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Content

Keynotes

Linking agriculture, environment and human health : "An AgroEcoHealth System thinking initiative for fighting Buruli Ulcer in wet agro-ecosystems of West and Central Africa".

Rousseau Djouaka, Benin

Abstract

Recently wetlands in West and central Africa have been targeted for food security and appear as new pathways to poverty reduction through increased agricultural productivity and higher food production. The intensification of agriculture in wetlands using inappropriate practices such as poor water management, inappropriate land use and inadequate use of agricultural inputs have resulted in a significant disruption of local agro-ecosystems and a poor supply of ecosystem services. Several published papers have revealed associations between the intensification of wetlands agriculture and the increased incidence of Buruli ulcer a neglected disease associated with large ulcers which often result in scarring, contractual deformities, amputations, and disabilities especially when the affected person is identified late. It is hypothesized that (i) inappropriate intensification of agricultural practices such as excess tillage moves the Mycobacterium ulcerans (Mu) responsible of BU from the internal soil layers to the surface soil then after (ii) the Mu brought at the surface soil is extensively spread in the environment through poor watering systems in irrigated agriculture.

The recently launched " ***AgroEcoHealth system thinking initiative for fighting BU***" led by IITA is a joint initiative from WHO and several health, environmental and agricultural institutions including international NGOs based in West and Central Africa. We have conducted set of activities for institutional arrangements and collaboration frameworks and, have launched a 5 years strategic plan for a multidisciplinary and pluri-countries research to address the links between BU and poor agricultural practices. We plan to analyze the mode of transmission from the environment to humans of the Mycobacterium ulcerans (MU) responsible for BU and, to develop a package of best bet environmentally friendly innovations for preventing the spread of this neglected diseases and improving the livelihood of poor rural communities in BU endemic areas of Central and West Africa.

Aspects of wheat quality with focus on the Fusarium fungi and mycotoxins

Manuela Filz, Elke Pawelzik
Germany

Abstract

Healthy food with an optimal quality is more and more important against the background of increasing world population. The global production of wheat makes up 30 % of the world's cereal production, whereas rice, maize and wheat make up about 60 % of the world's food energy intake (1, 2). In Germany winter wheat is the most important cereal. Wheat production takes more than half of the arable land in Germany and 48.9 % of the whole cereal production (2, 3). Wheat is important for bread making all over the world. But wheat and flour quality can be affected by fungal infections during the vegetation and fungal infestations during storage. One of the most typical field fungi is *Fusarium* spp. (4). The *Fusarium* fungi are able to invade grain during flowering and cause grain diseases named fusarium head blight (FHB). Furthermore some *Fusarium* species produce mycotoxins which are harmful for humans and animals (5). Because of the high quantity the most important mycotoxins produced by *Fusarium* spp. are deoxynivalenol (DON), nivalenol (NIV) und zearalenone (ZEA). These mycotoxins belong to the structural group of mycotoxins called trichothecenes and are produced mainly by *Fusarium graminearum* (*F. graminearum*) and *Fusarium culmorum* (*F. culmorum*). Zearalenone is also produced by *Fusarium equiseti* and *Fusarium cerealis* (6). All aspects considered lead to the fact that wheat quality depends on diseases like fungal infestation and on the mycotoxin content. Furthermore optimal storage conditions and possibilities for reducing the fungal infestation are important. The aim of this work is to pursue the influence of *Fusarium* infection during vegetation and storage on wheat quality.

Material and methods

In 2010 and 2011 two cultivars of winter wheat (*Triticum aestivum* spp. *vulgare*, cvs. Centrum and Ritmo) were grown in a field trial in Marienstein in the north of Goettingen in Lower Saxony, Germany. Ritmo is more susceptible to *Fusarium* infection than Cultivar Centrum. After harvest, the wheat samples were cleaned and moistened to a water content of 14 $\pm$ 1 %. After that, wheat was stored under defined optimal conditions (15 °C, 60 % air humidity) and suboptimal conditions (20 °C, 70 % air humidity) for six months. To get different infestation levels under natural conditions, different pre-crops (maize, winter wheat and sugar beet) were cultivated and a partly fungicide treatment was arranged on the field. Before storage, and after three and six months, the quality of wheat flour were determined by different quality parameters like total protein, falling number, wet gluten content, sedimentation value, water absorption and baking value by the ICC Standard Methods. Furthermore different mycotoxins (DON, NIV, ZEA) were determined by HPLC-MS-MS in the Department of Crop Science, Division of Molecular Phytopathology and Mycotoxin research, Georg-August-University Goettingen, Germany. In addition a visual evaluation of the baking products from the mikrobaking test was arranged.

Results

DON can only be quantified in samples with pre-crop maize, so there is a significant pre-crop effect. Samples with cultivar Ritmo show higher DON contents than samples with cultivar Centrum. During six months of storage DON content increases in all variants, especially under suboptimal storage conditions. After three months optimal und six months optimal and suboptimal storage the DON content is higher than the maximum level, established by the EU, of 750 mg kg^{-1} for cereals intended for direct human consumption and flour.

In samples with cultivar Ritmo with pre-crop maize the ZEA content is significant higher than in other samples with cultivar Centrum, so there is a significant cultivar and pre-crop effect. After three months of storage the ZEA content increases. But after six months the content decreases. This is a reason why other metabolomic activities seem to influence the ZEA content. In all samples ZEA content is lower than the EU maximum level of 75 µg kg^{-1} in cerelas intended for direct human consumption and flour. In samples without any fungicide treatment ZEA content is higher than in samples, which are treated by a fungicide.

Storage time and conditions have a significant influence on the wet gluten, sedimentation value and water absorption of the flour. But there is no significant influence on crude protein, falling number and baking volume. The results of the visual evaluation of the cookies show, that the test persons prefer cookies, which are not dark brown. These samples have low mycotoxin content.

Discussion

It is confirmed that maize is not a proper pre-crop for wheat cultivation because it causes high mycotoxin contents. The same conclusion applies for susceptible cultivars like Ritmo. During the storage period the DON and ZEA contents change. A reason for it can be further metabolomic activities of *Fusarium* spp. . The visual evaluation of the baking products show, that test persons prefer cookies with lighter browning. These samples were made by cultivar Centrum and pre-crop sugar beet with a fungicide treatment. So no mycotoxin contents could be quanitfied in these samples.

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Environment, Agriculture and Maternal Morbidity & Mortality

Chibuike O. Chigbu, Nigeria

Abstract

This paper examines the cross-linkage between the environment, agriculture and maternal health. The contribution of environmental degradation and low agricultural productivity to increasing maternal mortality in Africa is examined in a holistic approach. Environmental issues like climate change, deforestation, water scarcity, water pollution (especially by crude oil exploration) and soil erosion are taking heavy tolls on Africa leading to low agricultural outputs. Majority of African women live in rural and semi-rural settings. These women rely almost completely on agriculture for daily survival, which in turn relies on favourable environment. The day-to-day well-being of these women is closely tied to the natural environment. Consequently, adverse environmental changes lead to disproportionately high levels of poverty, hunger, poor nutrition and economic deprivation. Gender inequality existing in many African countries ensures that these adverse effects are tilted more to the disadvantage of women and the girl-child. This paper examines how each of these contributes to direct and indirect maternal death. In a way the paper cross-links MDG 1, 5, 6 and 7. Potential ways of improving maternal health in the light of the above-listed variables are also examined. Areas requiring more research are identified.

Affordable Safe Drinking Water for the Developing World

Chicgoua Noubactep, Germany

Abstract

The world is on schedule to meet the Water Millennium Development Goal of halving by 2015 the proportion of people (1.1 billion) without safe drinking water in 1990. However, up to 550 million people may still lack safe drinking in 2015. Therefore, the development of efficient and affordable water treatment technologies is a challenge for the scientific community. Resulted technologies should ideally be practicable for small communities with little technological skills. Water filtration on ceramic filter and biosand filter has been identified as such a universally applicable technology. However, both filters mainly address microbial contamination but virus removal is still non satisfying. Current efforts are directed towards improving these filtration systems. This communication presents the concept of amending biosand filter with a reactive layer containing metallic iron (Fe0 filters). Fe0 filters have the advantage of addressing both chemical and microbial contamination. The operating mode of Fe0 filters is explained and some research needs are discussed. It is hope that more researchers will be interested in co-developing this promising health-keeping technology in Ghana and in various parts of the globe.

Climate Change, its Evidence in Nigeria and Consequences on agriculture and Health

M. Anika Silva, Nigeria

Abstract

Climate change may be defined as any alteration in the climate directly or indirectly as a result of astronomical causes, earth-based causes or human activities. This presentation will be based on changes and its effects due to human activities in Nigeria. Nigeria is prone to adverse effects due to its size, population, lack of awareness or environmental education, improper environmental practices, inability to manage disasters and different climatic zones.

In agriculture the adverse consequences include among others coastal and gully erosion, severe flooding and storms which have increased both in frequency and intensity. There are also increase in biodiversity loss, deforestation, desertification and sand dunes. Nigeria also experiences frequent drought and low agricultural yield due to high temperature and insufficient water. Rivers and Lakes are also drying up (e.g Lake Chad).

In health, Nigeria has witnessed in recent times unusual excruciating heat wave and a resultant frequency in cerebral meningitis outbreak. There is also an increase in arthropod-borne diseases (malaria, sleeping sickness, filariasis etc), water-related diseases (diarrhea, gastroenteritis etc) due to enhancement in pest development rates and fertility. With the intensive and unprotected UV-rays cataracts develop to cause blurred vision and blindness. Also on the increase is allergy due to high pollen discharge into the environment. There are also new patterns of disease outbreaks (emerging diseases) and a resurgence of diseases such as swine flu and tuberculosis.

These adverse effects have triggered other side-effects such as poverty, hunger and malnutrition, forced migration, social unrest, restiveness, conflicts, women and children trafficking.

Evidence of most of the above will be demonstrated through slide (power) presentation. The way forward with respect to mitigation and adaptation will be presented and discussed.

Clean water issues in an irrigated agriculture village: Guièdougou in the Sourou Valley, Burkina Faso

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Germany, Burkina Faso

Introduction: This study was done in the framework of water-related diseases risk determination in Guièdougou, the first agricultural village created by governmental decree in December 1966 in the Sourou Valley, north-west of Burkina Faso. This work aims to assess the clean water access conditions 44 years after the first farmers' resettlement; and to see if the clean water supply has modified people behaviour by discouraging them from contaminated freshwater use.

Materials and method: A complete inventory of households and water drawing sites was made using a GPS device in March 2011. Four sites were held: irrigation canal (GDG_1), modern well (GDG_2), water fountain (GDG_3) and borehole (GDG_4) for observing populations water source selection behaviour. During three days, four fieldworks interviewed water drawers to gather drawing reasons and domains of use of the water.

Results: In March 2011 the population of Guièdougou was 7 quarters, 692 households and 8282 inhabitants. A total of 16 Functional hydraulic works (HW) were found: 5 water fountains (WF), 11 modern water points (MWP) (6 boreholes and 5 modern wells). The water demand index was 517.6 individuals per HW and was above the norm in force in the country (300-500 inhabitants per HW). 84% of the populations were located within the normal distance from a WF (500m) and a MWP (1000m); and 16% had normal access to MWP only. Despite this good access to HW, data show a net predominance of water drawing at GDG_1. On a total of 1,777 recordings 45% occurred at GDG_1 vs. 29%, 13% and 13% at GDG_2, GDG_3 and GDG_4, respectively. Data also show that people traverse long distances to reach GDG_1 compared to the other sites: 45%, 36% and 16% of Guièdougou households were found at 1500m, 2000m and 2500m from GDG_1, respectively. The water in the irrigation canal comes from the Sourou River, a contaminated freshwater. The strong attractiveness of GDG_1 was attributed to the easiness of the drawing, no rope to draw water from modern wells, the time saving and the gratuitousness of the water. This unclean water was used for 48%, 31%, 10% and 9% of water drawers for dishes and washing, cooking, traditional beer making and drinking, respectively.

Conclusion: The improvement of water supply in Guièdougou did not succeed to break the exposure to and consumption of contaminated freshwater. The availability of water from irrigation canal and divers socio-economic factors explain this situation. Clean water supply in rural context should be coupled with a long term health education. Further researches can be focused on how to discourage local people from contaminated freshwater drinking.

Acknowledgment: German Academic Exchange Service (DAAD).

Water Supply and Health Situation of Rural Households In Imo State, Nigeria

Adeola Olajide, Nigeria

Abstract

The availability of water has impact on health and the sanitary situation of farm families particularly because of the important role it plays in family care and household supply, hence, food security. Also the health situation of a family is felt in terms of loss of work and productivity. This study examines the health and water supply situation in the rural areas of some local governments in Imo state. The farming and rural systems approach was used. A total of 120 farming families selected through a multistage random sampling technique were interviewed using a structured questionnaire. The data collected were analyzed using non-parametric techniques (mann whitney test) after the sample had been regrouped into Peri-Urban and Remote farm families through a hierarchical clustering method. The results showed that the respondents in both clusters depended on external sources of water over which they had little control and as such experience regular shortage. The remotely located households are hardly able to purchase enough water to meet their needs or fill the gap. The health situation is quite poor since malaria and other illnesses are reported within the same household within a month. The peri-urban households however appear to fare better than their counter parts. A further break down of the remote farm families to male and female headed households shows that the health situation of male heads of households is very poor. The findings imply that rural households are still neglected in the supply of basic amenities and this will continue to hamper their productivity and overall well being.

Keywords: Water supply; Health Situation; Farming Families; Rural

The Interplay of Agriculture and Medicine in Holistic Health: A philosophical Approach

Michael Okoro, Nigeria

Abstract

It is factual that the natural environment encompasses all living and non-living things occurring naturally on Earth or some region thereof. It is an environment that encompasses the interaction of all living species. Agriculture on the other hand is the oldest and the most innocent of all professions and medicines are made from agricultural products. Food was, is, and remains the best and first medicine and cosmetics ever known to man. From the above premises; there is a strong relationship between Agriculture and Medicine. The impact of industrialisation, urbanisation and Infrastructural Development on the natural environment is enormous. They have harmful effect on the ecosystem, Ozone Layers, land, Water and its produce. Men and animals who consume these products develop sicknesses of various kinds: Cancer, Tumour, Prostrate, Vital Organs dis-functions and hunger which may be treated with medicines. Be that as it may, the Philosopher would not fold his hands and watch science and technology to destroy the human race and the environment in the name of surplus, mechanised Agriculture, genetic engineering and so on; neither would he keep quiet nor watch people live on drugs. This paper therefore aims at using the apparatuses of philosophic intellection to decipher the ways through which Environment, Agriculture, and Medicine should be approached, harnessed and harmonised into a gestalt and common stalk for the holistic health of man and the environment

High protein yellow maize: a hope for food security in Burkina Faso

Abdalla Dao, Burkina Faso

Abstract

Burkina Faso is a poor, landlocked, sub-Saharan country of 15 million inhabitants. Agriculture occupies approximately 80% of the working population. Maize is the third major cereal crop grown. Its growing is made possible throughout the year thanks to the existence of adapted varieties developed by INERA (Institut de l'Environnement et des Recherches Agricoles/Institute of Environmental and Agricultural researches) and the existence of a real policy of dissemination of its growing. Maize is increasingly replacing sorghum and millet in the diet of the population, which requires an improvement in productivity and quality to ensure food security.

The use of high protein maize QPM (Quality Protein Maize), non-GMO, is the alternative the most reliable and least expensive. Following the success of the dissemination and the use of the white variety "Obatanpa" high protein maize in Burkina Faso, the high protein yellow maize has been highly wanted by maize growers.

INERA fortunately developed a high protein variety "Espoir" from Pop 66 SR (CIMMYT /IITA), yellow to orange yellow, 97 days to maturity, moderately resistant to common maize diseases. Its yield potential of 6.5 t / ha makes it a productive variety. It is characterized by a *stay green* because its leaves remain green at maturity of the ear; this is an excellent fodder for animals. The high content of the grain in Beta-carotene, a precursor of vitamin A and in protein digestible by humans (lysine and tryptophan) makes the use of this variety one of the best ways for fighting child malnutrition (kwashiorkor) and adults. The grain is perfectly suited for animal feeding and help to compensate for the deficiency in nitrogen element found in ordinary maize.

The variety Espoir is a real hope for achieving food security because it combines productivity and qualities (high protein content and vitamin A, essential for good nutrition).

Stabilizing agricultural income through sustainable non-chemical control of crop-diseases: Example frosty pod rot of cocoa in Costa Rica

Heinrich Lehmann-Danzinger, Germany

Abstract

Cocoa production is one of the most important cash crops of countries in tropical humid climates. Biggest producers (t x10^3 of dry beans in 2004)) on a worldwide scale are Cote d'Ivoire (1,331), Ghana (733), Nigeria (336), Cameroon (167), and Indonesia (601 t x$10^{3)}$, which cover 90% of the world production. Undernourishment is closely related to income and generally lower and improving lately in the above mentioned cocoa producing countries. In developing counties there is a strong link of poverty and production of small scale famers. On a worldwide scale production of cocoa is essentially in farms or 9.5 to 3 ha in size.

Cocoa is an understory tree under the canopy of forest trees in agro-forest ecosystems and is extraordinarily well adapted to the climate of the humid tropics .Sustainable production of coco is based on (1) economic, (2) environmental, and (3) social (health!) sustainability, being addressed in this paper. Lowering health risks in cocoa production is either by reducing or avoiding insecticide, fungicide and herbicide application. One measure to lower the input of agrochemicals is by growing of cocoa in an agro-forest environment using forest trees to providing an overhead shade of 45% to 60%. Forest trees with deep reaching roots act as a nutrient pump, lowering or avoiding input of fertilizers. Overhead shade leads to a uniform flowering at the start of the rainy season, lowering the attack of pod sucking insects, reduce significantly growth of weeds, and speed up degradation of pathogens on diseased cocoa pods on the soil.

Diseases causing high losses on cocoa are the frosty pod and witches' broom, both limited up to now to the American continent, the swollen shoot limited to Africa, and the black pod disease (on a world wide scale). Research on frosty pod in Costa Rica (Central America) showed that control is possible in cocoa with overhead shade up to 60% , by reduction of the inoculum by detaching the infected pod before start of sporulation, and leaving them on the soil. Avoiding infection of healthy cocoa plantation from diseased plantation lacking control, is by removal of cocoa trees in a 30 m wide stripe in the diseased plantation at the border to the healthy plantation. Production of cocoa increased significantly in diseased plantation in the second year following the start of control with the above method which also reduces the attack by the black pod disease (causal agent *Phytophthora* sp.).

Methods. Spatial and temporal distribution of M. roreri (frosty pod) spores (conidia) was achieved with spore traps and the flight of conidia (number conidia/h/m^3 air) and was related to relative temperature, humidity, temperature and rainfall. Measuring disease severity (% diseased pods/tree) at weekly interval was by counting the detached pods with symptoms. Assessing yield was by counting healthy pods at harvest. Survival of spores on detached infected pods was by determining their germination by inoculating spores on nutrient media in Petri dishes and counting the developing colonies.

Socio - Economics

Choice of Delivery Facility among Expectant Mothers in Ghana-Does Access to Health Insurance Matters?

E. Nketiah-Amponsah, Eric Arthur, Ghana

Abstract

According to the WHO, Ghana's maternal mortality rate as of year 2011 stood at 350 per 100,000 women while 59% of births were supervised or attended by skilled personnel. Although Ghana's maternal health indicators such as maternal mortality rate and births attended by skilled personnel are better than the sub-Saharan average, they still remain alarming and far from the reach of the maternal-health related Millennium Development Goal targets. One of the most significant health policy initiatives since independence is the introduction of the Ghana National Health Insurance Scheme. In this study, we hypothesize that delivering in modern health facilities with skilled attendants has the potential to reduce maternal mortalities significantly. Home deliveries often endanger the health of women and newborns given ensuing complications, which are often, referred to appropriate health facilities only when the condition is already deteriorated. Consequently, this study examines the extent to which expectant mothers' access to health insurance influence their choice of delivery facility namely public health facility, private health facility, home delivery and 'other facilities'. Methodologically, the multinomial logistic regression is employed in the empirical estimation. Using the 2008 Ghana Demographic and Health Survey, We found that women with access to health insurance are more likely to deliver in modern health facilities; public and private. However, the propensity to deliver in a public health facility outweighs that of the private facility. There was no discernible statistical relationship between home delivery and health insurance ownership.

Some of the control variables that were found to significantly influence the choice of delivery facilities are age, educational attainment, wealth, area of residence, religion and region of residence. The study makes a case for scaling up access to health insurance among expectant mothers due to its positive effect on the choice of appropriate delivery facilities.

Keywords: expectant mothers, health insurance, delivery facilities, multinomial logistic regression, Ghana

Putting into utilization of small holder farmers in northern Nigeria of soybean processed products for improved household nutrition and health

Martin Jemo¸ Nigeria

Abstract

Small-holder farmers-communities in many Africa countries, especially in northern Nigeria are faced with real life challenges of hunger, malnutrition, health problems and low incomes. In many of the respective farming-communities, soybean (*Glycine max* L. Merr) is a relatively new crop and its cultivation has gained popularity as a consequence of the increasing need for food and fodder in recent times. Soybean is being primarily considered for soil-fertility improvement in cereal based cropping systems while the grain contains approximately 35% of essential dietary protein significant to improve human nutrition and health of diverse family groups. Soybean grains can be processed into various food products such as soybean-milk, soybean-yoghurt, soybean-eggs, soybean-bread, soybean-cake, soybean-porridge, soybean-flour, etc. However, small farmers lack adequate capacity to process and transform soybean grain to different products above-mentioned. In view of this, it is necessary to comprehensively build the capacity small holder farmers on processing, household utilization and commercialization of soybeans and its products. Important components of the study on soybean in human nutrition and health will be addressed, such as soybean and children nutrition/health, soybean and Women nutrition/health, soybean and the health of the old persons, soybean and the health of men, and soybean and HIV/AIDS persons. Combination of soybean with other nutritional and vitamins products will adequately be addressed to leverage the nutritional problems and improve health status of diverse family groups living in Northern Nigeria. The study will work closely with nutritional and health scientists to ensure successful incorporation of different end-products into the daily household menus as to effectively improve health and nutrition of the entire family.

Keys word: Health; Nigeria; Nutrition; Soybean; smallholder farmers' communities

The impact of socio-economic status and sanitation levels on the prevalence of diarrhoeal diseases in the Akim Oda area of Ghana

Fening, K.O., & Edoh, D.A.

Abstract

A survey was conducted between August and October, 1998 in Akim Oda area of Ghana to relate socio-economic differences, as measured by income, education, occupation and housing, among residents in three communities to diarrhoea prevalence. There was clinical and laboratory diagnosis of cholera and administration of structured interview-administered questionnaires to find from residents their demographic, socio-economic, health practices and status, and to seek their opinions on cholera transmission, control and prevention. The survey revealed that residents from Old-town and Aduasa belong to low social class and was reflected in their high illiteracy, unemployment rates and associated poor sanitation. As such, they had the highest prevalence of diarrhoeal diseases. Contrarily, residents from Quarters residential area were found to belong to high social class, which was reflected in their high literacy, employment rates and good sanitation. As such, they had no case of diarrhoea. The underlying factors responsible for this epidemic are discussed.

Medicine

GIS database for predicting the risk of human infection with major arboviruses in southwestern Cameroon

Eric Bertrand Fokam, Cameroon

Abstract

The research is proposing to examine the effects of deforestation and urbanisation on the ecology of chikungunya, yellow fever, and dengue viruses, in forested areas of southwest Cameroon.

Our long-term goal is to develop a GIS database to map transmission foci for the viruses in Cameroon, predict risk of outbreaks of human disease associated with human activity especially agriculture, and ensuing continued urbanisation, and design novel strategies for prevention and control.

We hypothesise that deforestation and varying land uses induce changes in vector behaviour that could enable arboviruses adapt to peridomestic transmission cycles involving *Ae. aegypti* and/or *Ae. albopictus* vectors, and human hosts.

In order to test our hypothesis, we propose to: *1*) Measure the intensity of enzootic arbovirus activity in representative biotopes, and determine how this arbovirus exposure changes with various degrees of human disturbance; 2) develop a GIS database to delineate the spatial and temporal exposure of humans living/working in these areas to enzootic arbovirus transmission.

We are proposing to collect serum and data from consenting febrile patients at participating clinics; mosquitoes and sentinel animals will also be used. Mosquito pools, human sera, and sentinel animal blood will be screened by RT-PCR followed by sequencing for virus identification, then isolation.

Data on virus isolation will be used to develop the GIS database which will employ satellite imagery to compare the distribution of human populations in relation to enzootic arbovirus habitats identified in the work.

Health Risks Associated With Irrigation Water In Ghana

Beatrice Asenso Barnieh, Ghana

Abstract

Agriculture is the major source of livelihood for most of the people in Ghana. However, improved agricultural yield partly depends on availability of water for irrigation. The water for irrigation must be safe and free from pathogens since the use of contaminated water for irrigation has been known to pose health risks to both the farmers and the consumers of agricultural produce. In Ghana, fresh water availability, even for human consumption, is limited by increased population growth, urbanization, climate change and human activity (Water pollution, deforestation, alluvial mining etc). The high demand on Agricultural produce has compelled farmers to farm at areas where there is little water supply for irrigation. In the midst of fresh water scarcity, farmers have switched to other sources of water for irrigation. Nevertheless, ensuring food security must not be at the expense of good health and hence we need to ensure that the alternative sources of water for irrigation are not contaminated with pathogens.

This paper reviews literature on the alternative sources of irrigation water used by Ghanaian farmers and the potential health risks. The research also explored whether Ghanaians have the capacity to cope and reduce the health risks associated with the alternative sources of water for irrigation. Literature on alternative sources of irrigation water and the associated health risks in Ghana were reviewed by using PubMed, Science direct and Google scholar. Out of the 100 articles retrieved, 20 of them were in line with this study.

The results from all the 20 articles indicated that untreated waste water, dams, ponds and rain water are the main sources of water for irrigation in urban and peri-urban areas in Ghana. It was also reviewed that Ghanaians have little capacity to cope and manage the health risks associated with the alternative sources of irrigation water and that there has been a significant increased in the spread of water related diseases such as cholera, dysentry, dracunculiasis, typhoid, scabies, hepatitis, malaria, schistosomiasis, onchocerchiasis, trachoma, intestinal helminthes and many more in the farming areas despite the fact that agricultural yields have been boosted due to the high nutrient contents of these irrigation water sources.

The results further showed that most of the farmers are not aware of the World Health Organization's guidelines for treating contaminated water for irrigation and even those who are already aware found it complicated and too expensive to comply with. They also found the risk reduction approach known to them as a top-down. It is therefore recommended that the current flexible World Health Organization guidelines for managing health risks associated with irrigation water must be made known to them through education. The cost of implementing such guidelines must be subsidized. Government must also incorporate flexible health safeguard into irrigation projects. A horizontal approach must be adopted so that farmers will appreciate and comply with the guidelines.

Screening local plants/fruits extracts for potential compounds that block malaria/filarial parasite transmission in both Anopheles gambiae s.l. mosquitoes and man.

Ignatius Cheng Ndong, Cameroon

Abstract

Many studies have been carried out on different malaria control strategies. These have focused on preventing parasite transmission (man to mosquito and vice versa), vector-man contact (Bed nets and insecticide sprays) and transmission blocking of parasites in the mosquito. Transmission blocking studies in the mosquito (genetic manipulation) have generally focused on how the mosquito immune system affects the developmental stages of the *Plasmodium* parasite, and lately, on how anti-helminthes drugs affect the mosquito's potential to take a next blood meal (Kobylinski *et al.*, 2010). Hardly have studies focused on malaria drugs or compounds that can kill the parasite within the mosquito to prevent transmission. No study has investigated the intra mosquitoes effect of different compounds in local brews used to treat malaria/filarial infections on the Plasmodium parasite/filarial worms as well as the effect on the mosquito itself. Many communities in Cameroon do use boiled plant/fruit brews to treat malaria and filarial parasitic infections. These brews could contain active ingredients that kill both malaria and filarial parasites. Though the brew is effective, most of these plants/fruits extracts are never used in large scale due to lack of the knowledge of the active ingredients, undetermined shelf-life, side effects as well as inappropriate formulation. Also, little is known on whether the active compound could be of great use in blocking transmission in the mosquito. If anti-helminthes when picked up in a blood meal are active against the mosquito then these plant/fruit extracts could therefore have a tri-action approach in that it clears the parasite in man and mosquito and even lowers the mosquito's ability to take the next blood meal. Thus, this breaks the transmission chain. Obtaining an active compound from this brew will greatly enhance control efforts and provide an available, low-cost and easy-to-use product with limited side effects. The aim of this study is to extract and identify plant/fruit based compounds that clear *Plasmodium* parasites as well as the filarial worms within the mosquito when picked up during a blood meal as well as in man. This project is expected to succeed because the brews are being used by the local communities but what is lacking is the scientific backing to make brew extract to be used in a large scale.

Hypothesis:

There are compounds in local plant/fruit brews used to treat malaria and filarial infections that even low concentration (5ul) could prevent intra *Anopheles* mosquito development of the *Plasmodium* parasites and the filarial.

Evidence of Inhalational Exposure to Lead, Neuro- and Neprotoxicity in free Ranged Chickens living in small-Scale Gold Mining Area of Zamfara State Nigeria

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Nigeria

Abstract

Introduction: Lead is the most ubiquitous environmental pollutant having diverse deleterious effects on man and animal health. It is highly toxic and the main heavy metal causing intoxication of birds. Following the death of several children as a result of exposure to lead from artisanal and small-scale Gold mining in Zamfara State in Nigeria, Our team from the National Veterinary Research Institute, Vom, Nigeria went to investigate the involvement of animals.

Materials and Methods: Moribund and comatose free-ranged chickens showing ataxia and incoordination from Dareta village were investigated using hematological test, Bacteriology, Virology and Toxicological Pathology.

Results: Blood parameters fell within normal range. Gross pathologic examination revealed myocardial hemorrhage and necrosis; and hepatic lipidosis. Microscopically, tracheal hyaline cartilage (chondrocytes) and epithelium are masked by large deposits of bluish-black homogenous material on H&E stain, interpreted as Lead inclusions. Neurons of the gray matter of the cerebrum and the granular cells of the cerebellum stained red with Ziehl Neelsen (ZN) special stain. There was Nephrotoxicity and tubular epithelium was ZN positive. Mean liver lead concentration was 47.72 ± 10.52 mg/K, while brain and bone lead level were 87.52 ± 12.53 mg/Kg and 156.80 ± 64.16 mg/Kg respectively. Bacteriology did not yield any significant bacterium while virus isolation was negative for Newcastle disease virus.

Conclusion: It is evident that the chickens were severely intoxicated with lead and inhalational exposure may have lead to the toxicoses. There is a serious public health risk as environmental lead dusts are being inhaled by animals and humans.

Key words: Chicken; Lead toxicity; Gold mining; Inhalational exposure; Nigeria.

Geosciences and Water

Infrastructure development and Biodiversity: a case Study of the Livelihood Development around Mole National Park

Michael Commeh, Dadson Awunyo-Vitor, Ghana

Abstract

The dialogue between infrastructures, development and enhancement of other sectors are closely linked. It is simply natural that society's potential is unleashed when good practices and trust is practice under informed democracy. But it is also factual that when infrastructure in a system is developed, the quantum explosion of creative innovative potential entrepreneurs and non entrepreneurs cannot be gainsaid. Of course resilience or coping strategy of human nature that corresponds and respond to climate change's complexities can also be identified to be linked to sustainable innovative skills but mostly to basic road infrastructure development. Three cross cutting areas were looked at; namely road infrastructure development particularly roads network, transportation, women in agriculture, clean energy, water and biodiversity. The qualitative analysis from stakeholders indicated that road infrastructure as main underlying narrative that hinders the development of the value chain system. The lack of all seasonal roads network in Ghana is the fundamental cause of the development of energy, water and food security through biodiversity development. There is a relationship between road infrastructural development and societal development in agriculture, health, and education. However, Remote Sensing and Geographic Information system depict a different story. Satellite imageries showed how the road infrastructure is devastating the biodiversity for that matter agriculture development and its value change process.

Keywords: Road Infrastructure, climate change, biodiversity, water, food security and energy

Determination of Pesticide Residues in Vegetable, Water Soil and Sediment from Selected Farm Settlements in South Western Nigeria

Omolara Jeminah Ojezele, Nigeria

Abstract

Pesticides, like cypermethrin and glyphosate used in cultivating food crops such as vegetables are considered as one of the major environmental contaminants. There could be a possible presence of such compound residues in the food crops. The run-offs from the farms as well as dispersal or carriage by wind makes the pesticides enter the nearby streams which serve as alternative sources of drinking water for most communities.

This study therefore investigated the residual impact of activities involving the use of pesticides on water, soil, sediments and vegetable samples from selected farm settlements supplying vegetables to major open markets in South-West Nigeria.

Questionnaires were administered to farmers to assess the level of understanding of and compliance to the recommended application of pesticides and disposal of leftover. The concentrations of glyphosate/cypermethrin residues, heavy metals and other physicochemical parameters in cultivated soil, sediment, water and vegetable (*Amarantus cruentus*) were determined to assess the level of contamination compared with FAO/WHO allowable residue limits. Samples were collected from five locations on the cultivated farmland. Control samples were also collected from uncultivated land that is 100km far from farm. Pesticides residues were extracted from soil, sediment and vegetables using Soxhlet extractor; acetone and hexane (1:1) were used as solvents. Adapt Cecil 4200 High performance Liquid Chromatography was used for the instrumental analysis.

Results showed that farmers did not use protective clothing during pesticide application, follow the recommended period before consumption of vegetable nor dispose leftover appropriately. The average concentration of α-Cypermethrin was 0.7±0.4 µg/mL in water, 8.7±4.1 µg/g in soil, 15.4±8.5 µg/g in sediment and 4.9±3.2 µg/g in vegetable samples. Glyphosate had mean concentrations of 0.07±0.005 µg/mL in water, 3.05±1.1 µg/g in soil, 4.4±2.7 µg/g in sediment and 12.1±6.1 µg/g in vegetable samples. Glyphosate and α-Cypermethrin had higher accumulation factors in vegetable samples than in soil samples. The transfer factors of Glyphosate and α-Cypermethrin from soil to vegetable were 0.56 and 3.96 respectively. The average concentrations of Fe (7.2±6.0 mg/L) and Mn (0.3±0.1 mg/L) in water samples were above the recommended limits by WHO and Nigerian standard for drinking water quality. The order of decreasing pollution index of the metals in water is Fe > Zn > Co > Pb > Mn. The data obtained for other physicochemical parameters are 6.4±0.2 for pH, 32±2.7^{o}C for temperature, 108±49 mg/L for TDS, 211±95 mg/L for TS, 103.9±47 mg/L for TSS, 8.8±3.3 mg/L for DO, 53.2±16.5 mg/L for total hardness, 90±29 mg/L for alkalinity, 0.5±0.3 µg/mL for nitrate, 0.2±0.04 µg/mL for phosphate, 1.14±0.2 mg/L for sulphate, while COD, chloride and turbidity had mean concentrations of 90.8±14 mg/L, 5.7±2.5 mg/L and 51.8±43 FTU respectively. Statistical analysis revealed that all the parameters except for turbidity had their concentrations significantly different from their corresponding values for the control samples.

From this study, incorrect application of pesticides may result in toxicity to the farmers. The study also showed that the pesticides residues in the samples were higher than the permissible limits of 0.07mg/L. This may lead to health hazards to the consumers.

Further studies will be necessary to investigate the effects of the pesticides on the farmers through comprehensive medical assessment and; haematological and biochemical (organ toxicity) analyses. Also, there may be need to assess the pesticides residues in the open markets just before consumption.

Key words: pesticides, vegetables, physicochemical parameters, water, soil, sediment, heavy metals

Heavy Metals Contamination of Soils and Vegetables around the Phosphorite Processing Plant of Kpeme, Southern Togo.

Kissao Gnandi and Adoté ADUAYI, Togo

Abstract

Many studies carried out on the sedimentary phosphorite deposits of Togo show not only that they have high grad of P2O5 but also content high amounts of trace metals such as Cadmium, Chromium, Copper, Nickel, Vanadium, Zinc, Fluorine etc (Gnandi and Tobschall 1999 a et b; Gnandi 2002). The treatment of the raw ore to the commercial phosphorite is done in the factory of Kpémé near to the coast. It consists of eliminating the impurities especially the clayey gangue by wet sieving and hydrocyclone processes. It results from these treatments 3 types of wastes: solid wastes rich in particles fraction > 2 mm that are dumped on fields; muddy wastes rich in fine particles fraction < 45 μm that are dumped directly into the sea and phosphorite dusts and gases, rejected in the atmosphere through the factory chimney.

The present study was carried out to assess the impact of mining activities on soil and food contamination around the treatment plant. Chemical analyses have been performed on soils, maize and cassava samples cultivated and consumed by peoples in the villages situated around the plant. The concentrations of four heavy metals (cadmium, lead, nickel and copper) have been determined.

The average concentrations of heavy metals expressed in mg/kg for soils of the villages Aglomé II, Kpémé, Goumoukopé and Séwatsrikopé are respectively 43, 37, 36 and 22 for Cd; 16, 16, 122 and 3 for Pb; 69, 57, 51 and 21 for Ni; 39, 40, 35 and 27 for Cu.

For foods of Aglomé II, Kpémé, Goumoukopé and Séwatsrikopé the concentrations are respectively 3, 1, 2 and 0.8 for Cd; 15, 0.4, 0.9 and 0.11 for Pb; 13, 0.54; 0.32 and 0.7 for Ni; 16, 16, 17 and 14 for Cu mg/Kg.

The concentrations of these metals in soils samples are higher than the standards enacted by the Canadian Council of the Ministers for Environment (CCME) for soil quality. Same manner, the concentrations of these metals in food samples are largely higher than the standards enacted by the World Health Organization (WHO). Aglomé II appears more polluted and cadmium is most polluting element.

Key words: heavy metasl, phosphorites, soils, vegetables, Togo

Food and Nutrition/Plant

The Nutritional, Medicinal and Commercial importance of the Fluted Pumpkin Leaves in West Africa (*Telfairia occidentalis*)

Prize Jacobs, Ghana

Abstract

African indigenous vegetables are known for their importance in providing nutritious food, both in rural and urban areas. The vegetables play a crucial role in income generation and subsistence. Some of them have been attributed with having medicinal-value properties and are grown for home consumption. They are considered traditional crops, because whereas some of the plants were planted, others were readily available and harvested in their habitat appearing as volunteer crops or weeds. Others had been consumed for countless generations signifying their value and importance in local cultures. The value of indigenous vegetables is not fully appreciated in Africa especially in urban areas.

Many species of African traditional vegetables are poorly known, being used only locally. However, they are extremely important for nutrition and farm income throughout Africa, often supplying most of the daily requirements for vitamins A, B complex and C for rural people. The production and utilization of vegetables can make a much-needed contribution to better nutrition and income in many African countries but there is a serious threat that many species will drop out of use in some areas if no appropriate countermeasures are taken.

Knowing the nutritional, medicinal and economic value of native West African vegetable could definitely add value to the cultivation, consumption, conservation, and regional/international commercialization of native West African vegetables. Such knowledge if well exploited could as well serve as one of the main corridors for hunger and poverty alleviation in the West African region.

The Latin name is (*Telfairia occidentalis*). The Igbo people of Nigeria and most Nigerians call it Ugu. The Ghana people call it Krobonko, while people from Sierra Leone call it Gonugbe. The English name is Fluted pumpkin, fluted gourd and the Spaniards call it Costillada.

This Paper is an expose of the Nutritional, Medicinal and Commercial importance of the Fluted Pumpkin Leaves in West Africa (*Telfairia occidentalis*).

Development of Urban and Periurban Horticulture Support Project, Case of Cote d'Ivoire

Samuel Kouakou, Cote d'Ivoire

Abstract

Côte d'Ivoire, with 15 million people in 1998, faces an extremely fast urban growing. 15% in 1960, the urbanization rate is 43% in 1998. The average annual growth rate, over the period 1988 to 1998 of the population size, is 4.2% in urban areas against 2.8% in rural areas.

Under the Special Program for Food Security, FAO has implemented a pilot project in support of urban and peri-urban horticulture. This pilot project targeted the towns of Bingerville and Yamoussoukro and performed some pilot activities and some training on the sites selected using the approach IPP (Integrated Production and Protection)

The Project is part of an initiative to support the policy of Côte d'Ivoire for better food security and in particular to the supply of fresh produce in cities with all the guarantees of quality, particularly in terms of health. He relied on a participatory methodology that has been instrumental in achieving the objectives.

On the sites selected for development, analysis of soil and irrigation water that were performed showed a contamination of irrigation water by the germs Escherichia colly, Streptococci and Salmonella. The recommendations provide for adjustments to avoid the use of contaminated water for irrigation. A teaching document has been prepared on "Water management and soil fertility at the plot of cultures."

The project succeeded in establishing dynamic sectors of the Urban and per-iurban Agriculture. Decisions are made for improving the conditions of production of vegetable and also to improve the sanitary quality of products.

Key words: Health, agriculture, urban, peri-urban, evaluation, irrigation

Antioxidant, Nutritional and Anti-Nutritional Compositions of two Socio-Economically Important Forest Food Tree Species from Rainforest Ecosystem of Nigeria

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Nigeria, München

Abstract

Fruits are important for growth, maintenance of good health and vitality due to their richness in essential nutrients, vitamins, natural antioxidants and low anti-nutrients content. Rainforests contain many edible fruit tree species with immense socio-economic, nutritional and cultural importance. They serve as alternative sources of food and income and thus contribute to food security and rural poverty alleviation. The antioxidant, nutritional and anti-nutritional compositions of two socio-economically important forest food tree species (*Garcinia kola* and *Chrysophyllum albidum*) fruits from tropical rainforest ecosystem of Ondo state, Nigeria were investigated. The proximate compositions investigated were: moisture ash, fat, fibre, carbohydrate, and protein while tannin, saponin, alkaloid, phytin phosphorus while phytate and oxalate were the anti-nutritional compositions determined. Total phenolic content, total flavonoid, vitamin C and DPPH were the antioxidants investigated. Results show that the edible portions of *C. albidum* (i.e. fruit pulp) and *G. kola* (i.e. seed kernel) have significantly higher fibre (range: 1.94–16.58% for *C. albidum* and 0.53–3.33% for *G. kola*), protein (range: 2.68–3.45% for *C. albidum* and 1.0–1.74% for *G. kola*) and fat (range: 0.71–1.65% for *C. albidum* and 0.38–0.95% for *G. kola*) contents than their inedible parts. Carbohydrate content was significantly higher in *G. kola* seed kernel (range: 5.81–21.79%) than the inedible portion but significantly lower in *C. albidum* fruit pulp (range: 1.1–14.71%) than the inedible portion. Anti-nutrients content in *G. kola* and *C. albidum* fruits (especially their edible portions) were low, indicating that their consumption will not pose any serious nutritional or health problems. The low anti-nutrients also implies that the absorption of minerals essential for metabolism of the body (e.g. iron, magnesium, potassium, calcium and amino acid) will not be prevented. The antioxidant compositions of the edible portions of the two species were generally high, implying that they can be good sources of natural antioxidants, can play important role in controlling oxidative stress and can be used as supplement in food manufacturing. Thus, *C. albidum* and *G. kola* fruits contain essential nutrients and antioxidants necessary for good functioning of human body as well as low anti-nutrients content that will not prevent absorption of essential minerals.

Keywords: Antioxidant, nutritional and anti-nutritional content, edible fruit trees, tropical rainforest, *Garcinia kola*, *Chrysophyllum albidum*, Nigeria

Impact of Pesticide use in Vegetable Production in South East Ghana

Emmanuel Salu, Ghana

Introduction

The majority of Ghana's population depends on agriculture as the main source of employment and sustainable livelihood. In the south eastern coast of Ghana, there is a long stretch of sand bars between the Keta lagoon and the Atlantic Ocean. The people in this area are mainly fishermen but with increasing population there developed an intensive agricultural production.

Vegetable production in Anlo coast land

Vegetable cultivation in the area is dependent on a substantial input of manure and irrigation from shallow wells. There are three seasons for shallot cultivation within a year but irrigation is important because of the semi arid climatic condition of the area. The people produce pepper, okro, tomato and shallot for sustainable income levels. This is because the profit margin is low in growing shallot alone. The sandy soils are low in organic matter and clay content. The topsoil is shallow but 1meter depth groundwater is found. The shallow groundwater is not salty. The plant nutrient content is low but the heavy application of manure has raised the nutrient level.

Problems of Pesticides used in production

The vegetable farming is done on man-made sand beds located in areas with easily accessible shallow ground water. Initially cow dung is used during the three major planting seasons of the year but has the problem of regenerative weeds and weed control continues to be a problem. Most vegetable farmers in Ghana (87%) use synthetic chemical pesticides to control pests and diseases on vegetables. They include lindane, endosulfan and DDT which are restricted or banned in Ghana

Research work

A survey conducted in the Keta District is to determine the sources, types and application frequency of pesticides used on vegetables. It is aimed to identify the levels of residues remaining on vegetables and whether these exceeded Code MRL.

Research findings

Farmers failed to adequately protect themselves. Most of them rely on experience o measure the amount of pesticide to be applied. Residues of chlorpyrifos, DDT, cypermetthrin and dimethoaste were detected in 90% of of samples submitted for Gas Chromatography analysis. Over 50% of samples had chlorpyrifos residue levels above Codex and EU MRLs of 0.05mg/kg.

Implications. Due to close proximity of agricultural fields to water such as the Keta lagoon the use of DDT and Gammalin 20 (lindane) poses health hazard to residents and consumers of food produced in the area. These products are Persistent Organic Pollutants. Residues of DDT have been detected in wells in the area. It is possible that leaching and runoff in the rainy season could transfer these from the agricultural field to drinking wells in households and into the Keta lagoon which is a fishing ground for the surrounding communities of Atiave, Anyako and Afiadenyigba.

Assessment of environmental risks associated with the introduction of genetically modified cowpea (Bt-Cowpea) in Africa

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Abstract

Cowpea (*Vigna unguiculata*) is a diploid plant species contributing significantly to food security in developing countries, especially in Africa where it feeds people, their livestock and the next crop. In connection with the upcoming introduction of the Genetically Modified (GM) cowpea in Africa, environmental risk through genetic swamping of the Bt-gene is the main concern. Using starch gel electrophoresis, alleles frequencies and gene flow were assessed within and between natural populations of wild *V. unguiculata* by (1) Determining the level of outcrossing in a natural population (tm, ts) using computer program of Ritland (2) estimating the number of migrant in a population per generation (Nm) by the help of Wright formula and Slatkin method, (3) evaluating the relationship betweens outcrossing rates and climatic conditions using Pearson correlation coefficients of the SAS Software. These analyses showed that Gene flow is more pronounced within than between populations of cowpea. We found that gene flow is quite dynamics with cowpea, changing with time with strong correlations with climatic conditions. Gene escape was found to be negatively associated with rainfall distribution and positively correlated with temperature. Implications of these results in the light of the releasing of genetically modified cowpea in Africa are discussed.

Keys words: *Vigna unguiculata*, gene flow, Outcrossing rate, Genetically modified cowpea

Variation in vitamin C, calcium and iron in baobab (Adansonia digitata L.) fruit pulp from Mali: opportunities for domestication and food security

David Simbo, Senegal

Abstract

The Sahel region of West Africa is characterized by low rainfall during a short rainy season lasting only three months with an extended dry season lasting 9 months of the year. With an annual population growth of about 2.5%, higher than the annual increase in crop production of 2% (World Bank 2004), local people rely on trees and shrubs found in the parkland to meet some of their nutritional needs (Kalinganire et al. 2008). Among the priority species identified for domestication in the Sahel region of Sub-Sahara Africa is the baobab (*Adansonia digitata* L.) tree. The baobab is known to be rich in nutrients and vitamins (Chadare et al. 2009). The quantification of the variation in nutrient content and fruit morphological traits of trees is one of the most important steps in identifying superior planting material for domestication to ensure food security. Ten provenances in Mali covering all the different agro-ecological zones were selected and the fruit morphological traits, vitamin C, calcium, iron and colour were studied. Mean pulp content was 2149 ± 1117 mg kg^{-1}, 2406 ± 776 mg kg^{-1} and 25 ± 17 mg kg^{-1} for vitamin C, calcium and iron, respectively. Fruit pulp colour varied from white, creamy to pink and a significant correlation between pulp vitamin C content and reflectance in the green and blue bands was observed. Significant negative correlations were found between rainfall and pulp vitamin C content and between mean annual temperature and fruit and pulp weight and pulp fraction, suggesting that these traits are influenced by the environment. Pulp iron content correlated positively with topsoil sodicity and base saturation. Similarly, pulp vitamin C content correlated positively with topsoil sand fraction. Pulp reflectance in the blue and green bands correlated negatively with topsoil pH water and base saturation, respectively. The vitamin C and calcium content of baobab fruit pulp is significantly higher than in most tropical fruits. The correlation between vitamin C content and reflectance is strategic for estimating vitamin C content since reflectance is easier to measure than chemical methods of determining vitamin C content. The variation in fruit nutritive and morphological traits offers the opportunity for selecting plus trees with a combination of desired traits for domestication for fruit production. The domestication of fruit rich in nutrients will contributes reducing food insecurity.

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CBL
Centre of Biodiversity
and sustainable Land Use

SeTSAF

DAAD Deutscher Akademischer Austausch Dienst
German Academic Exchange Service

BMZ Bundesministerium für
wirtschaftliche Zusammenarbeit
und Entwicklung