstract: Cultivation of the oil palm (*Elaeis guineensis* Jacq.) has expanded tremendously in recent years such that it has now become a major source of the world supply of vegetable oil, and is one of the most important tree crops in the humid tropics, with its main centre of production in Southeast Asia. Oil palm is the world's most productive oil crop and is, in addition very versatile, producing two distinct oils, mesocarp (palm) oil and palm kernel oil, which find a variety of food and non-food applications, as well as palm kernel cake (used as animal feedstuff) and a number of

other products of fruit processing that find use as fertilizers, soil conditioners and as a source of fuel. Biological features recognized as critical to the high productivity of the crop include it's perennial and evergreen nature (resulting in a continuous year-round canopy that intercepts a high proportion of incoming solar radiation, a year-round production of fruit bunches and a high partitioning of total assimilates into harvested products. It has also, for a C3 plant, a relatively high rate of photosynthesis. This chapter examines these features, the relationships between vegetative and reproductive growth, and the sensitivity of the crop to environmental conditions.

[122] B. Janssen. (2010). Methodologies for design, analysis and interpretation of fertilizers tests performed in the CATALIST program. Internal report for IFDC, Kigali, Rwanda. Wageningen, The Netherlands. pp 1 - 37.
Reference ID: 24448
Note: #24448e (note: the grammar is typed as per report)
Abstract: Agronomists and farmers of CATALIST carry out various fertilizer tests in the Great Lakes countries. Most simple are the 'tests participatifs' consisting of one treatment only. Another group of testes deal with soil acidity and attempts to improve the acid soils. They consist of one to three treatments. Both, 'tests participatifs' and 'test d'acidite', offer some information on the best way to manage soil fertility. More conclusions can be drawn from two other tests carried out: 'tests comparatifs' and 'Essais soustractifs'. The 'tests comparatifs' usually consists of four treatments: control, N, NP, NPK, sometimes another treatment is added, for instance, NPK+micro-elements. In 2009 some 'minus one' experiments ('Esais soustractifs') were carried out in Burundi and RDC. They contained five fertilizer treatment: control; -N (=PK); -P (=NK); -K (=NP); and NPK. These 'esais soustractifs' provide more and better information than the 'tests comparatifs'.
In this document it is discussed what information can be derived from the various types of tests. The paper starts with the 'essais soustractifs' because they present the clearest picture. In this document it only is show how the effects and agronomic efficiencies can be calculated, for the separate nutrients N, P and K, as well as for all three nutrients together. Next the tests 'comparatifs' are considered. The simple 'tests participatifs' are difficult to interpret; it is tried to apply some recently developed concepts for the understanding of their results. The scientific background and justification is presented in another document, dealing with the interpretation of factorial experiments.
The 'tests d'acidite' deal with another problem than the optimum nutrient application and require a different approach.

[123] T.M. Maaz. 2018. Plant Nutrition Today - Summer 2018 Issue 2 No 1: What We Should Be Saying When We Talk About Nitrous Oxide Emissions. (2). pp 1 - 2.
Reference ID: 24449
Note: #24449e

[124] H. Peterson. 2018. Plant Nutrition Today - Summer 2018 Issue 2 No 2: 4R Management to Reduce Phosphorus Losses from Agricultural Subsurface Drainage. (2). pp 1 - 2.
Reference ID: 24450
Note: #24450e
Abstract: Fertilizer source, rate, timing and placement – the 4Rs – must be considered collectively in order to reduce subsurface dissolved P drainage losses.

[125] M. Pampolino. 2018. Plant Nutrition Today - Summer 2018 Issue 2 No 3: Fertilizer Application in Cassava: Why it is Important. (2). pp 1 - 2.
Reference ID: 24451
Note: #24451e
Abstract: Cassava benefits from nutrients, especially potassium, to produce high yields and improve quality of cassava products."

[126] R. Pool. (2014). The Nexus of Biofuels, Climate Change, and Human Health. Washington, D.C. pp 1 - 200.
Reference ID: 24452
Note: #24452e

[127] T. Wright, A. Rahmanulloh. (2016). Indonesia Biofuels Annual 2016: Gain Report. Gain Report. USA. pp 1 - 11.
Reference ID: 24453
Note: #24453e
Abstract: Indonesian palm oil-based biodiesel production is booming due to growing Indonesian demand. The rise of Indonesia's biodiesel consumption is directly attributable to the country's biodiesel subsidy, which under a low oil price environment since 2015 is now financed through a levy on palm oil and palm oil product exports. Post expects domestic biodiesel production to remain robust, although Indonesia's biodiesel subsidy will be challenged by low palm oil production in 2015/16 and lower-than-expected fossil fuel prices. Post thus expects biodiesel production to reach 2.45 billion liters in 2016, a rebound from 2015, but still below record levels experienced in 2014.

[128] E.B. Owen. (2011). Fertilización de la palma africana (*Elaeis Guinee*nsis Jacq.) en Colombia: Fertilization from the palm african (*Elaeis Guineensis* Jacq.) In Colombia. Revista Palmas Volumen. 13(2) pp 39 - 64.
Reference ID: 24454
Note: #24454e
Abstract: El cultivo de palma africana es de gran importancia en Colombia, ya que es el cultivo que más aceite y energía produce por hectárea. Aporta el 70% de la producción total en aceites vegetales.
Por su adaptación a zonas de altas precipitaciones y suelos de baja fertilidad, se siembra en zonas marginales. El establecimiento de las plantaciones en estas áreas, representa generación de empleo, implementación de obras de infraestructura, mejoramiento del nivel de vida.
Es necesario escoger los mejores suelos para el cultivo y así se reducen las inversiones. Uno de los costos más altos en el cultivo es la fertilización. Para reducir los costos de los fertilizantes es necesario hacer investigación en las plantaciones y así obtener las dosis óptimas para usarlos eficientemente.
Este trabajo sobre fertilización de la palma africana está basado en la revisión de literatura tanto nacional como de otros países tropicales; investigaciones llevadas a cabo por el Instituto Colombiano Agropecuario (ICA) y observaciones hechas a nivel de campo. Se hace énfasis en las características del suelo, el estado nutricional y el uso eficiente de fertilizantes. Se espera que este documento contribuya a aumentar la producción y la productividad de la industria palmera y sea un aporte a la consulta de los asistentes técnicos dedicados al cultivo de la palma africana.

[129] E.J.O. Barlett. (1993). Requerimiento de micronutrimentos para el cultivo de palma de aceite (*Elaeis guineensis* Jacq.): Requirements of micronutrients for the oil palm crop (*Elaeis guineensis* Jacq.). PALMAS. 14(4) pp 9 - 25.
Reference ID: 24455
Note: #24455e (Note: The journal is in spanish)
Abstract: Micronutrients are found in the soil in small quantities and the amount the plants can use is much smaller. Fortunately, oil palm requires very low micronutrient levels. Micronutrient deficiency is higher in coarse soils, with low organic matter content and a neutral or alkaline pH, except for molybdenum, which is low in neutral or alkaline soils. Micronutrient levels of oil palm soils in Colombia are adequate, except for boron. The micronutrient content (g/tree) of the aerial part of oil palms over 12 years of age is Iron=10,69; Manganese=50,9; Zinc=18,4; Copper=4,7; and Boron=4,5. Micronutrient movement is the plant, except for Molybdenum and Chlorine, is low. Micronutrient translocation from old to new fronds is reduce producing deficiency symptoms in the young fronds. Microelement application varies according to the microelement and the source. This paper is expected to contribute to the production and productivity of the industry, as well as to provide a consultation source for the Technical Assistants responsible for oil palm crops.

[130] A. Nolver, A. Arias, F.M. Munevar. (2006). Riesgos de Toxicidad con Boro en viveros de palma de aceite: Risk of Boron Toxicity to Oil Palm Seedlings in the Nurseries. PALMAS. pp 37 - 44.
Reference ID: 24456
Note: #24456e (Note: Journal is in spanish)
Abstract: Since there is a lack of experimental bases for making decisions on boron (B) fertilization in oil palm nurseries, and there is a risk of causing toxicity due to excessive fertilization, an exploratory trial on this matter was conducted in Barrancabermeja, Colombia. Six B rates were evaluated during six months. Boron fertilization resulted in greater concentrations of this element in leaf No 3 of the treated seedlings as compared to the control ones. Although the lowest rate of application (0.5g Borate 48/plant every 15 days) increased leaf area and stem length, higher rates had a negative effect on the above mentioned and other growth variables. All treatments, but the control, induced the development of leaf toxicity symptoms. The pattern of development of toxicity symptoms is described in detail; it begins with a yellow stripping pattern which conducts to almost a complete necrosis and shredding of leaflet blades. Therefore, the results indicate that the level of available B in the experimental soil was adequate for sustaining oil palm seedling growth under experimental conditions and/or that the lowest fertilization rate used in the trail was excessive. Further studies on this subject are encouraged.

[131] A.A. Garcia. (2010). Manejo integrado de la nutrición de la palma de aceite: experiencias en América tropical: Integrated management of oil palm nutrition: experiences in tropical America. PALMAS. 31 pp 178 - 190.
Reference ID: 24457
Note: #24457e (Note: Journal is in spanish)
Abstract: This document presents a compilation of experiences and concepts that have been developed on oil palm nutrition in Central America, Colombia and Brazil. In any case, nutrition must be addressed once particularly important points that affect its effectiveness have been solved, considering also the expression of the production potential of plantations: irrigation, drainage and diseases. If the problems associated with them are not corrected, it will be very difficult to achieve good efficiencies in

fertilizer management.

Resumen: El tema de este documento es una recopilación de experiencias y conceptos que se han ido desarrollando sobre nutrición de la palma de aceite, durante el tiempo que se ha trabajado en Centroamérica, Colombia y Brasil. En cualquier caso, la nutrición deben abordarse una vez se hayan resuelto puntos especialmente importantes que afectan su efectividad y también la expresión del potencial productivo de las plantaciones: el riego, el drenaje y las enfermedades. Si los problemas asociados a ellos no se corrigen, será muy difícil lograr buenas eficiencias en fertilizante.

[132] Y.D.M. Rivera, D.G.S. Cayón, J.E.M. López. (2013). Physiological and morphological characterization of american oil palms (*Elaeis oleifera* HBK Cortes) and their hybrids (*Elaeis oleifera* × *Elaeis guineensis*) on the Indupalma plantation. Agronomia Colombiana. 31(3) pp 314 - 323.
Reference ID: 24458
Note: #24458e
Abstract: The morphological and photosynthetic activity were characterized in six genotypes of American oil palm (*E. oleifera*) of different origins and three of their OxG hybrids (*E. oleifera* × *E. guineensis*) with a completely randomized experimental design, three replications and 16 palms per replication. Determinations were made for: photosynthesis, internal CO_2 concentration, chlorophyll content, stomatal openings and density, specific leaf area, and measurements of vegetative growth. The genotypes were differentiated by growth rate, emission, area and dry weight of the leaves. The stomatal openings of all the genotypes were maximum in the morning hours, with partial closures at midday; therefore, the maximum rate of photosynthesis was between 9:00 and 12:00 hr. The 'Perú' American oil palm and 'hybrid 2' (Sinú-Coarí × La Mé) showed higher CO_2 internal concentrations, total chlorophyll contents, light saturation points and photosynthetic rates, even with low levels of photosynthetically active radiation; characteristics that indicate a high capacity for the fixation of CO_2. The photosynthetic rate showed a high positive correlation with the chlorophyll content and a negative correlation with the specific leaf area. In conclusion, the 'Perú' American oil palm showed relevant characteristics for use in breeding programs as female parent of OxG hybrids, while 'hybrid 2', due to its outstanding morphophysiological characteristics, is considered a genotype with good agronomic performance.

[133] J.P. Caliman. (2009). Oil Palm Mineral Nutrition Management. International Journal of Oil Palm. 6(1) pp 1 - 17.
Reference ID: 24459
Note: #24459e
Abstract: Irrespective of soil and climate, fertilisation is essential in oil palm cultivation if growth and production potential is to be achieved. It is also necessary for maintaining and improving soil fertility, which is very often a limiting factor on tropical soils. Oil palm is usually very responsive to fertiliser application. However, significant differences in yield responses between distinct pedo-climatic areas, as well as differential nutrient requirements between mature and immature stages are observed. Manuring generally represents the largest, single component of production cost, accounting today frequently for around 65% of expenditure for maintenance cost in South East Asia, while in the sixties accounted for 54% according to Piggott (1968) in Malaysia. Compared to total production and management cost, fertiliser remains at the first rank

(Baskett et al., 2002). Actually scientific methods for management of mineral nutrition that give highly satisfactory results if correctly applied are available. Such management approaches are generally based on the response of the palms, aiming at determining the rate of fertiliser and the nutrient level in the leaf to achieve the best performance. The most performing plantation companies are also looking for a best balance between production level and economic factors. This can be achieved by taking into consideration economical parameters (like the price of palm products and the cost of applied fertilisers) and scenario about their trends, as the time lag between fertiliser applications and the oil palm response can be up to 3 years. Beside these two main factors for fertiliser management, environmental impact of agricultural practices are becoming a major concern for environmentalists and consumers, and it is assumed that this aspect will have to be taken into account in oil palm manuring. Relatively few studies have been carried out on the relation between mineral nutrition of the palms and water management, especially for irrigated palms. Some past results will be presented.

[134] H. Albertazzi, C.M. Chinchilla, C. Ramirez. (2009). Dinámica del sistema radical de la palma aceitera (*Elaeis guinnensis* Jacq.) en respuesta a la fertilización mineral y orgánica en suelos de áreas afectadas por pudriciones del cogollo: Dynamics of the root system of the oil palm (*Elaeis guineensis* Jacq.) In response to mineral and organic fertilization in soils of areas affected by bud rot. ASD Oil Palm Papers. 33 pp 40 - 47.
Reference ID: 24460
Note: #24460e (Note: Journal is in spanish, title and abstract translated via google translate)
Abstract: Se siguió la dinámica del sistema radical de palmas aceiteras jóvenes en suelos afectados por pudriciones de cogollo, los cuales fueron enmendados con fertilización orgánica o mineral. Se utilizó la metodología de sacos de muestreo, la cual consiste en enterrar, a aproximadamente 30 cm de profundidad, sacos de un material de lenta degradación dentro de los cuales se colocaron los tratamientos deseados. Los tratamientos usados en los sacos fueron: 1) suelo de una área con alta incidencia de PC (suelo 1) sin enmienda (testigo uno), 2) el mismo suelo enmendado con 100 g de fertilizante químico (18-5-15-6-0,2), 3) ese suelo enmendado con 10% (p/p) de compost hecho a partir de racimos vacíos de palma aceitera, y 4) suelo de un área con baja incidencia de PC (Suelo 2: testigo dos). Un grupo de sacos de cada tratamiento se extrajo del suelo a los 2, 4, y 6 meses después de iniciado el experimento para evaluar el sistema radical. Durante el periodo experimental en 1999 se observó un incremento gradual en la cantidad total de raíces. El mayor aumento en la cantidad de materia seca de raíces totales se encontró en el tratamiento tres (alta incidencia de PC enmendado con compost), excepto en el segundo muestreo. Con respecto al sistema radical grueso, se encontraron resultados erráticos, los cuales pueden deberse a una variación estacional causada por el patrón de lluvias, y no a una respuesta a los tratamientos. El crecimiento del sistema radical fino (raíces III y lV) fue más constante en el tiempo. En todos los tratamientos se observó un aumento de este tipo de raíces con el tiempo. La enmienda del suelo 1 con fertilizante químico, promovió inicialmente un mejor crecimiento de raíces finas, pero ese efecto no fue duradero y luego la masa radical pareció reajustarse a las condiciones nutricionales intrínsecas del suelo usado. El efecto del tratamiento con compost fue más duradero, probablemente debido a que el compost acompleja parte de sus elementos nutricionales y se comporta como un fertilizante de lenta liberación. Aunque las diferencias en la cantidad de raíces entre tratamientos parecían bastante

evidentes, las mismas no resultaron significativas, ya que la variabilidad en la cantidad de raíces entre plantas y tratamientos fue muy grande; lo cual es normal para esta variable en la que es común observar una variabilidad mayor a 20%. No obstante, el usar cada planta como un bloque o repetición ayudó a reducir dicha
variabilidad. En forma complementaria se corrió un análisis de regresión entre el peso de la muestra de raíces (gramos) y la longitud de estas (milímetros), encontrándose un modelo lineal con un valor de R^2 de 0,76 y una probabilidad < 0,01 para la familia de datos del ámbito de muestras entre 0 y 7 gramos. El modelo para estimar el valor de lre (longitud radical específica) con el peso en gramos de muestras dentro del ámbito señalado, facilitará el análisis e interpretación de futuros experimentos en los que se contemplen éste tipo de variables.

[135] B. Dubos, C. Gallardo, J.E. Zambrano. (2013). Comportamiento nutricional de los híbridos interespecíficos *Elaeis oleifera* x *Elaeis guineensis* (oxg) en el oriente ecuatoriano y colombiano: Nutritional Behavior of Interspecific Hybrids (*E. Oleifera* x *E. Guineensis*) in Eastern Ecuador and Colombia. PALMAS. 34(1) pp 337 - 344.
Reference ID: 24461
Note: #24461e (Note: Journal is in spanish)
Abstract: Frente al aumento progresivo de enfermedades letales que afectan al cultivo de la palma de aceite desde hace más de dos décadas, el cultivo de los híbridos interespecíficos OxG ha sido inevitable en aéreas importantes de Colombia y Ecuador, y las superficies sembradas siguen creciendo. Palmeras del Ecuador y Hacienda La Cabaña tienen sembrado 5.670 y 3.650 hectáreas de híbridos OxG de origen Coari x *Elaeis guineensis*, respectivamente. Para el manejo a escala industrial de este nuevo material ha sido necesario que se identifiquen contenidos de referencia para el control nutricional y la fertilización.
Al igual que para el *E. guineensis*, el método experimental consiste en establecer relaciones entre los contenidos foliares y dosis de fertilizantes, este método ofrece la vía más rigurosa para obtener rápidamente los niveles críticos para los elementos mayores.
Este artículo utiliza los resultados de dos dispositivos factoriales montados en condiciones de suelos y de clima contrastados, con el objetivo de obtener las primeras normas que puedan ayudar al diagnóstico de bloques industriales a partir de resultados de análisis foliares. Para N y K el efecto de la edad en la evolución de los contenidos es menos marcado que para el *E. guineensis* y de manera general hay que aceptar contenidos óptim más bajos en cultivos adultos. La correlación entre los contenidos N y P es muy marcada y una regresión lineal similar a la que se estableció para el *E. guineensis* puede servir de modelo para balancear los dos elementos. Los contenidos foliares de referencia para Mg y Cl pueden ser considerados como equivalentes a los del *E. guineensis*.
Las conclusiones fueron establecidas a partir de una mezcla de códigos representativos de la fuente Coari x La Mé, pero las pruebas y las observaciones de campo indican que existen amplias variaciones dentro del material OxG. En el futuro será necesario distinguir el material vegetal para ciertos elementos como el magnesio.

Abstract: In the face of the progressive increase of lethal diseases affecting oil palm crop for more than two decades, cultivation of Interspecific Hybrids oxg has been inevitable in important areas of Colombia and Ecuador, and the planted areas keep growing. Palmeras del Ecuador and Hacienda La Cabaña have 5,670 and 3,650 hectares of hybrids oxg of Coari origin x *Elaeis guineensis* planted, respectively. For industrial scale management of this material, it has been necessary the identification

of reference contents for nutritional control and fertilization.
As with *E. guineensis*, the experimental method consists in establishing relationships between foliar contents and fertiliser dosage. This method provides the most stringent pathway for rapidly obtaining the critical levels for the major elements.
This paper uses the results of two factorial devices set up in contrasted soil conditions and climate, with the aim of obtaining the first standards that can help in the diagnosis of industrial blocks based on results from foliar analyses. For N and K, the effect of age on the evolution of contents is less marked than on *E. guineensis*, and generally, lower optimum contents in adult crops should be accepted. The correlation between N and P contents is very marked and a linear regression similar to the one established for *E. guineen*sis may serve as a model to balance the two elements. The reference foliar contents for Mg and Cl can be considered equivalent to those of *E. guineensis*.
Conclusions were established based on a mix of codes representative of the Coari x La Me source, but the trials and field observations indicate that there are wide variations within the oxg material. It will be necessary, in the future, to distinguish the vegetable material for certain elements such as magnesium.

[136] E. Benítez, C. García. (2014). The history of research on oil palm bud rot (*Elaeis guineensis* Jacq.) in Colombia: Historia de las investigaciones en pudrición del cogollo de la palma de aceite (*Elaeis guineensis* Jacq.) en Colombia. Agronomia Colombiana. 32(3) pp 390 - 398.
Reference ID: 24462
Note: #24462e
Abstract: This article presents an overview of the main results obtained from research on oil palm bud rot. Aetiologic studies with biotic and abiotic approaches were explored, aiming for a model that would help in the understanding of the ethology of this disease. It also discusses how the results of the studies are contradictory and how the arguments for biological causes have not shown progress. Furthermore, the results of measuring the influence of abiotic factors, where there is greater consensus, are discussed; however, there is controversy due to the fact that different researchers placed different weight on the final model of this disease. This situation has led to controls being directed toward potential pathogens associated with the disease, as determined by circumstantial evidence, wherein the positive or negative response to the control may be confused with extrinsic factors such as disease escape or foci formation. Even the role played by the insect *Rhynchophorus palmarum* (L.) in the death of palms affected by this disease is in doubt. Finally, this paper shows how the process of general disease research has important biases arising from the risk aversion of palm producers or the lack of continuity in results obtained by different research groups.

[137] E.T.S. Putra, Issukindarsyah, Taryono, B.H. Purwanto. (2015). Physiological Responses of Oil Palm Seedlings to the Drought Stress Using Boron and Silicon Applications. Journal of Agronomy. pp 1 - 13.
Reference ID: 24463
Note: #24463e
Abstract: The objectives of the study were to determine (1) The level of physiological resistance of oil palm seedlings to drought stress by boron (B) and silicon (Si) application and (2) The mechanism of B and Si actions to induce physiological resistance of oil palm seedlings to drought stress. The B and Si were the elements capably inducing the internal resistance of plant tissues to drought stress, especially through physiological resistance mechanisms. Field trial was arranged in the factorial

Randomized Complete Block Design (RCBD) using three blocks as replications. The first factor was six dose of B: 0.00, 0.17, 0.44, 0.87 and 1.31 g plant^{-1}. The second factor was five dose of Si: 0.00, 1.15, 2.31, 3.46 and 4.69 g plant^{-1}. Observations were done on the Nitrate Reductase Activity (NRA), the content of chlorophyll a, b and total, density, length and width of stomatal aperture, stomatal conductance and transpiration rate, photosynthetic rate and photosynthetic activity per plant, dry weight of plant parts and trunk height and diameter of the oil palm seedlings. The data were analyzed using ANOVA and the means were separated using Duncan's multiple range test at 5% level. Meanwhile, the optimum dose of B and Si were determined using regression analysis. The results showed that B and Si application could induce physiological resistance of oil palm seedlings to drought stress. Mechanism of action of B in inducing physiological resistance of oil palm seedlings to drought stress were by increasing of greenish leaves, width of stomatal aperture and photosynthetic activity per plant while Si application capable to increase of greenish leaves and to decrease the density of lower leaf surface stomatal. The optimal dose of B was 0.33-0.57 g/seedlings and the optimal dose of Si was 2.22 g/seedling in inducing physiological resistance of oil palm seedlings to drought stress.

[138] J. Ollivier, E. Lamade, B. Dubos, E. Surya, P. Permadi, E. Suryana, A. Flori, B. Cochard, J.C Jacquemard. (2013). Hacia un diagnóstico nutricional preciso para la palma de aceite, teniendo en cuenta el origen del material de siembra: Towards an Accurate Nutritional Diagnosis for Oil Palm Taking into Account the Origin of the Planting Material. PALMAS. 34(Special Issue) pp 203 - 220.
Reference ID: 24464
Note: #24464e (Note: Article is in Spanish)
Abstract: Los esquemas de selección y mejoramiento de la palma de aceite se centran principalmente en la tasa de extracción de aceite y en el peso de los racimos producidos por palma, conjuntamente con los rasgos de resistencia a enfermedades. A fin de expresar lo máximo del potencial genético, la práctica de una fertilización razonada depende de los resultados de los experimentos de referencia y del análisis de los contenidos de minerales en diferentes órganos de las plantas.
La existencia de requerimientos nutricionales específicos según el material de siembra es aun relativamente desconocida. Por tanto, este factor es tenido en cuenta como criterio de selección del material de siembra.
No obstante, se reportaron diferencias en los niveles foliares entre varios materiales de siembra (Tan y Rajaratnam, 1978). Se observaron deficiencias de magnesio en algunas progenies, así como diferencias en los contenidos de nutrientes entre clones y entre progenies en Costa de Marfil e Indonesia (Caliman et al., 1994; Dubos et al., 1999).
Más recientemente, se han demostrado diferencias significativas entre distintos orígenes del material de siembra en dos bloques genéticos (Aek Kwasan y Aek Loba Timur) de PT Socfindo, plantados en la isla de Sumatra (Indonesia). Dos perimentos adyacentes sobre nutrición, plantados con dos tipo de material de siembra en la vecindad de los bloques genéticos, también han revelado la influencia genética en los niveles críticos foliares (Jacquemard et al., 2002, 2009).
El realce de los niveles foliares contrastados según el origen genético del material de siembra tiene un efecto importante en la determinación de los niveles críticos que impulsan las recomendaciones de fertilizantes. A fin de refinar las herramientas de diagnóstico, es por tanto necesario desarrollar un montaje experimental teniendo en cuenta un material de siembra más contrastado y profundizar el conocimiento sobre la movilización de los nutrientes a escalas de la planta completa.

Abstract: The selection and breeding schemes in oil palm mainly focus on the oil extraction rate and the weight of bunches produced per tree jointly with disease resistance traits. In order to express the maximum of the genetic potential, the practice of reasoned fertilisation relies on the results of reference experiments and the analysis of mineral contents in different plant organs.
The existence of specific nutritional requirements according to the selected planting material is still relatively unknown. This factor is therefore not taken into account as a selection criterion of the planting material.
However, differences in foliar levels among various planting materials were reported (Tan and Rajaratnam, 1978). Magnesium deficiencies in some progenies have been observed as well as differences in the nutrient contents between clones and between progenies in Ivory Coast and Indonesia (Caliman et al.,1994; Dubos et al., 1999).
More recently, significant differences between different origins of planting material have been demonstrated on two genetic blocks (Aek Kwasan and Aek Loba Timur) of PT Socfindo planted in the island of Sumatra (Indonesia). Two adjacent nutrition experiments planted with two types of planting material in the vicinity of the genetic blocks have also revealed the genetic influence on the foliar critical levels (Jacquemard et al., 2002, 2009).
The highlighting of contrasted foliar levels according to the genetic origin of the planting material has therefore an important effect on the determination of the critical levels driving the fertiliser recommendations. In order to refine the diagnostic tools, it is therefore necessary to develop an experimental setup taking into account a more and more contrasted planting material and to deepen the knowledge on the mobilization of nutrients at the whole plant scale.

[139] A. Acosta, F. Ramirez, H. Albertazzi. (2007). El Papel Del Silicio en el desempeño de palmas con flecha seca en una plantación comercial de palma aceitera en Quepos, Costa Rica: Role of Si in the performance of palms suffering spear rot on a commercial oil palm plantation in Quepos, Costa Rica. PALMAS. 28(Special Issue 1) pp 389 - 393.
Reference ID: 24465
Note: #24465e (Note: Journal in Spanish)
Abstract: En muchos cultivos el silicio ha sido relacionado con tolerancia a enfermedades. El presente informe describe los resultados de pruebas semi-comerciales donde se evaluó el efecto de una fuente de silicio en la evolución de focos de flecha seca en la División de Quepos. Centros fruteros completos de 1,1 hectárea en promedio fueron utilizados como parcelas experimentales en las cuales alternadamente se aplicó el equivalente a 30 kg de Si/ha. La fertilización complementaria a los tratamientos fue similar en N, P, K, Mg y B. En total fueron aplicadas 148 parcelas, en un área experimental total de 1.44.4 hectáreas. Como variable de respuesta se evaluó el porcentaje de palmas sanas, palmas enfermas y en recuperación. Además, se evaluó el Índice de Recuperación Vegetativa, como una razón de la cantidad de palmas en recuperación entre el total de palmas enfermas acumuladas. Al cabo de un año de evaluaciones se observaron diferencias altamente significativas entre los tratamientos, encontrándose que aquellas parcelas que recibieron silicio lograron aumentar la recuperación en 62% y 94% en los dos casos evaluados.

Abstract: Silicon has been many times related to disease tolerance. This paper describes the results of semi-commercial tests in which the effect of a silicon source was assessed in the evolution of spear rot foci in the Quepos Division. Complete fruit

centers of 1,1 ha in average were used as experimental plots in which an alternate application of 30 kg of Si per ha were applied. Complementary fertilization to the treatments was very similar in N, P, K, Mg and B. The application took place in 148 plots in an experimental area of 144.4 hectares. The percentage of healthy, sick and under recovery palms was assessed as a response variable. The Vegetative Recovery Rate was also assessed as a result of the number of palms under recovery among the total number of accumulated sick palms. Highly significant differences were found among the treatments after 1 year of evaluations. The most outstanding result was that the plots that received Silicon increased their recovery in 62% and 94% in the two assessed cases.

[140] V.D. Meena, M.L. Dotaniya, V. Coumar, S. Rajendiran, Ajay, S. Kundu, A. Subba Rao. (2014). A Case for Silicon Fertilization to Improve Crop Yields in Tropical Soils. Proceedings of the National Academy of Sciences India Section - Section B. 84(3) pp 505 - 518.
Reference ID: 24466
Note: #24466e
Abstract: Long period of intensive crop cultivation deplete the available soil silicon (Si). Depletion of available Si in the soil could be one of the possible limiting factors amongst others contributing to declining yields. The lower values for Si in the soil can be justified due to (i) severe and frequent soil erosion and sediment transportation. (ii) Usually plants absorb Si almost equal to the concentration of most of macronutrients. (iii) Due to the desilication process, Si in the soil is continuously lost as the result of leaching process. Subtropical and tropical soils are generally low in available Si and would benefit from Si fertilization. The silicon content in some regions might be limited to sustainable crop production. Hence, improved Si management to increase yield and sustain crop productivity appears to be necessary in temperate as well in tropical countries. In order to address this problem of yield decline or stagnation, it seems necessary to survey the Si status of agriculturally important soils of different parts of the country and develop region-specific integrated nutrient management systems that include the Si element.

[141] I.E. Henson, R.R. Ruiz, H.M. Romero. The greenhouse gas balance of the oil palm industry in Colombia: a preliminary analysis - I. Carbon sequestration and carbon offsets: Balance de los gases de efecto invernadero de la industria de la palma de aceite en Colombia: análisis preliminar - I. Secuestro de carbono y créditos de carbono. Agronomia Colombiana. 30(3) pp 359 - 369.
Reference ID: 24467
Note: #24467e (part 2 is #24468)
Abstract: Colombia is currently the world's fifth largest producer of palm oil and the largest producer in South and Central America. It has substantial areas of land that could be used for additional oil palm production and there is considerable scope for increasing yields of existing planted areas. Much of the vegetation on land suitable for conversion to oil palm has a low biomass, and so establishing oil palm plantations on such land should lead to an increase in carbon stock, thereby counteracting greenhouse gas (GHG) emissions responsible for global warming. The first part of this study examines changes in carbon stock in Colombia resulting from expansion of oil palm cultivation together with factors (offsets) that act to minimize carbon emissions. The results are subsequently used to construct a net GHG balance.

Abstract in Spanish: Colombia es el quinto productor de aceite de palma en el

mundo y el más grande en América Central y del Sur. Tiene áreas sustanciales de tierra que podrían ser usadas para producción adicional de palma de aceite y existe una brecha interesante para incrementar los rendimientos en las áreas existentes. La mayoría de la vegetación de las áreas adecuadas para la conversión a siembra de palma tienen una biomasa baja, de tal manera que al establecer plantaciones de palma de aceite en esas tierras debería incrementarse el carbono almacenado, de tal manera que haya una reducción en las emisiones de gases de efecto invernadero (GHG) responsables del calentamiento global. La primera parte de este estudio examina los cambios en el carbono almacenado como resultado de la expansión del cultivo de la palma de aceite junto con aquellos factores (créditos) que actuan para minimizar las emisiones. Los resultados son subsecuentemente usados para construir el balance neto de GHG.

[142] I.E. Henson, R.R. Ruiz, H.M. Romero. (2012). The greenhouse gas balance of the oil palm industry in Colombia: a preliminary analysis - II. Greenhouse gas emissions and the carbon budget: Balance de gases de efecto invernadero de la agroindustria de la palma de aceite en Colombia: análisis preliminar - II. Emisión de gases de efecto invernadero y balance de carbono. Agronomia Colombiana. 30(3) pp 370 - 378.
Reference ID: 24468
Note: #24468e (part 1 is #24467)
Abstract: In the preceding paper we examined carbon sequestration in oil palm plantations and in mill products and by products as part of a study of the greenhouse gas balance of palm oil production in Colombia, showing how this has changed over time. Here, we look at the opposing processes of greenhouse gas (GHG) emission and calculate the resulting net carbon budget for the industry. The main emission sources, in decreasing order of magnitude, assessed using ‘default’ or ‘most probable’ options, were found to be land use change (40.9% of total), mill methane production (21.4%), direct use of fossil fuel (18.5%), indirect use of fossil fuel (11.9%) and nitrous oxide production (7.3%). The total (gross) emissions, expressed in carbon equivalents (Ceq.), were less than the amount of sequestered carbon, resulting in a positive net Ceq. balance. All oil palm growing regions showed a net gain with the exception of the western zone, where emissions due to land-use change were judged to be substantial. Of the 11 alternative scenarios tested, only three resulted in Ceq. balances lower than the default and only two gave a negative balance.

Abstract in Spanish: Se evaluó el secuestro de carbono por parte de plantaciones de palma de aceite y en los productos del procesamiento y sus subproductos, como parte de un estudio del balance de gases de la producción de aceite de palma en Colombia, mostrando como este ha cambiado a través del tiempo. Se examinaron los procesos opuestos de la emisión de gases de efecto invernadero y calcula el balance neto de carbono resultante para la industria. La principales fuentes de emisiones en orden decreciente de magnitud, usando las opciones “por defecto” o “más probables” fueron el cambio de uso de tierra (40,9% del total), producción de metano en las plantas de procesamiento (21,4%), uso directo de combustibles fósiles (18,5%), uso indirecto de los combustibles fósiles (11,9%) y producción de óxido nitroso (7.3%). El total de emisiones (valor bruto) expresadas en carbono equivalente (Ceq.) fue menor que la cantidad de carbono secuestrado, resultando en un balance positivo neto de Ceq. Todas las zonas palmeras mostraron una ganancia neta con excepción de la zona Occidental en donde las emisiones dadas por el cambio de uso de tierra fueron sustanciales. De los 11 escenarios alternativos analizados solamente tres resultaron

en un menor balance de Ceq. comparado al utilizado por defecto y solamente dos de ellos tuvieron un balance negativo.

[143] H. Albertazzi, C. Chinchilla, C. Ramirez. (2009). Oil palm root development as a response to mineral and organic nutrition in soils with prevalence of spear rots. ASD Oil Palm Papers. 33 pp 33 - 39.
Reference ID: 24469
Note: #24469e
Abstract: Soil from an area where bud rots (PC = pudriciones del cogollo) were prevalent was amended with organic and mineral fertilizers to study the dynamic of the root system of young oil palms. In-growth bags made of a slow-degrading fabric containing the treatments were buried (30 cm) close to the palms. Soils from two sites were used, the first being a plot where PC incidence was high, and the other was the control with low incidence of PC. The soil from site one was amended with either of three treatments: 1) control, 2) amended with 100 g of chemical fertilizer (18-5-15-6-0,2), and 3) amended with compost prepared from oil-palm empty fruit bunches. Treatment four was the other control (soil from an area with low PC so far). A sample from all treatments was collected at 2, 4 and 6 months in 1999 to observe and measure root growth. A gradual increase in root mass was observed throughout the experiment. A higher increase in root dry weight was observed in soil from site one amended with compost, except for the second sampling. The amount of large roots (primary and secondary) within the bags did not follow any particular pattern in time that could be associated with the treatments, but to normal seasonal variation caused by factors such as rainfall pattern. Growth of the fine root system (tertiary and quaternary roots), however, increased steadily through time in all treatments. Soil from site one amended with chemical fertilizer promoted root growth initially but this effect was of short duration and root mass soon returned to what was probably the normal levels sustained by this particular substrate. On the other side, the effect of the organic amendment had a longer effect on root mass due in part to the slow nutrient-releasing properties of organic matter. Differences in root mass, though evident, were not statistically significant due to the high data variability (large differences between plants). This is a normal behavior of the root system, where variability can be higher than 20%. However, the use of each plant as a block or replication helped to reduce such variability. Complementarily, a regression analysis was run between root weight and length, where the lineal model had a R^2 of 0.76 for samples where weight was between 0 and 7 grams. This model allows estimating an srl (specific root length) value from the weight of a root sample facilitating analysis and data interpretation.

[144] M.R. Melendez, W.P. Ponce. (2016). Pollination in the oil palms *Elaeis guineensis*, *E. oleifera* and their hybrids (OxG), in tropical America. Pesquisa Agropecuaria Tropical. 46(1) pp 102 - 110.
Reference ID: 24470
Note: #24470e
Abstract: Oil palm (*Elaeis guineensis*) is very important in the Central and South American economies. Plants suffer from a devastating fungal disease known as “lethal decay” or “pudrición del cogollo”, in Spanish. Producer countries in Africa, Asia and tropical America have developed breeding programs that seek the tolerance of this disease by plants. The hybrids *Elaeis guineensis* x *Elaeis oleifera* (OxG) are resistant, but show physiological problems that affect commercial productivity. Natural pollination in these hybrids is low and manual pollination has high labor costs. The Coleoptera order is the most numerous and diverse natural pollinator, and the

Elaeidobius genus has high efficiency and specificity to oil palm species. *Elaeidobius kamerunicus*, *Elaeidobius subvittatus* and *Mystrops costaricensis* are the insects most commonly associated with oil palm inflorescences. Dynamics in insect populations change according to palm species and weather conditions. It is necessary to understand the insect behavior and population dynamics in OxG hybrids. Thus, recent studies on oil palm pollination, insect diversity and distribution in Latin America are discussed in this study.

Abstract in Portuguese: A palma azeiteira (*Elaeis guineensis*) apresenta grande importância paras as economias da América Central e do Sul. Essa planta sofre com o ataque de uma doença fúngica devastadora conhecida como “lethal decay” ou “amarelecimento fatal”, em Português. Países produtores da África, Ásia e América tropical têm desenvolvido programas de melhoramento que buscam tolerância a essa doença pelas plantas. Os híbridos *Elaeis guineensis* x *E. oleifera* (OxG) são resistentes, no entanto, apresentam problemas fisiológicos que afetam a produtividade comercial. A polinização natural nesses híbridos é baixa e a manual tem custos de mão de obra muito elevados. A ordem Coleoptera é o polinizador natural mais numeroso e diverso, e o gênero *Elaeidobius* tem alta eficiência e especificidade para as espécies de palma azeiteira. *Elaeidobius kameronicus*, *Elaeidobius subvittatus* e *Mystrops costaricensis* são os insetos mais comumente associados às inflorescências dessa cultura. A dinâmica em populações desse inseto varia de acordo com as espécies de palma e condições climáticas. Faz-se necessário entender o comportamento desse inseto e a dinâmica de sua população nos híbridos OxG. Por isso, estudos recentes sobre a polinização da palma azeiteira, bem como a diversidade e distribuição do seu polinizador na América Latina, são discutidos neste estudo.

[145] A. Bah, M.H.A. Husni, C.B.S. Teh, M.Y. Rafii, S.R. Syed Omar, O.H. Ahmed. (2014). Reducing Runoff Loss of Applied Nutrients in Oil Palm Cultivation Using Controlled-Release Fertilizers. Advances in Agriculture. 2014 pp 1 - 9.
Reference ID: 24471
Note: #24471e
Abstract: Controlled-release fertilizers are expected to minimize nutrient loss from crop fields due to their potential to supply plant-available nutrients in synchrony with crop requirements. The evaluation of the efficiency of these fertilizers in tropical oil palm agroecological conditions is not yet fully explored. In this study, a one-year field trial was conducted to determine the impact of fertilization with water soluble conventional mixture and controlled-release fertilizers on runoff loss of nutrients from an immature oil palm field. Soil and nutrient loss were monitored for one year in 2012/2013 under erosion plots of $16m^2$ on 10% slope gradient. Mean sediments concentration in runoff amounted to about 6.41 t ha^{-1}. Conventional mixture fertilizer posed the greatest risk of nutrient loss in runoff following fertilization due to elevated nitrogen (6.97%), potassium (13.37%), and magnesium (14.76%) as percentage of applied nutrients. In contrast, this risk decreased with the application of controlled-release fertilizers, representing 0.75–2.44% N, 3.55–5.09% K, and 4.35–5.43% Mg loss. Meanwhile, nutrient loss via eroded sediments was minimal compared with loss through runoff. This research demonstrates that the addition of controlled release fertilizers reduced the runoff risks of nutrient loss possibly due to their slow-release properties.

[146] P.B. Tinker, P.H. Nye. (1993). Root System Architecture, Density and Measurement. pp 224 - 227, 277-280.
Reference ID: 24472
Note: #24472e > S 2.7 #10404 (note, Chapter 9 to 9.1 only and some pages of 10.2.5-10.2.6)

[147] E.J. Hewitt. (1983). The effects of mineral deficiencies and excesses on growth and composition. pp 56 - 57.
Reference ID: 24473
Note: #24473e > S 2.5 #925 (note: only Nitrogen and Phosphorus scanned)

[148] P.D. Turner. (1981). Nutritional Disorders in Field Palms. pp 242 - 276.
Reference ID: 24474
Note: #24474e > S 8.1.1.4 #14 (Chapter 11)
Abstract: The importance of nutritional disorders in field palms and the necessity for their avoidance is borne out by the vast expenditure incurred world-wide on fertilizer, which has been shown to be necessary through widespread experimentation. The significance of deficiencies and their relation to decreased growth and yield is reflected in the situation found on most well-run estates: the cost of fertilizers accounts for over one-half of the total annual expenditure on maintenance.

[149] H. Varkkey, A. Tyson, S.A.B. Choiruzzad. (2018). Palm oil intensification and expansion in Indonesia and Malaysia: Environmental and socio-political factors influencing policy. Forest Policy and Economics. 92 pp 148 - 159.
Reference ID: 24475
Note: #24475e
Abstract: Intensification and expansion are two essential tenets of commercial agriculture. This paper analyses trends of intensification and expansion at the national level, particularly in the oil palm sector in Indonesia and Malaysia. Despite similar starting points and also comparable rates of increasing productivity and profit in this sector, both countries have developed almost opposite trajectories of land use. While both intensification and expansion has occurred in these countries, national indicators show that Malaysia has largely pursued intensification while Indonesia has overwhelmingly favoured expansion. Using the framework of the Jevons paradox, this paper contributes to the existing literature by arguing how and why political and social factors, rather than technology and market incentives, can better account for the differences between yield and land use efficiency in Indonesia and Malaysia today. The paper argues that expansion in Malaysia has been curtailed by the Malaysian government's pledge to maintain at least 50% forest cover in the late 1990s, coupled with a government supported corporate strategy of establishing plantations in Indonesia. Indonesia has made no such pledge, leading to expansionist policies focused on market creation and production goals with limited incentives for technology driven intensification. It also notes however that in recent years, new socio-political developments in both countries may yet change this clear dichotomy of opposing land use strategies between these two countries, namely Sarawak's recent autonomous tendencies over land use and Indonesia's new leadership and international No Deforestation Peat and Exploitation (NDPE) commitments.

[150] B. Taniputra, C. Muluk. (1989). The Influence of Elaeidobius kamerunicus on the Yield Pattern of Elaeis quineensis at Bukit Sentang Estate, North Sumatra, Indonesia. The Planter. 65 pp 493 - 499.
Reference ID: 24476
Note: #24476e
(This journal is available in hard copy Volume 1989 Vol 3 currently in serial section in library)
Abstract: The release of *Elaeidobius kamerunicus* has changed the pollination system of oil palm. The first four year pattern of the yield Bukit Sentang was oscillating, with characteristic that the decline of the yield was coupled with the lowering of the bunch number, and the increase of the yield with increase of bunch number.
The average bunch weight was more or less doubled in comparison with that before the release of the weevil and now remains constant with the tendency that it is still increasing.
Applying extra fertilizer could not prevent the decline of bunch number.
As the yield of Bukit Sentang has now returned to the level of pre-weevil period, it can be concluded that it takes five years for the oil palm to adjust to the change of pollination system.

[151] V.O. Sadras, R.F Denison. (2016). Neither crop genetics nor crop management can be optimised. Field Crop Research. 189 pp 75 - 83.
Reference ID: 24477
Note: #24477e
Abstract: Natural selection does not lead to optimal solutions due to trade-offs and environmental variation, genetic and developmental constraints, and historical contingency. In this paper we propose that constraints like these also often apply to the improvement of both crop varieties and management practices, creating a dual biological and agronomic barrier for the optimisation of crops. We discuss constraints on optimisation of 1) crop ancestors, by natural selection, 2) crop traits, by artificial selection and biotechnology, and 3) crop management. We outline how trade-offs and environmental variation make single-factor optimisation (e.g. “optimum leaf angle” or “optimal fertiliser rate”) impossible. Definitions of “optimal” that recognise trade-offs and variability can help, but we argue there are major constraints on even those forms of optimality. Optimality theory may be useful to formulate null hypotheses, however, as divergence between actual traits and theoretical optima can highlight constraints that are biologically interesting and agronomically relevant. Understanding the nature and size of these constraints can help us map more likely pathways for future improvements in agriculture.

[152] V. Rao, I.H. Law. (1998). The Problem of Poor Fruit Set in Parts of East Malaysia. The Planter. 74(890) pp 463 - 483.
Reference ID: 24478
Note: #24478e
(This journal is available in hard copy of The Planter Vol 74 1998 in serial section of library)
Abstract: Millions of ringgit are lost annually in recent years in East Malaysia from mid-year reductions in FFB, OER and KER because of poor fruit set. The latter is due to poor pollination some five months earlier when weevil numbers are drastically low. An important cause of the population reduction appears to be increased nematode parasitism reducing weevil reproducing rates and life expectancy. Coincident scarcity of male inflorescences, the weevil breeding sites, reduces populations to levels sub-

optimal for adequate pollination.

[153] B.Z. Houlton, S.L. Morford, R.A. Dahlgren. (2018). Convergent evidence for widespread rock nitrogen sources in Earth's surface environment. Science. 360(6384) pp 58 - 62.
Reference ID: 24479
Note: #24479e
Abstract: Nitrogen availability is a pivotal control on terrestrial carbon sequestration and global climate change. Historical and contemporary views assume that nitrogen enters Earth’s land-surface ecosystems from the atmosphere. Here we demonstrate that bedrock is a nitrogen source that rivals atmospheric nitrogen inputs across major sectors of the global terrestrial environment. Evidence drawn from the planet’s nitrogen balance, geochemical proxies, and our spatial weathering model reveal that ~19 to 31 teragrams of nitrogen are mobilized from near-surface rocks annually. About 11 to 18 teragrams of this nitrogen are chemically weathered in situ, thereby increasing the unmanaged (preindustrial) terrestrial nitrogen balance from 8 to 26%. These findings provide a global perspective to reconcile Earth’s nitrogen budget, with implications for nutrient-driven controls over the terrestrial carbon sink.

[154] R. Chapman, S. Cook, C Donough, Y.L. Lim, P.V.V. Ho, K.W. Lo, T. Oberthur. (2018). Using Bayesian networks to predict future yield functions with data from commercial oil palm plantations: A proof of concept analysis. Computers and Electronics in Agriculture. 151 pp 338 - 348.
Reference ID: 24480
Note: #24480e
Abstract: Bayesian networks were used to predict yield functions from three commercial oil palm estates. The networks were trained using a range of environmental, agronomic and management data routinely collected during plantation management. The Bayesian networks predicted fruit yield (FFB), average weight of fruit bunches (ABW) and average bunch number per hectare (BUNCH_HA). Comparing the predictions of most probable yield against observed data showed the Bayesian networks were highly accurate, with r^2 values between 0.6 and 0.9. Predictions for attaining specific yield targets exceeded 75% accuracy for the FFB, 85% for the BUNCH_HA, and 90% for the ABW function. Supplementary analysis compared the precision of the Bayesian networks with artificial neural networks (ANNs), and demonstrated that the Bayesian networks gave equivalent or superior accuracy for every test. The utility of the networks were demonstrated by predicting the probability of achieving above average yield functions for each block across the three estates using a set of hypothetical rainfall and fertiliser input scenarios during the year prior to harvest. For the majority of blocks, the probability of exceeding the yield target depended on the level of fertiliser and rainfall inputs received, indicating that production from these blocks is greatly influenced by prior rainfall and fertilizer. However, some blocks in favourable areas showed a very high probability of exceeding the mean yields at all rainfall and fertiliser inputs, while a number of other blocks showed a consistently low probability of achieving the same productivity; production from these blocks will be resistant to the effects of historic rainfall and fertiliser inputs. The ability of Bayesian networks to represent future yield expectations will greatly assist managers under pressure to improve the economic and environmental sustainability of plantations. The demonstration that machine learning can extract important insight from complex datasets will have broad application in the analysis of big data collected from oil palm as well as other agricultural industries.

[155] J.V. Silva, P. Reidsma, M.L. Velasco, A.G. Laborte, M.K. van Ittersum. (2018). Intensification of rice-based farming systems in Central Luzon, Philippines: Constraints at field, farm and regional levels. Agricultural Systems. 165 pp 55 - 70.
Reference ID: 24481
Note: #24481e
Abstract: Understanding the opportunities for sustainable intensification requires an integrated assessment at field, farm and regional levels of past developments. Two hypotheses regarding current rice production in Central Luzon (Philippines) were developed for this purpose. First, we hypothesize that there are trade-offs between rice yields, labour productivity, gross margin and N use efficiency and, second, that farm(er) characteristics and socioeconomic conditions at farm and regional level affect the management practices used by farmers. These hypotheses were tested using two household surveys characterizing rice-based farming systems in Central Luzon in terms of changes over time (1966–2012) and spatial variability. Over the past half-century there was an increase in the proportion of irrigated fields and adoption of improved varieties, which allowed the cultivation of a dry season rice crop in Central Luzon. Moreover, transplanting has been replaced by direct-seeding and herbicides substituted hand-weeding. These resulted in greater rice yields and labour productivity, and contributed to gradual transition from subsistence to commercial farming systems, as observed in the increasing proportion of hired labour and rice sold. Our results indicate the existence of a trade-off between rice yields, labour productivity and N use efficiency as yield levels maximising labour productivity and N use efficiency were ca. 25% and 35% lower than climatic potential yield in the wet and dry season, respectively. At field level, this can be explained by 1) the use of transplanting as crop establishment method, which resulted into higher yields but lower labour productivity as compared to direct-seeding, and 2) the high N application levels, which led to higher yields but lower N use efficiency. In contrast, yield levels which maximised gross margin were ca. 80% of the climatic potential in both wet and dry seasons, so there was little trade-off between rice yields and economic performance. Regarding the second hypothesis results were not always conclusive. As an example, N application per ha was negatively associated with farm size and the timing of the first fertiliser application positively associated with household size and with the number of parcels. More intensive practices, and better farm performance, were recorded in the province at the heart of the irrigation system. We thus conclude that closing rice yield gaps in the production systems of Central Luzon incurs trade-offs with environmental and social objectives at field and farm levels but less with economic objectives. However, we could not clearly show whether, and to what extent, management practices used by farmers are influenced by farm or regional level constraints.

[156] A.E. Imogie, P.O. Oviasogie, B.O. Ejedegba, C.V. Udosen. (2012). Effect of Potassium (K) Source on Oil Palm Yield at Okomu Oil Palm Plc, Ovia North East L.G.A. of Edo State. International Journal of Plant Research. 2(1) pp 35 - 38.
Reference ID: 24482
Note: #24482e
Abstract: The study investigated effect of K sources on oil palm fresh fruit bunch (ffb) production at Okomu Oil Palm Plc, from 1999 to 2008. Two sources of K were evaluated at four rates. The sources of K evaluated were inorganic fertilizer Murate of Potash (MOP) at 1.0, 1.5, 2.0 and 2.5 kg/palm/year and local rock mineral that is Potassium Rock Mineral (PRM) at 1.67, 2.50, 3.33 and 4.16 kg/palm/year respectively. These were evaluated along the Control that is the zero application. The field layout

was Randomized Complete Block Design (RCBD) in four replicates. Data were collected on oil palm fresh fruit bunch (ffb) production components (mean bunch number, mean bunch weight kg / bunch and ffb production ton / ha). Data collected were subjected to analysis of variance (ANOVA) and their means were compared using New Duncan's Multiple Range Test (DMRT) at 5% level of probability. Applied K source enhanced soil nutrient status thus making the soil nutrient available for optimum oil palm ffb production over the control. The applied K source significantly P ≠ 0.05% affected ffb production. Bunch number, bunch weight and ffb production were significantly higher in palm receiving K fertilizers than the control. As rates of K application increases the ffb production also increases until what seem to be optimum rates of 2.0 K / palm / year was reached beyond which there was no significant increases in ffb production. Generally palms treated with K fertilizers in- respective of source of K fertilizer were highly significant than the control.

[157] J. Arango, D. Moreta, J. Nunez, K. Hartmann, M. Dominguez, M. Ishitani, J. Miles, G. Subbarao, M. Peters, I. Rao. (2014). Developing methods to evaluate phenotypic variability in biological nitrification inhibition (BNI) capacity of Brachiaria grasses. Tropical Grasslands. 2 pp 6 - 8.
Reference ID: 24483
Note: #24483e
Abstract: As part of the nitrogen (N) cycle in the soil, nitrification is an oxidation process mediated by microorganisms that transform the relatively immobile ammonium (NH_4+) to the water soluble nitrate (NO_3-), producing nitrous oxide (N_2O, a potent greenhouse gas) as a by-product (Can-field et al. 2010). Researchers at CIAT-Colombia, in collaboration with JIRCAS-Japan, reported that the tropical forage grass, Brachiaria humidicola, has the ability to inhibit the nitrification process by exuding chemical compounds from its roots to the soil. A major hydrophobic compound was discovered and named brachialactone (Subbarao et al. 2009). This capacity of Brachiaria grasses is known as biological nitrification inhibition (BNI) and could contribute to better N use efficiency in crop-livestock systems by improving recovery of applied N, while reducing NO_3- leaching and N_2O emissions. The current methodologies for quantifying the BNI trait need enhancement to accelerate the process of identifying differences between genotypes.
In this paper, we aim to develop new (or improve the existing) phenotyping methods for this trait. Preliminary results were obtained using 3 different methods to quantify BNI: (1) a mass spectrometry method to quantify brachialactone; (2) a static chamber method to quantify N_2O emissions from soils under greenhouse conditions; and (3) an improved molecular method to quantify microbial populations by real-time PCR (polymerase chain reaction). Using these 3 methods we expect to apply scores to a bi-parental hybrid population (n=134) of 2 B. humidicola accessions differing in their BNI capacity, CIAT 26146 (medium to low BNI) x CIAT 16888 (high BNI), in an attempt to identify QTLs (quantitative trait loci) associated with the BNI trait.

[158] S.K. Behera, B.N. Rao, K. Suresh, K. Manoja. (2014). Soil Nutrient Status and Leaf Nutrient Norms in Oil Palm (Elaeis guineensis Jacq.) Plantations Grown on Southern Plateau of India. Proceedings of the National Academy of Sciences, India. 2015 pp 1 - 7.
Reference ID: 24484
Note: #24484e
Abstract: Oil palm is a heavy feeder of nutrients and requires balanced and adequate supply of nutrients for optimum growth and yield. Information regarding soil nutrient

status and leaf nutrient concentration is very much required for proper fertilizer application. Therefore, a survey was conducted for assessment of soil nutrient status and leaf nutrient concentration in 42 oil palm (*Elaeis guineensis* Jacq) plantations in the state of Karnataka, situated in southern plateau of India. In surface soil layers, soil acidity (pH), electrical conductivity (EC) and organic carbon (OC) content ranged from 4.91 to 8.74, 0.10 to 2.54 dS m^{-1} and 1.17 to 28.9 g kg^{-1} respectively. The values of available potassium (K) (NH_4OAc–K), phosphorus (P) (Olsen-P) and exchangeable calcium (Ca) (Exch. Ca) varied from 31.2 to 386 mg kg^{-1}, 7.69 to 242 mg kg^{-1} and 156 to 1273 mg kg^{-1} respectively. The concentration of exchangeable magnesium (Mg) (Exch. Mg), available sulphur (S) ($CaCl_2$-S) and hot water soluble boron (B) (HWB) ranged from 52.8 to 307 mg kg^{-1}, 2.25 to 73.5 mg kg^{-1} and 2.29 to 16.0 mg kg^{-1} respectively. Diagnosis and recommendation integrated system (DRIS) norms were established for different nutrient expressions and it was used to compute DRIS indices. As per DRIS indices, the order of requirement of nutrients in the region was found to be K[P[nitrogen (N)[B[Mg. Optimum leaf nutrient ranges varied from 2.24 to 2.97 %, 0.08 to 0.14 % and 0.78 to 0.91 % for N, P and K respectively, from 0.74 to 1.53%, 0.25 to 0.98 % and 0.72 to 1.09% for Ca, Mg and S respectively and from 5.71 to 31.0 mg kg^{-1}, 7.42 to 12.9 mg kg^{-1}, 33.6 to 58.6 mg kg^{-1}, 82.5 to 681 mg kg^{-1} and 82.8 to 936 mg kg^{-1} for B, copper (Cu), zinc (Zn), manganese (Mn) and iron (Fe) respectively. On the basis of DRIS derived sufficiency ranges, 57, 24, 62, 3, 3, 9, 7, 5, and 26 % leaf samples were having less than optimum concentration of N, P, K. Ca, Mg, S, B, Cu and Mn respectively. The optimum ranges developed can be used as a guide for routine diagnostic and advisory purpose for balanced utilization of fertilizers.

[159] I. Cakmak. (2006). The role of potassium in alleviating detrimental effects of abiotic stresses in plants. Journal of Plant Nutrition and Soil Science. 168 pp 521 - 530.

Reference ID: 24485

Note: #24485e

Abstract: Plants exposed to environmental stress factors, such as drought, chilling, high light intensity, heat, and nutrient limitations, suffer from oxidative damage catalyzed by reactive oxygen species (ROS), e.g., superoxide radical (O_2–), hydrogen peroxide (H_2O_2) and hydroxyl radical (OH•). Reactive O_2 species are known to be primarily responsible for impairment of cellular function and growth depression under stress conditions. In plants, ROS are predominantly produced during the photosynthetic electron transport and activation of membrane-bound NAD(P)H oxidases. Increasing evidence suggests that improvement of potassium (K)-nutritional status of plants can greatly lower the ROS production by reducing activity of NAD(P)H oxidases and maintaining photosynthetic electron transport. Potassium deficiency causes severe reduction in photosynthetic CO_2 fixation and impairment in partitioning and utilization of photosynthates. Such disturbances result in excess of photosynthetically produced electrons and thus stimulation of ROS production by intensified transfer of electrons to O_2. Recently, it was shown that there is an impressive increase in capacity of bean root cells to oxidize NADPH when exposed to K deficiency. An increase in NADPH oxidation was up to 8-fold higher in plants with low K supply than in K-sufficient plants. Accordingly, K deficiency also caused an increase in NADPH dependent O_2• – generation in root cells. The results indicate that increases in ROS production during both photosynthetic electron transport and NADPH-oxidizing enzyme reactions may be involved in membrane damage and chlorophyll degradation in K-deficient plants. In good agreement with this suggestion, increases in severity of K deficiency were associated with enhanced activity of

enzymes involved in detoxification of H_2O_2 (ascorbate peroxidase) and utilization of H_2O_2 in oxidative processes (guaiacol peroxidase). Moreover, K-deficient plants are highly light-sensitive and very rapidly become chlorotic and necrotic when exposed to high light intensity. In view of the fact that ROS production by photosynthetic electron transport and NADPH oxidases is especially high when plants are exposed to environmental stress conditions, it seems reasonable to suggest that the improvement of K-nutritional status of plants might be of great importance for the survival of crop plants under environmental stress conditions, such as drought, chilling, and high light intensity. Several examples are presented here emphasizing the roles of K in alleviating adverse effects of different abiotic stress factors on crop production.

[160] G. Danyo. (2013). Commercial Oil Palm Cultivation in Ghana: An Outline. ProJournal of Agricultural Science Research (PASR). pp 22 - 42.
Reference ID: 24486
Note: #24486e
Abstract: An outline of commercial cultivation of oil palm in Ghana was carried out, to highlight the key operations in commercial cultivation of oil palm, policy interventions of central governments, constraints and prospects of commercial oil palm cultivation in Ghana. The African oil palm (*Elaeis guineensis* Jacq.) is the most important member of the genus Elaeis in terms of production and economic yield. An estimated total land area of 305, 758 hectares is under oil palm cultivation in Ghana. Oil palm growth and yield are influenced by factors such as the quality of planting material, soil type and method of land preparation (zero-burning), crop spacing (plant population density), weed, pest and disease management as well as crop nutrition. Commercial production is restricted predominantly to the forest zones whose climates are ecologically suitable for oil palm cultivation. Three major scales of production are recognized in the commercial oil palm cultivation in Ghana: (1) Large industrial plantations with large-scale processing mills and a network of smallholder and out-grower farmers; (2) Medium-scale plantations with medium-scale industrial mills with a network of out-growers; and (3) Small private farmers cultivating less than 10 hectares. The industry is supported with scientific research and technical innovations by the Oil Palm Research Institute of the Council for Scientific and Industrial Research. The prospects of oil palm cultivation to Ghana's socio-economic advancement are greater than presently appreciated, if more investments (capital input, prioritized research, and appropriate policy interventions) are made into its cultivation and industry by governments and corporate bodies alike There are, however, pertinent socio-economic and environmental issues that if not addressed, may hinder future commercial oil palm plantation development in Ghana.

[161] H. Gan, Y. Jiao, J. Jia, X. Wang, H. Li, W. Shi, C. Peng, A. Polie, Z.-B. Luo. (2015). Phosphorus and nitrogen physiology of two contrasting poplar genotypes when exposed to phosphorus and/or nitrogen starvation. Tree Physiology. 36 pp 22 - 38.
Reference ID: 24487
Note: #24487e
Abstract: Phosphorus (P) and nitrogen (N) are the two essential macronutrients for tree growth and development. To elucidate the N physiology of woody plants during acclimation to P and/or N starvation, we exposed saplings of slow-growing Populus simonii Carr (Ps) and the fast-growing Populus x euramericana Dode (Pe) to complete nutrients or starvation of P, N or both elements (NP).

[162] Ministry of Agriculture and Co-operatives. (2010). Good Agricultural Practices for Oil Palm. Royal Gazette. Thailand. pp 1 - 26.
Reference ID: 24488
Note: #24488e
Abstract: Oil palm is one of the potential tree crops grown in Thailand and oil palm bunches can be used as raw materials in the process of palm oil production as a form of safe edible vegetable oil used in many food and non-food products. The Agricultural Standards Committee deems it necessary to establish the standard for Good Agricultural Practices for Oil Palm to be used as guidance for oil palm growers.

[163] S.K. Behera, K. Suresh, B.N. Rao, K. Manoja, K. Manorama. (2016). Soil Nutrient Status and Leaf Nutrient Norms in Oil Palm (*Elaeis Guineensis* Jacq.) Plantations Grown in the West Coastal Area of India. Communications in Soil Science and Plant Analysis. 47(2) pp 255 - 262.
Reference ID: 24489
Note: #24489e
Abstract: Oil palm (*Elaeis guineensis* Jacq.) is a heavy feeder of nutrients and requires balanced and adequate supply of nutrients for optimum growth and yield. Information regarding soil nutrient status and leaf nutrient concentration is very much required for proper fertilizer application. Therefore, a survey was conducted for assessment of soil nutrient status and leaf nutrient concentration in 64 oil palm plantations in the state of Goa lying in the west coastal region of India.

[164] Z. Rengel. (2003). Handbook of Soil Acidity. Secondary Handbook of Soil Acidity. Marcel Dekker Inc. USA. pp 1 - 479.
Reference ID: 24490
Note: #24490e

[165] I.A.G.E. Herrera Peña. 2015. Obtención del sistema de diagnóstico y recomendación integral (DRIS) en el cultivo de Palma de aceite (*Elaeis guineensis* Jacq.): Obtaining the system of diagnosis and integral recommendation (DRIS) in the cultivation of oil palm (*Elaeis guineensis* Jacq.). pp 1 - 179. Universidad Nacional de Colombia.
Reference ID: 24491
Note: #24491e
Abstract: El diagnostico nutricional a partir de anális is de tejido foliar y de suelos es un instrumento eficiente para detectar desequilibrios nutricionales y ayudar en el proceso de recomendación de fertilizantes. Así, se tuvo por objetivo la utilización de esta información para la implementación del Sistema Integrado de Diagnóstico y Recomendación (DRIS), método que utilizada las relaciones entre nutrientes y sus respectivos coeficientes de variación, en una población de alta productividad, constituyendo las normas. En el presente trabajo fueron desarrolladas las normas e índices DRIS, en el cultivo de Palma de aceite, hibrido IRHO en la región central palmera de Colombia. El orden decreciente de las limitantes por deficiencia para concentraciones en tejido foliar es Fe>Zn>S>P>Cl>Mg>B>Na>K>Ca>Cu=Mn>N y para concentraciones de elementos en suelo es Cu>B>Mn=Mg>Al=Na>S>Fe=Ca=N=K>P>Zn, de igual manera fueron calculados los nivele s críticos y las franjas de suficiencia con base a los índices DRIS. Con el propósitode obtener mayor confiabilidad en la obtención de los DRIS, previamente se analizó la variabilidad espacial de las diferentes propiedades evaluadas; lo cual permitió su utilidad para la determinación de unidades de manejo mediante el uso del

análisis clúster y por componentes principales.

Abstract: Nutritional diagnosis through tissue analysis and soil fertility test is an efficient tool to identify nutritional imbalances, and in that way, to help in the fertilizers recommendation process. The main goal of the study was to implement a Diagnosis and Recommendation Integrated System (DRIS). This analytical method utilizes the relationships among nutrients rather than nutrient concentration themselves, their coefficient of variation, and it is usually established in highly productive populations as norm. Noms and DRIS index for oil palm IRHO in the Central Region of Colombia were developed in the present study. Nutrient deficiency in tissue samples was observed following the decreasing pattern described below: Fe>Zn>S>P>Cl>Mg>B>Na>K>Ca>Cu=Mn>N. Nutrient deficiency in soil showed the following trend: Cu>B>Mn=Mg>Al=Na>S>Fe=Ca=N=K>P>Zn. Critical levels and sufficient ranges were calculated based on DRIS index. Spatial variation of the evaluated patterns was calculated previously in order to improve reliability of the DRIS analysis. Such information also allowed for identification of management units through Cluster Analysis and Principal Component Analysis

[166] P. Hormaza, Fuquen. E.M., H.M. Romero. (2012). Phenology of the oil palm interspecific hybrid *Elaeis oleifera* x *Elaeis guineensis*. Scientia Agricola. 69(4) pp 275 - 280.
Reference ID: 24492
Note: #24492e
Abstract: Oil palm is one of the most important oil crops in the world. Because of its high productivity and perennial nature, it has been expanding quickly. Commercial plantations consist mostly of the African palm *E. guineensis* Jacq. However, producers in Latin America are increasingly planting the O × G interspecific hybrid, a cross between African palm (*E. guineensis*) and the American palm (*E. oleifera* (Kunth) Cortés). This interspecific hybrid has emerged as a promising solution to diseases such as the bud rot of oil palm because of the apparent partial resistance of this genotype to the disease. This work studied and described the phenology of the O × G interspecific hybrid. The phenology stages were coded using the BBCH scale. The scale for the phenophases was defined using a three-digit code. Due to the nature of the palm, no descriptions were used for stage two (formation of side shoots/tillering) and stage four (development of harvestable vegetative plant parts or vegetative reproductive organs) because these stages do not apply to oil palm. The scale was constructed using germinating seeds, pre-nursery and nursery plants and five year-old palms. For the description of the stem elongation, different age palms of the same O × G hybrid were used. Observations were performed during an 18-month period. Additionally, the interval for the change from one phenology stage to another was determined both in days and degree-days (DD). The interspecific O × G hybrid required 6408 DD from when the spear leaf unfolds until the bunch was ripened and harvested, and 4427.6 DD from leaf unfolding to anthesis.

[167] M. Wang, Q. Zheng, Q. Shen, S. Guo. (2013). The Critical Role of Potassium in Plant Stress Response. International Journal of Molecular Science. 14 pp 7370 - 7390.
Reference ID: 24493
Note: #24493e
Abstract: Agricultural production continues to be constrained by a number of biotic and abiotic factors that can reduce crop yield quantity and quality. Potassium (K) is an

essential nutrient that affects most of the biochemical and physiological processes that influence plant growth and metabolism. It also contributes to the survival of plants exposed to various biotic and abiotic stresses. The following review focuses on the emerging role of K in defending against a number of biotic and abiotic stresses, including diseases, pests, drought, salinity, cold and frost and waterlogging. The availability of K and its effects on plant growth, anatomy, morphology and plant metabolism are discussed. The physiological and molecular mechanisms of K function in plant stress resistance are reviewed. This article also evaluates the potential for improving plant stress resistance by modifying K fertilizer inputs and highlights the future needs for research about the role of K in agriculture.

[168] K+S Kali GmbH. (2013). The importance of magnesium in the production of palm oil. Secondary The importance of magnesium in the production of palm oil. pp 1 - 5.
Reference ID: 24494
Note: #24494e
Abstract: Oil palm has a high Mg requirement which even exceeds that of P. Today, the target of high palm oil yields cannot be realized without adequate supply of this essential macronutrient, especially on the sizeable and generally Mg deficient replanting areas in Malaysia.

[169] K. Kouame, B. Camara, B. Kone, K. Ballo, D. Sekou, S. Ake. (2017). Bibliographical Review About Mineral Nutrition and Fertilization of Palm Tree (*Elaeis guineensis* Jacq.) at Production Stage. International Journal of Agriculture and Environmental Research. 3(1) pp 2040 - 2064.
Reference ID: 24495
Note: #24495e
Abstract: The stage of production preceding is characterized by the production of the palm plantation. During the exploitation, fertilization allows the palm tree to express its full potential for sustainable production. This work made it possible to take stock of the knowledge on the nutrition and the fertilization of the oil palm through the major production zones, and especially the consequences of the uncontrolled use of fertilizers on the environment. From the start of production, fertilization is driven by an annual intake of potassium, the dose of which is established by foliar diagnosis, used as the main method of studying the mineral nutrition. The doses applied vary according to the different production zones. For a necessary balance of all mineral elements, phosphate, nitrogen and magnesium fertilizers are applied to certain types of soil for a better expression of the production potential of the material used. The main stages of fertilizer application are: fertilizer selection, determination of doses, dates and methods of application. Fertilization makes it possible to obtain a surplus value at least equal to three times the expenditure granted when they are brought in quantity and balance. Because uncontrolled use of fertilizers acts dangerously on the environment, water, humans, soil and greatly reduces biodiversity. The cultivation of oil palms, with the advent of hybrids and a rational fertilization policy, can be a better tool for the development and improvement of the living standards of small rural farmers in the tropical world, the main component of the production chain.

[170] H. Muhammad Asraf, N.W. Md Tahir, S.B. Shah Rizam, R. Abdullah. (2012). Elaeis Guineensis Nutritional Lacking Identification based on Statistical Analysis and Artificial Neural Network. Recent Advances in System Science and Mathematical Modelling. pp 1 - 6.
Reference ID: 24496
Note: #24496e
Abstract: In this study, nutritional disease classification of *Elaeis guineensis* or widely known as oil palm is discussed. At present, nitrogen, potassium, magnesium are the main category nutrition deficient prevalent in oil palm plantation and these deficiencies can be identified based on the affected leaves surface appearance. Hence in this work, an alternative method based on image processing technique is proposed for identification of nutritional lacking in *Elaeis guineensis*. Firstly, twenty seven features are extracted from three main groups that represent the *Elaeis guineensis* leaf surface images namely RGB color features, RGB histogram based texture features as well as gray level co-occurrence matrix attributes. Next, feature selection via ANOVA and Multiple Comparison Procedure is conducted. Further, to verify the effectiveness of feature extraction and feature selection done, ANN is chosen as classifier. Initial findings based on classification accuracy attained confirm that the proposed method is capable to categorize nutritional lacking in *Elaeis guineensis* with above 83% success rate prior to statistical analysis and over 86% with ANOVA as subset selection.

[171] B.N. Kaiser, K.L. Gridley, J.N. Brady, T. Phillips, S.D. Tyerman. (2005). The Role of Molybdenum in Agricultural Plant Production. Annals of Botany. pp 745 - 754.
Reference ID: 24497
Note: #24497e
Abstract:
- *Background* The importance of molybdenum for plant growth is disproportionate with respect to the absolute amounts required by most plants. Apart from Cu, Mo is the least abundant essential micronutrient found in most plant tissues and is often set as the base from which all other nutrients are compared and measured. Molybdenum is utilized by selected enzymes to carry out redox reactions. Enzymes that require molybdenum for activity include nitrate reductase, xanthine dehydrogenase, aldehyde oxidase and sulfite oxidase.
- *Scope* Loss of Mo-dependent enzyme activity (directly or indirectly through low internal molybdenum levels) impacts upon plant development, in particular, those processes involving nitrogen metabolism and the synthesis of the phytohormones abscisic acid and indole-3 butyric acid. Currently, there is little information on how plants access molybdate from the soil solution and redistribute it within the plant. In this review, the role of molybdenum in plants is discussed, focusing on its current constraints in some agricultural situations and where increased molybdenum nutrition may aid in agricultural plant development and yields.
- *Conclusions* Molybdenum deficiencies are considered rare in most agricultural cropping areas; however, the phenotype is often misdiagnosed and attributed to other downstream effects associated with its role in various enzymatic redox reactions. Molybdenum fertilization through foliar sprays can effectively supplement internal molybdenum deficiencies and rescue the activity of molybdoenzymes. The current understanding on how plants access molybdate from the soil solution or later redistribute it once in the plant is still unclear; however, plants have similar physiological molybdenum transport phenotypes to those found in prokaryotic systems. Thus, careful analysis of existing prokaryotic molybdate transport

mechanisms, as well as a re-examination of know anion transport mechanisms present in plants, will help to resolve how this important trace element is accumulated.

[172] F.A.A. Mourão Filho. (2004). DRIS: Concepts and Applications on Nutritional Diagnosis in Fruit Crops: DRIS: CONCEITOS E APLICAÇÕES NA DIAGNOSE NUTRICIONAL EM PLANTAS FRUTÍFERAS. Scientia Agricola. Brazil. pp 550 - 560.
Reference ID: 24498
Note: #24498e
Abstract: Nutrition and fertilization are important factors in determining fruit yield and fruit quality. There are several methods for plant nutritional status diagnosis, among them, two are relevant and named as Sufficiency Range Approach (SRA) and Diagnosis and Recommendation Integrated System (DRIS). This research reports the main concepts and applications of DRIS in nutritional diagnosis of fruit crops, comparing it with current nutritional diagnosis methods, indicating advantages and disadvantages, and possible limitations to be investigated.

Resumo: A nutrição e a adubação são fatores determinantes na produtividade dos pomares e na qualidade de frutos. Dentre os diversos métodos de diagnose nutricional das plantas, destacam-se o critério de faixas de suficiência (CFS) e o sistema integrado de diagnose e recomendação (DRIS – “Diagnosis and Recommendation Integrated System”). São relatados neste trabalho os principais conceitos e aplicações do método DRIS na diagnose nutricional em fruteiras, comparando-o com os sistemas atuais de diagnose nutricional, apontando vantagens e desvantagens, e possíveis limitações a serem investigadas.

[173] S.R. Noack. 2014. Crop residue phosphorus: Speciation and release in cropping soils. Agriculture. Australia. Doctor of Philosophy. pp 1 - 111. University of Adelaide.
Reference ID: 24499
Note: #24499e
Abstract: Crop residues remaining after grain harvest are an important potential source of nutrients, including phosphorus (P), to the cropping system. Crop residues contain both inorganic and organic forms of P and these forms may take different pathways into soil P pools. The rate and quantity of residue P released depends partly on the specific P compounds in the residues. The most commonly used measure of P in crop residues is total P, followed by separate measurement of inorganic P and organic P. These measures do not speciate residue P into specific compounds and consequently, residue P dynamics in soils remains poorly understood.

[174] J.C. Obi, B.T. Udoh. (2012). Nutrient Budget for Optimal Oil Palm (*Elaeis guineensis* Jacq) Yield on Coastal Plain Sands Soils of Akwa Ibom State Nigeria. Open Journal of Soil Sciences. 2 pp 289 - 298.
Reference ID: 24500
Note: #24500e
Abstract: The objective of the study was to establish approximate relationships between yield and soil nutrients in oil palm production. The study was conducted in Nigerian Institute for Oil Palm Research (NIFOR) substation Ibesit ekoi in Oruk Anam Local Government Area of Akwa Ibom State Nigeria. Soil, rainfall and yield data were collected from oil palm plantation established 49, 29, 9 and 0 (control) years ago in an area underlain by coastal plain sands. Descriptive statistics, analysis of variance and multiple stepwise regression analysis were used to study variations, effect of land use on soil properties at different depths and contributions of various soil nutrients at

different depths to the yield (fresh fruit bunch 'FFB' and palm oil) of oil palm. Results of coefficient of variability revealed that approx. 45.5% of the variables were highly variable including available phosphorus, extractable zinc, FFB and palm oil, while others were either least or moderately variable. Oil palm trees influenced soil development with its effect on silt content at 30 - 60 cm depth. Uptake of phosphorus in oil palm land use system decreases with depth. This was further confirmed by the relative contribution of available phosphorus to FFB yield that decreased from the surface of the soil downwards. Extractable zinc contents of oil palm land use were not significantly different from each other (ranging between 9.65 $mg \cdot kg^{-1}$and 7.84 $mg \cdot kg^{-1}$) but significantly different from the control (23.99 $mg \cdot kg^{-1}$). In the modeling process, it was observed that the absolute contribution of texture was minimal while exchangeable sodium was highest (i.e. 66.5%) in the quantity of oil palm production. Also extractable copper and zinc were found to have made large contributions to FFB and oil palm. Oil palm (*Elaeis guineensis*) is a high-yielding source of edible and technical oils but requires proper knowledge and precise administration of nutrient demands for management of a major production constraint which is soil fertility

[175] R.H.M. Op den Camp, E. Polone, E. Fedorova, W. Roelofsen, A. Squartini, H.J.M. Op den Camp, T. Bisseling, R. Geurts. (2012). Nonlegume *Parasponia andersonii* Deploys a Broad Rhizobium Host Range Strategy Resulting in Largely Variable Symbiotic Effectiveness. Molecular Plant-Microbe Interactions. 25(7) pp 954 - 963.
Reference ID: 24501
Note: #24501e
Abstract: The non-legume genus *Parasponia* has evolved the rhizobium symbiosis independent from legumes and has done so only recently. We aim to study the promiscuity of such newly evolved symbiotic engagement and determine the symbiotic effectiveness of infecting rhizobium species. It was found that *Parasponia andersonii* can be nodulated by a broad range of rhizobia belonging to four different genera, and therefore, we conclude that this non-legume is highly promiscuous for rhizobial engagement. A possible drawback of this high promiscuity is that low-efficient strains can infect nodules as well. The strains identified displayed a range in nitrogen-fixation effectiveness, including a very inefficient rhizobium species, *Rhizobium tropici* WUR1. Because this species is able to make effective nodules on two different legume species, it suggests that the ineffectiveness of *P. andersonii* nodules is the result of the incompatibility between both partners. In *P. andersonii* nodules, rhizobia of this strain become embedded in a dense matrix but remain vital. This suggests that sanctions or genetic control against underperforming microsymbionts may not be effective in *Parasponia* spp. Therefore, we argue that the Parasponia-rhizobium symbiosis is a delicate balance between mutual benefits and parasitic colonization.

[176] L. Pardon, C. Bessou, N. Saint-Geours, B. Gabrielle, N. Khasanah, J.P. Caliman, .P. Nelson. (2016). Quantifying nitrogen losses in oil palm plantations: models and challenges. Biogeosciences. 13 pp 5433 - 5452.
Reference ID: 24502
Note: #24502e
Abstract: Oil palm is the most rapidly expanding tropical perennial crop. Its cultivation raises environmental concerns, notably related to the use of nitrogen (N) fertilisers and the associated pollution and greenhouse gas emissions. While numerous and diverse models exist to estimate N losses from agriculture, very few are currently available for tropical perennial crops. Moreover, there is a lack of critical analysis of their

performance in the specific context of tropical perennial cropping systems. We assessed the capacity of 11 models and 29 sub-models to estimate N losses in a typical oil palm plantation over a 25-year growth cycle, through leaching and runoff, and emissions of NH_3, N_2, N_2O, and NO_3. Estimates of total N losses were very variable, ranging from 21 to 139 kg Nha^{-1} yr^{-1}. On average, 31% of the losses occurred during the first 3 years of the cycle. Nitrate leaching accounted for about 80% of the losses. A comprehensive Morris sensitivity analysis showed the most influential variables to be soil clay content, rooting depth, and oil palm N uptake. We also compared model estimates with published field measurements. Many challenges remain in modelling processes related to the peculiarities of perennial tropical crop systems such as oil palm more accurately.

[177] C. Plassard, B. Dell. (2010). Phosphorus nutrition of mycorrhizal trees. Tree Physiology. 30 pp 1129 - 1139.
Reference ID: 24503
Note: #24503e
Abstract: Globally, phosphorus (P) limits productivity of trees in many forests and plantations especially in highly weathered, acidic or calcareous profiles. Most trees form mycorrhizal associations which are prevalent in the organic and mineral soil horizons. This review critically examines mechanisms that enhance the acquisition of P by tree roots. Mycorrhizal roots have a greater capacity to take up phosphate (Pi) from the soil solution than non-mycorrhizal root tips. Factors that contribute to this include the extent of extraradical hyphal penetration of soil and the physiology and biochemistry of the fungal/soil and fungal/plant interfaces. Ectomycorrhizal (ECM) trees are likely to benefit from association with basidiomycetes that possess several high-affinity Pi transporters that are expressed in extraradical hyphae and whose expression is enhanced by P deficiency. To understand fully the role of these putative transporters in the symbiosis, data regarding their localization, Pi transport capacities and regulation are required. Some ECM fungi are able to effect release of Pi from insoluble mineral P through excretion of low molecular-weight organic anions such as oxalate, but the relative contribution of insoluble P dissolution in situ remains to be quantified. How the production of oxalate is regulated by nitrogen remains a key question to be answered. Lastly, phosphatase release from mycorrhizas is likely to play a significant role in the acquisition of Pi from labile organic forms of P (Po). As labile forms of Po can constitute the major fraction of the total P in some tropical and temperate soils, a greater understanding of the forms of Po available to the phosphatases is warranted.

[178] N.E. Prabowo, H.L. Foster, S. Nelson, B. Sitepu, P. Nelson. (2012). Practical use of oil palm nutrient physiological efficiency with regard to nutrient recovery and agronomic efficiencies at different Sumatran sites. International Oil Palm Conference, 26-28 September 2012, Cartagena, Colombia. pp 1 - 19.
Reference ID: 24504
Note: #24504e
Abstract: The results from seven North and South Sumatra oil palm field fertiliser trials, which were recorded from 1994-2009, were used to study nutrient uptake and efficiencies. The different trial sites allowed effects of different soil properties and climate (rainfall) on dry matter production and yield to be investigated. Additional information was also assessed from two nursery trials to support the field trial results. The results showed that the nutrient recovery efficiency (RE), which is defined as palm nutrient uptake per unit of given nutrient is subject to variation in site properties.

However, the field and nursery trial results demonstrated that the physiological efficiency (PE), or yield increment per unit of nutrient uptake of oil palm, at a particular age and planting material, remains relatively constant over a range of environments. The increased yield per unit of given fertiliser known as agronomic efficiency (AE) is therefore solely dependent upon the RE for a specific planting material. However, a nursery fertiliser showed variation for dry matter production for the same unit of nutrient uptake. Assuming the current daily field management practices have been developed to meet optimal RE and yield then agronomists are able to assess PE of different oil palm planting materials to screen the most suitable for different environments. From a practical point of view agronomists can predict potential yield based on dry matter production which can be helpful in determining the oil palm fertiliser requirement. PE results can also be used to identify and evaluate problem fields in oil palm plantations.

[179] IPNI SEAP. (2015). An Introduction IPNI Best Management Practice (BMP) Process Supported by Plantation Intelligence & Estate-Scale Experimentation: Sustainable Intensification - Reduced yield gaps, increased oil yields. Secondary An Introduction IPNI Best Management Practice (BMP) Process Supported by Plantation Intelligence & Estate-Scale Experimentation: Sustainable Intensification - Reduced yield gaps, increased oil yields. IPNI. pp 1 - 24.
Reference ID: 24505
Note: #24505e
Abstract: Commercially cultivated oil palm has the potential to yield up to 11 tons of crude palm oil (CPO) per hectare. Yet CPO yield in Malaysia and Indonesia—the source of more than 85% of global production—averages between 3 and 4 tons per hectare, with the best private plantation groups achieving 6–7 tons per hectare. As terms of trade deteriorate and expansion through rapid land acquisition becomes unsustainable, finding new ways to raise productivity has become a key agenda for CPO producers. Best Management Practice (BMP) —a diverse set of plantation management practices that draw on in-field experiments to derive customized intervention activities—has been put forth as a most viable strategy going forward. The idea is that by understanding existing “yield gaps” and investigating them as opportunities for intensification, a CPO producer will be able to progressively achieve higher yields and maximize the potential of its crop.

[180] R.A. Syed, A. Saleh. (1988). Population of Elaeidobius kamerunicus FST. in Relation to Fruitset. International Oil Palm/Palm Oil Conferences: Progress and Prospects. Conference I: Agriculture. pp 528 - 534.
Reference ID: 24506
Note: #24506e > S 8.1.1 #11333
Abstract: Since the introduction of Elaeidobius kamerunicus in South-east Asia the question of the level of population of the weevils on anthesising male inflorescences required for adequate pollination has remained unanswered. The studies reported in this article indicate that about 1500 weevils available on anthesising male flowers to pollinate each receptive female inflorescence may provide between 50 to 60 percent fruitset. For about 70 percent fruitset about 3000 weevils should be available.

[181] ICCO, International Cocoa Organization. (2017). The International Symposium on Cocoa Research (ISCR 2017): Promoting Advances in Research to Enhance the Profitability of Cocoa Farming, 13-17 November 2017, Lima, Peru. The International Symposium on Cocoa Research (ISCR 2017). Lima, Peru.
Reference ID: 24507
Note: #24507e
(note: in folder containing conference paper from proceedings)

[182] H. Rennenberg, C. Herschbach. (2013). Phosphorus nutrition of woody plants: many questions – few answers. Plant Biology. 2013 pp 1 - 4.
Reference ID: 24508
Note: #24508e
Abstract: Phosphorus (P) acquisition, cycling and use efficiency has been investigated intensively with herbaceous plants. It is known that local as well as systemic signalling contributes to the control of P acquisition. Woody plants are long-lived organisms that adapt their life cycle to the changing environment during their annual growth cycle. Little is known about P acquisition and P cycling in perennial plants, especially regarding storage and mobilisation, its control by systemic and environmental factors, and its interaction with the largely closed ecosystem-level P cycle. The present report presents a view on open questions on plant internal P cycling in woody plants.

[183] B. Samedani, A.S. Juraimi, S.A.S. Abdullah, M.Y. Rafii, A.A. Rahim, M.P. Anwar. (2014). Effect of Cover Crops on Weed Community and Oil Palm Yield. International Journal of Agriculture & Biology. 16 pp 23 - 31.
Reference ID: 24509
Note: #24509e
Abstract: Sustainable weed management in oil palm plantation has been a challenge now a day. Weed suppression by cover cropping is considered as a viable alternative to herbicidal control. This study0020was, therefore, conducted during 2010-2012 in a Malaysia oil palm plantation to characterize oil palm weed communities and evaluate oil palm yield under four different perennial cover-crop systems. Experimental treatments included four different cover crop combinations such as *Axonopus compressus*, *Calopogonium caeruleum* + *Centrosema pubescens*, *Mucuna bracteata*, *Pueraria javanica* + *Centrosema pubescens*, and herbicidal control by glufosinate-ammonium and weedy control. Weed composition in the un-weeded treatment was different from that of cover crop treatments. The un-weeded treatment favored *Paspalum conjugatum* and *A. compressus* as the dominant species. In the *A. compressus* and *C. caeruleum* + *C. pubescens* treatments the associated weed species with highest dominance was *Asystasia gangetica*, while the weeds *A. compressus* and *A. gangetica* were associated with M. bracteata and *P. javanica* + *C. pubescens* treatments. In the weeded treatment receiving 6 sprays of glufosinateammonium over the two years, *B. latifolia* was dominant. The *A. compressus* cover treatment had the lowest species richness and diversity. Weeded plots had lowest yield, bunch number tree-1 and bunch weight during the 18-24 MAP. The study confirms variation in weed community in oil palm plantation under different cover-crop systems and thus, contributes to improving current understanding of weed community structures and may help formulate sustainable weed management strategy for oil palm plantation.

[184] J. Shen, L. Yuan, J. Zhang, H. Li, Z. Bai, X. Chen, W. Zhang, F. Zhang. (2011). Phosphorus Dynamics: From Soil to Plant. Plant Physiology. 156 pp 997 - 1005.
Reference ID: 24510
Note: #24510e
Abstract: With increasing demand of agricultural production and as the peak in global production will occur in the next decades, phosphorus (P) is receiving more attention as a non-renewable resource (Cordell et al., 2009; Gilbert, 2009). One unique characteristic of P is its low availability due to slow diffusion and high fixation in soils. All of this means that P can be a major limiting factor for plant growth. Applications of chemical P fertilizers and animal manure to agricultural land have improved soil P fertility and crop production, but caused environmental damage in the past decades. Maintaining a proper P-supplying level at the root zone can maximize the efficiency of plant roots to mobilize and acquire P from the rhizosphere by an integration of root morphological and physiological adaptive strategies. Furthermore, P uptake and utilization by plants plays a vital role in the determination of final crop yield. A holistic understanding of P dynamics from soil to plant is necessary for optimizing P management and improving P-use efficiency, aiming at reducing consumption of chemical P fertilizer, maximizing exploitation of the biological potential of root/rhizosphere processes for efficient mobilization, and acquisition of soil P by plants as well as recycling P from manure and waste. Taken together, overall P dynamics in the soil plant system is a function of the integrative effects of P transformation, availability, and utilization caused by soil, rhizosphere, and plant processes. This update focuses on the dynamic processes determining P availability in the soil and in the rhizosphere, P mobilization, uptake, and utilization by plants. It highlights recent advances in the understanding of the P dynamics in the soil/rhizosphere-plant continuum.

[185] C.C. Sim, A.R. Zaharah. (2015). Potassium Uptake Kinetics by Oil Palm Root via Radiotracer Techniques. Asian Journal of Plant Sciences. 2015 pp 1 - 3.
Reference ID: 24511
Note: #24511e
Abstract: Rubidium is widely used as a tracer for potassium in many physiological studies because its physicochemical properties are similar to potassium. The usage of rubidium as tracer are often used with caution as several plant species were able to selectively acquire potassium over rubidium. However, its usage depends on the non-selective absorption of potassium and rubidium by the plant.

[186] S.K. Behera, B.N. Rao, K. Suresh. (2017). Soil Health Management in Oil Palm. pp 115 - 144.
Reference ID: 24512
Note: #24512e
Abstract: In India, oil palm is the highest edible oil yielding perennial crop producing two types of oil i.e., crude palm oil and palm kernel oil, which are used for domestic and industrial purposes. It produces about 4 to 6 tonnes of crude palm oil and 0.4 to 0.6 tonnes of palm kernel oil per hectare per year during its productive life span from 4th to 30th years. Seeing its potential, Government of India has given emphasis to expand the area under oil palm cultivation to meet the ever increasing vegetable oil demand of the country and reduce the expenditure on import of vegetable oils. At present, about 2.68 lakh ha area is under oil palm cultivation in India and the country has the potential for cultivation of oil palm in 19.30 lakh ha area spreading over nineteen states (Rethinam et al., 2012).

[187] G.V. Subbarao, I.M. Rao, K. Nakahara, Y. Ando, K.L. Sahrawat, T. Tesfamariam, J.C. Lata, S. Boudsocq, J.W. Miles, M. Ishitani, M. Peters. (2013). Nitrogen management in grasslands and forage-based production systems – Role of biological nitrification inhibition (BNI). Tropical Grasslands – Forrajes Tropicales. 1 pp 168 - 174.
Reference ID: 24513
Note: #24513e
Abstract: Nitrogen (N), the most critical and essential nutrient for plant growth, largely determines the productivity in both extensive and intensive grassland systems. Nitrification and denitrification processes in the soil are the primary drivers of generating reactive N (NO_3-, N_2O and NO), largely responsible for N loss and degradation of grasslands. Suppressing nitrification can thus facilitate retention of soil N to sustain long-term productivity of grasslands and forage-based production systems. Certain plants can suppress soil nitrification by releasing inhibitors from roots, a phenomenon termed 'biological nitrification inhibition' (BNI). Recent methodological developments [e.g. bioluminescence assay to detect biological nitrification inhibitors (BNIs) from plant-root systems] led to significant advances in our ability to quantify and characterize BNI function in pasture grasses. Among grass pastures, BNI capacity is strongest in low-N environment grasses such as *Brachiaria humidicola* and weakest in high-N environment grasses such as Italian ryegrass (*Lolium perenne*) and *B. brizantha*. The chemical identity of some of the BNIs produced in plant tissues and released from roots has now been established and their mode of inhibitory action determined on nitrifying Nitrosomonas bacteria. Synthesis and release of BNIs is a highly regulated and localized process, triggered by the presence of NH_4+ in the rhizosphere, which facilitates release of BNIs close to soil-nitrifier sites. Substantial genotypic variation is found for BNI capacity in *B. humidicola*, which opens the way for its genetic manipulation. Field studies suggest that Brachiaria grasses suppress nitrification and N_2O emissions from soil. The potential for exploiting BNI function (from a genetic improvement and a system perspective) to develop production systems, that are low-nitrifying, low N_2O-emitting, economically efficient and ecologically sustainable, is discussed.

[188] C. B. S. Teh. (2016). Availability, use, and removal of oil palm biomass in Indonesia. Internation Council on Clean Transportation. Malaysia. pp 1 - 39.
Reference ID: 24514
Note: #24514e
Abstract: Oil palm is Indonesia's largest source of agriculture biomass. In 2013, Indonesia is estimated to have produced 570 mil. t of oil palm biomass, among which 299 mil. t is OPF (oil palm fronds), 134 mil. t is OPT (oil palm trunk), and 28 mil. t is EFB (empty fruit bunches). This biomass are conventionally applied in the oil palm plantations as soil mulch and fertilizer. This is because they contain large quantities of nutrients, and decomposition studies have shown that these biomass can fully decompose in the field within one to two years (two to three years for OPT), during which the nutrients stored in the biomass are released in a gradual manner into the soil. How fast and how much of these nutrients are released depend on how much biomass is applied in the field, how easily decomposable the biomass is, and how much nutrients the biomass contains. How the biomass is processed for mulching is also important. The industrial process of converting the EFB into a carpet-like material known as Ecomat (ECO), for instance, would effectively reduce the bulk volume of EFB, but at the cost of losing 30 to 70% of the nutrients in the EFB and owering the rate of decomposition. In contrast, OPT's much slower decomposition rate can be

hastened by chopping or shredding the OPT into smaller pieces. This would increase the total surface area for a faster decomposition rate and in turn allow the OPT to release larger amounts of its nutrients.

[189] T.Y. Wu, A.W. Mohammad, J. Md. Jahim, N. Anuar. (2009). A holistic approach to managing palm oil mill effluent (POME): Biotechnological advances in the sustainable reuse of POME. biotechnology advances. 27 pp 40 - 52.
Reference ID: 24515
Note: #24515e
Abstract: During the last century, a great deal of research and development as well as applications has been devoted to waste. These include waste minimization and treatment, the environmental assessment of waste, minimization of environmental impact, life cycle assessment and others. The major reason for such huge efforts is that waste generation constitutes one of the major environmental problems where production industries are concerned. Until now, an increasing pressure has been put on finding methods of reusing waste, for instance through cleaner production, thus mirroring rapid changes in environmental policies. The palm oil industry is one of the leading industries in Malaysia with a yearly production of more than 13 million tons of crude palm oil and plantations covering 11% of the Malaysian land area. However, the production of such amounts of crude palm oil result in even larger amounts of palm oil mill effluent (POME), estimated at nearly three times the quantity of crude palm oil. Normally, POME is treated using end-of-pipe processes, but it is worth considering the potential value of POME prior to its treatment through introduction of a cleaner production. It is envisaged that POME can be sustainably reused as a fermentation substrate in the production of various metabolites, fertilizers and animal feeds through biotechnological advances. The present paper thus discusses various technically feasible and economically beneficial means of transforming the POME into low or preferably high value added products.

[190] M.H. Mohd Zainudin, N. Ramli, M.A. Hassan, Y. Shirai, K. Tashiro, K. Sakai, Y. Tashiro. (2017). Bacterial community shift for monitoring the co-composting of oil palm empty fruit bunch and palm oil mill effluent anaerobic sludge. Journal of Industrial Microbiology and Biotechnology. 2017 pp 1 - 9.
Reference ID: 24516
Note: #24516e
Abstract: A recently developed rapid co-composting of oil palm empty fruit bunch (OPEFB) and palm oil mill effluent (POME) anaerobic sludge is beginning to attract attention from the palm oil industry in managing the disposal of these wastes. However, a deeper understanding of microbial diversity is required for the sustainable practice of the co-compositing process. In this study, an in-depth assessment of bacterial community succession at different stages of the pilot scale co-composting of OPEFB-POME anaerobic sludge was performed using 454-pyrosequencing, which was then correlated with the changes of physicochemical properties including temperature, oxygen level and moisture content. Approximately 58,122 of 16S rRNA gene amplicons with more than 500 operational taxonomy units (OTUs) were obtained. Alpha diversity and principal component analysis (PCoA) indicated that bacterial diversity and distributions were most influenced by the physicochemical properties of the co composting stages, which showed remarkable shifts of dominant species throughout the process. Species related to *Devosia yakushimensis* and *Desemzia incerta* are shown to emerge as dominant bacteria in the thermophilic stage, while *Planococcus rifietoensis* correlated best with the later stage of co-composting.

This study proved the bacterial community shifts in the co-composting stages corresponded with the changes of the physicochemical properties, and may, therefore, be useful in monitoring the progress of co-composting and compost maturity.

[191] Z.Z. Zakaria, A.M. Tarmizi. 2007. Efficient Use of Urea as Nitrogen Fertilizer for Mature Oil Palm in Malaysia. 362. (348). pp 1 - 4.
Reference ID: 24517
Note: #24517e
Abstract: For good oil palm growth and production, heavy fertilization is required especially with nitrogen (N). Based on the current area under oil palm, it is estimated that the N fertilizer requirement exceeds three million tonnes N a year. Currently, urea is mostly used in compound fertilizers for oil palm.

[192] I.E. Henson, M.H. Harun, K.C. Chang. (2008). Some Observations on the Effects of High Water Tables and Flooding on Oil Palm, and a Preliminary Model of Oil Palm Water Balance and Use in the Presence of a High Water Table. Oil Palm Bulletin. 56 pp 14 - 22.
Reference ID: 24518
Note: #24518e
Abstract: High water tables, indicating impeded drainage, are known to reduce yields although quantitative information is somewhat sparse. However, complete flooding can cause death of young palms as well as reduce the yield of older ones.

[193] I.E. Henson. (2007). Modelling Oil Palm Yield Based on Source and Sink. Oil Palm Bulletin. 54 pp 27 - 51.
Reference ID: 24519
Note: #24519e
Abstract: Although fruit bunch production by oil palm is often considered to be mostly dependent upon the ability of the plant to produce assimilates, the availability of an adequate sink is also of importance in optimizing yield. The model OPRODSIM initially simulated yield based on the assimilates remaining after the requirements of vegetative growth had been met, in accordance with an 'overflow' principle.

[194] I.E. Henson. (2007). Modelling Oil Palm Bunch Components, Palm Oil and Kernel Yields. Oil Palm Bulletin. 55 pp 15 - 25.
Reference ID: 24520
Note: #24520e
Abstract: The source-based model OPRODSIM (Oil Palm Production Simulator) simulates fresh fruit bunch (FFB) yield based on the assimilate remaining after the requirements of vegetative growth have been met. However, in its initial form it does not take account of pollination as a factor limiting yield, nor does it provide an estimate of palm mesocarp oil (PO) or palm kernel (PK) yields.

[195] IPNI. (2018). Making a Difference: IPNI 2018 Program Report USA. pp 1 - 54.
Reference ID: 24521
Note: #24521e

[196] IPNI. (2018). IPNI Research Projects: Interpretive Summaries 2017 Crop Year. IPNI Research Projects. USA. pp 1 - 96.
Reference ID: 24522
Note: #24522e

[197] M.J. Guiltinan. (2017). The Future of Cacao Research: System Science in Support of Cacao Farmers. The International Symposium on Cocoa Research (ISCR 2017): Promoting Advances in Research to Enhance the Profitability of Cocoa Farming, 13-17 November 2017, Lima, Peru. Lima, Peru. ICCO.
Reference ID: 24523
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(these slides were presented in ISCR 2017) Thematic 1: Genetic and Breeding as T1 No 1

[198] P. Bastide. (2017). Agronomic challenges for productive and sustainable cocoa production: taking stock and perspectives. The International Symposium on Cocoa Research (ISCR 2017): Promoting Advances in Research to Enhance the Profitability of Cocoa Farming, 13-17 November 2017, Lima, Peru. Lima, Peru. ICCO.
Reference ID: 24524
Note: #24524e > in folder #24507e
(these slides were presented in ISCR 2017) Thematic 2: Agronomy and cropping system as T2 No 30

[199] W. Niether, L. Armengot, C. Andres, M. Schneider, G. Gerold. (2017). Tree management in monocultures and agroforestry systems affect microclimatic growing conditions and fine-root growth. The International Symposium on Cocoa Research (ISCR 2017): Promoting Advances in Research to Enhance the Profitability of Cocoa Farming, 13-17 November 2017, Lima, Peru. Lima Peru. ICCO.
Reference ID: 24525
Note: #24525e > in folder #24507e
(these slides were presented in ISCR 2017) Thematic 2: Agronomy and cropping systems as T2 No 31

[200] J. Flood. (2017). A review on the effect of climate change on cacao pests and diseases. The International Symposium on Cocoa Research (ISCR 2017): Promoting Advances in Research to Enhance the Profitability of Cocoa Farming, 13-17 November 2017, Lima, Peru. Lima, Peru. ICCO.
Reference ID: 24526
Note: #24526e > in folder #24507e
(these slides were presented in ISCR 2017) Thematic 3: Pests and Diseases as T3 No 63

[201] P. Hadley. (2017). Overview of advances in cacao and climate change research and future perspectives. The International Symposium on Cocoa Research (ISCR 2017): Promoting Advances in Research to Enhance the Profitability of Cocoa Farming, 13-17 November 2017, Lima, Peru. Lima, Peru. ICCO.
Reference ID: 24527
Note: #24527e > in folder #24507e
(these slides were presented in ISCR 2017) Thematic 4: Climate Change Adaptation and Mitigation as T4 No 85

[202] D.A. Sukha. (2017). Evidence for applying the concept of "Terroir" in cocoa flavour and quality attributes: Elements of a harmonized international standard for cocoa flavour assessment. The International Symposium on Cocoa Research (ISCR 2017): Promoting Advances in Research to Enhance the Profitability of Cocoa Farming, 13-17 November 2017, Lima, Peru. Lima, Peru. ICCO.
Reference ID: 24528
Note: #24528e > in folder #24507e
(these slides were presented in ISCR 2017) Thematic 5: Quality, Flavour/sensory evaluation and post harvest as T5 No 96

[203] G. Ramtahal. (2017). Mitigation of Cadmium Bioaccumulation in Cacao through Soil Remediation. The International Symposium on Cocoa Research (ISCR 2017): Promoting Advances in Research to Enhance the Profitability of Cocoa Farming, 13-17 November 2017, Lima, Peru. Lima, Peru. ICCO.
Reference ID: 24529
Note: #24529e > in folder #24507e
(these slides were presented in ISCR 2017) Thematic 6: Cadmium contaminant and food safety as T6 No 121

[204] F. Amon-Armah, N.A. Anyidoho, S. Muilerman, A.I. Amoah, M. Asamoah. (2017). From labour demand to business prospects for rural youth: A study in the Fanteakwa district of Ghana. The International Symposium on Cocoa Research (ISCR 2017): Promoting Advances in Research to Enhance the Profitability of Cocoa Farming, 13-17 November 2017, Lima, Peru. pp 1 - 8.
Reference ID: 24530
Note: #24530e > in folder #24507e
(Presented in ISCR 2017) Thematic 7: Marketing, socio-economics, technology transfer and adoption as T7 No 129
Abstract: Ask cocoa farmers in Ghana whether they would like their child to be a cocoa farmer and they will often respond ‘no’. Now, ask if they would like them to go into cocoa business, and the vast majority will say ‘yes’ (Wagner et al., 2015). But what cocoa business opportunities do youth see for themselves within the rural communities? This paper identifies and maps out potential enterprises for youth within some cocoa farming communities in the Fanteakwa District of the Eastern Region of Ghana. A survey was conducted with 251 respondents including adult farmers, young cocoa farmers, and youth not in cocoa. Descriptive and regression analysis were performed on the survey data. The findings suggest a high demand for agricultural services by cocoa farmers mainly for activities such as land preparation and farm maintenance activities (e.g., pesticide spraying, regular weeding and mistletoes removal). Over 59% of the time, the farmers were willing to pay for individual farming activities ranging from land clearing to harvesting. These could be business opportunities for youth employment in rural cocoa communities. However, the youth did not perceive business opportunities in services provision to the same extent as demanded by the older cocoa farmers. Most youth were also interested in Holing and Planting cocoa seedling as a business (52%), while other in Harvesting and Gathering of cocoa pods as a business (39%), and pruning as a business (30%). Yet, the prices that older farmers were willing to pay for such services though highly demanded by them were up to Gh¢40.00 ($10.00) lower than expected by the youth. It is concluded that, there is obvious demand on the side of farmers, mostly for land clearing and maintenance activities. With some level of interest among the youth on business opportunities along the local cocoa production chain, some mechanisms to structure

agricultural labour into professional labour could be encouraged to promote youth entrepreneurship in rural cocoa economies.