SOCIETY FOR AGRICULTURE, ENVIRONMENTAL RESOURCES AND MANAGEMENT (SAEREM)

4th

NATIONAL (Virtual) ANNUAL CONFERENCE

BOOK OF ABSTRACTS & PROCEEDINGS

UNIABUJA2021

THEME:

CLIMATE CHANGE, COVID-19 PANDEMIC INSECURITY, IMPACTS ON FOOD SECURITY, AND ENVIRONMENTAL RESOURCES

Date:15th to 17th November, 2021

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BIOREMIDIATION POTENTIAL OF *Pleurotusostreatus*(Jacquin; Fries) P. Kummer: A CASE OF AGRO-WASTESIN UMUDIKE ABIA STATE.

***A. C. Amadioha and E. N. Nosike**

Department of Plant Health Management, Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State

*** To receive all correspondence; amadioha4u@yahoo.com**

ABSTRACT

Biodegradation of agricultural wastes that constitute major source of environmental hazards and pollution by *Pleurotusostreatus* is of importance in bioremediation of plant organic residues. Different agro-wastes; saw dust (SD), sugarcane baggasse (SB) and maize stalk (MS) and in combination (SD+MS, SD+SB, SB+MS, SD+MS+SB), were used to investigate the polysaccharide degrading potentials of *P. ostreatus*at the Department of Plant Health Management, Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State.The fungus significantly ($P \leq 0.05$) degraded the hemicelluloses, cellulose and lignin contents of the substrates though to varying degrees. The loss of polysaccharide content of the test substrates due to the fungus ranged as follows; hemicelluloses, from 20.64% with MS substrate to 48.92% with SB substrate; cellulose from 24.06% with SD substrate to 41.92% with SB substrate and lignin content from 4.01 % with MS substrate to 27.45% with SD substrate. The average delignification of the substrate polysaccharides by *P. ostreatus*was highest with SB substrate (37.86%), followed by SD+SB substrate (31.76%) and SD substrate (27.56%). This not only showed the ability of *P. ostreatus*to degrade agricultural wastes efficiently and grow at a wide range of substrates but also a potent organism capable of biodegrading and detoxifying a wide range of wastes and pollutants.

People Awareness, Perception and Coping Strategies to Covid 19 Pandemic in Nigeria.The Case Study of Kuje Area Council Abuja.

Paul, A. H., Hauwa, B. and Joy, A. P.
Department of Agricultural Extension and Rural Sociology. Faculty of Agriculture
University of Abuja, Nigeria.
National Space Research Development Agency (NASRDA) Obasanjo Space Center
UmaruYardua Express Way, PMB 437 Lugbe Abuja
National Biotechnology Development Agency FCT Abuja

Abstract

The study examined People Awareness, Perception and Coping Strategies to Covid 19 Pandemic in Kuje Area Councils, Federal Capital Territory, simple random techniques was used to select 100 respondents for the study. A well-structured questionnaire was used to elicit information from the respondents. Data obtained where analysed using descriptive statistics like percentage and frequency. The respondents were within the age range of 40-60, majority (52%) of the respondents are civil servants who are majorly (83%) married with household size of between 2-10 persons. Majority (96%) of the respondents are aware about covid-19 pandemic in their area, and agreed that dry cough (23%), fever (56%), tiredness (11%) and loss of taste/smell (10%) are major symptoms of covid-19 pandemic. Mode of transmission of covid-19 according to the respondents are through body contact (23%), through body droplet like saliva and sweat (53%), shaking of hands (19%) and illicit behavior (5%). Most (67%) of the respondents have not done the covid-19 test. Coping strategies based on the respondents are through salaries (50%), donations (21%) and other (29%) means. Donations from family (48%), friends (22%), Religion Organization (13%) and Government (7%) are many coping strategies accessed by the respondents. Behavioral dimension of coping strategies of the respondents indicates washing of hands often (27%), avoiding public/events places (43%), avoiding public transportation (10%) and contact with risk group (16%). Constraints caused by covid 19 pandemic in the study area on a Likert scale are increased level of poverty (41%), high rate of sickness and disease (40%), high rate of death (59%), loss of jobs (63%) and high cost of standard of living (67%). Conclusion of the study is that people are aware of covid-19 pandemic and have developed some coping strategies to make them survival the period. Recommendations include Government must make available covid-19 testing centers closer to the people and corruption should be eliminated from the government palliatives distribution through proper monitoring and evaluation.

Keywords: People, Awareness, Perceptions, Covid-19, Pandemic

Welcome and Opening Remarks at the 4th Annual National (Virtual) Conference of Society for Agriculture, Environmental and Management (SAEREM)

BY Prof. E. M. Agu (National President)

With Profound gratitude to God Almighty I welcome all of you to the 4thAnnual National (Virtual) Conference of Society for Agriculture, Environmental and Management (SAEREM). After leaving Calabar last year, we had no idea that a year later we would be hosting the first virtual conference this year. We are sorry that we need to meet virtually rather than in person but obviously due to COVID-19, we have no choice. I thank all our Central Organizing Committee, Conference Editorial Committee, Local Organizing Committee and all participants in this event. Special thanks go to the National secretary and his team for planning and organizing this event. **SAEREM** is a peer-reviewed open access interdisciplinary research-based organization, which provides a wider view on topical issues as addressed by the central theme of this year's conference **"Climate Change, Covid-19 Pandemic, Insecurity Impacts on Food Security, and Environmental Resources"**.. After brainstorming, we hope to come out with holistic results, for policy formulations and workable recommendations.

Now, in only a short period of time, the COVID-19 pandemic has unleashed an unprecedented crisis, causing further disruption to SDG progress, with the world's poorest and most vulnerable affected the most. Climate change is not just an environmental problem but a threat to food and human security.

Nigeria's situation with regards to climate change is serious, but not hopeless. If Nigeria is to effectively tackle the enormous challenges to food security presented by climate change, then innovation and awareness of climate change impacts should be cultivated in all parts of the agricultural ecosystem. Food security is a significant step in ensuring a life of dignity for every Nigerian. Given its vast resources, Nigeria has the opportunity to become a global leader in building a productive and resilient agricultural system for the 21st century.

The major threat to the agricultural sector is insecurity from both the Boko Haram and Fulani herdsmen. In the northeast of Nigeria, the sustained terrorist activities of the Boko Haram have had negative impact on agricultural activities. Not only are farming activities incapable of being carried out under an insecure environment, domestic agricultural production is stifled, farming communities are displaced and access to regional market is blocked. In addition to the Boko Haram group, the Fulani herdsmen have become a major threat to farming communities due to incessant attacks on these communities with attendant fatalities.

Finally, I wish to appreciate our keynote Speaker for this year conference, Prof. Adeshola O. Adepoju, and the Lead Speakers, Prof. Samuel O. Agele, Prof. Cordelia I. Ebenebe, Prof. Umunagbu S. Offor, for their great work. Thank you all.

4TH NATIONAL ANNUAL CONFERENCE OF THE SOCIETY FOR AGRICULTURE, ENVIRONMENTAL RESOURCES AND MANAGEMENT (SAEREN)

THEME

"CLIMATE CHANGE, COVID-19 PANDEMIC, INSECURITY, IMPACTS ON FOOD SECURITY AND ENVIRONMENTAL RESOURCES"

"Climate change, Covid 19 pandemic and National insecurity: Triple tragedy against food insecurity and environmental resources management in Nigeria"

Keynote Address by

Prof. Adeshola Olatunde Adepoju
Director-General/CEO, Forestry Research Institute of Nigeria

Preamble

I want to thank the organizer of this conference and the leadership of the Society for Agriculture, Environment Resources and Management (SAEREN) for inviting me as keynote speaker in this conference with the theme **"climate change, covid-19 pandemic, insecurity, impacts on food security and environmental resources".** It is therefore with utmost great delight and singular honour that I will be addressing our esteem participants on the topic **"Climate change, Covid 19 pandemic and national insecurity: Triple tragedy against food insecurity and environmental resources management in Nigeria".**

The theme of this conference is apt and timely, and could not have come at a better time like this given the all-encompassing change, past and present tragedy, as well as unprecedented scenarios created by the triple effects of climate change, global pandemic outbreak and insecurity on all facets of human activities and livelihood, environment and economy at large. The natural environment is humanity's first line of defence against many hazards and a healthy planet is a pre-requisite for healthy people and that in turn is the foundation of a healthy economy.

Concept of Food Security

Distinguished Ladies and Gentlemen,

The term **"food security"** first emerged in the mid-1970s, at the World Food Conference (1974). Food security was then defined as "*assuring the availability and price stability of basic foodstuffs at the international and national level*" (FAO, 2006). However, after this conference, the concept of food security further evolved into a general acceptable definition which was adopted during the World Food Summit in 1996. It was then agreed that food security *"exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life"* (FAO, 2008, 2009; Burke & Lobell, 2010; Jones et al., 2013).

EFFECT OF DEHYDRATION METHODS ON LYCOPENE AND VITAMIN C CONTENTS OF TOMATO VARIETIES GROWN IN KANO, NIGERIA.

***Ibrahim Bala[1], Farida U. Ahmad [2], Abdullahi T. Ibrahim[3], Ahmad K. Yerima[4] and Khadija M. Aminu[5]**
[1,2,3,4]Nigerian Stored Products Research Institute, Plot 24, Batawa Close, P.M.B. 3032, Kano [5]Bayero University, Kano, P.M.B 3011, Kano State, Nigeria.
***Corresponding Author Emails binbala04@gmail.com**

ABSTRACT

This study investigated the effect of three dehydration methods on Lycopene and Vitamin C contents of three commonly grown tomato varieties in Kano state, Nigeria. The level of lycopene and vitamin C were determined using standard protocols. Data collected were subjected to analysis of variance and mean differences were compared at 5% probability level. There were significant ($p< 0.05$) decrease in the level of lycopene and vitamin C of each variety after drying relative to dehydration methods. Lycopene contents were in the order: cherry>grape>plum both in fresh and dehydrated forms. The percentage decrease in lycopene contents (39.50%, 27.59% and 35.08%) was highest with sun-drying method for plum, cherry and grape tomatoes respectively. Although, vitamin C were evaluated in the fresh forms as 13.08±2.22mg/100g, 13.53± 3.23mg/100g and 15.05±2.91mg/100g for plum, grape and cherry tomatoes respectively, however, each of these value reduced by about 80%, 70% and 60% respectively after sun-drying. Cherry tomato in this study had more of lycopene and vitamin C and their retentions were better after drying in all methods of dehydration than the 'grape' and plum tomato varieties. It is therefore pertinent to say that sun-drying of all tomato varieties lead to more reduction of lycopene and vitamin C than the parabola tent dryer and cabinet food dryer.

Keywords: bioactive, functional, dehydration, tomato varieties

RESOURCE USE EFFICIENCY AND PROBLEMS OF VEGETABLE PRODUCTION IN AKWA IBOM STATE, NIGERIA

[(1)]Eteyen E. Nyong [(1)] Matthew Ekaette [(2)] Esther B. Enaregha
[1,] Department of Agricultural Economics & Extension, Faulty of Agriculture., Akwa Ibom State University,Nigeria. [2)] Biology Department, Isaac Jasper Boro College Of Education, Sagbama ,Bayelsa State, Nigeria.

Abstract

The study assessed the profitability and problems of vegetable production in the flood plains of Akwa Ibom State, Nigeria. Multi-stage random sampling technique was used in the selection of 120 respondents. Data were collected with the aid of questionnaire and analyzed with descriptive statistics, gross margin and mean score from three point Likert type of scale. The results showed that most of the vegetable farmers were married, in their active age of 47 years and a mean household size of 8 persons with an average farm size of 1.1 hectares. The study estimated N165, 775 as the gross margin per hectare with a net return of N150, 525 and a benefit cost ratio of 2.28. Vegetable farmers in the area were constrained with inadequate access to credit facility (mean score=2.71), poor storage and processing facilities (mean score=2.42) and perishability of the produce (mean score=2.30). It is recommended that vegetable production should be encouraged in flood areas of the state due to its profitability. Also, farmers should organize themselves into cooperative societies to access credit facilities and expand their scale of production.

Keywords: Fadama, Farming, Marketing, Perishability, Vegetable

Data obtained were subjected to analysis of variance and treatment means compared at Duncan multiple range tests at 5% probability level. There were significant ($p<0.05$) difference in the physicochemical parameters between variants of vegetable baskets. There were decreasing trends in each of moisture, vitamin C, ß-carotene, total chlorophyll and carbohydrate contents in terms of reduction of weight loss, (3.7% weight loss), properties retention (85.36%, 98.04%, 94.90% and 45.38% vitamin C, total chlorophyll, ß-carotene and carbohydrate contents respectively). In all, jute wrapped vegetable baskets performed better than the foam wrapped vegetable baskets. The order of performance in physical, microbial and physicochemical properties retention in the various vegetable baskets are: JSB(0.5L:8hourly) > JSB(0.75L:8hourly) > JBB(1.25L: 12hourly) > JBB(1.25L:8hourly) > JBB(1L:8hourly) > FSB(0.5L:8hourly) > JSB(0.75L:12hourly) > JBB(1L:12hourly) > JSB(0.5L:12hourly) > FSB(0.75L: 12hourly) > FBB(1L:8hourly) > FBB(1.25L:12hourly).

INTEGRATED MANAGEMENT OF *Cylas puncticollis* (Boheman) IN UMUAHIA NIGERIA.

Tochukwu-Okpara, U. G., Emeasor, K. C. and Asawalam, E. F.
Department of Plant Health Management, College of Crop and Soil Science, Micheal Okpara University of Agriculture, Umudike, Abia State.

Abstract

Cylas puncticollis (Boheman) is a major insect pest resulting in the reduction of the quality and quantity of sweetpotato roots. Integrated management practices in agriculture can be a suitable option to the hazardous use of synthetic insecticides. In Umuahia Nigeria, two field experiments were carried out in two cropping seasons on Umuspo/1 and Umuspo/3 orange fleshed sweetpotato varieties were: (i) Three levels of earthing-up and (ii) Mulching with leaves of three plants; *Tephrosia vogelii, Alchornea cordifolia* and *Ageratum conyzoides*. The 2×4 factorial experiments were laid out in randomized complete block design with three replicates. Plot size was $6m^2$. Parameters evaluated were weevil population density, progeny development, marketable and unmarketable roots. There was high significant difference ($P\leq 0.05$) in the low weevil population density observed on the mulch plots, where plots mulched with *T.vogelii* had 4.54% at 6 weeks after planting (WAP) to 13.72% at 12 WAP in 2018 and 2.31% at 6WAP to 11.50% at 12WAP in 2019. Thrice earthing-up plots significantly recorded low weevil population density than twice and once levels of earthing up plots, in both cropping seasons. *T.vogelii*mulched plot obtained lower *Cylas puncticollis* progeny development and higher marketable roots among mulched plots in both cropping seasons. Similarly, thrice earthing-up plots obtained lower *Cylas puncticollis* progeny development and higher marketable roots. Generally, higher ($P\leq 0.05$) weevil population density, progeny development, and unmarketable roots were recorded in the controls. These studies revealed the effectiveness of earthing-up thrice practice and mulching with botanical leaves for better management of *Cylas puncticollis*. This integrated management practices should be practiced for sustainable orange fleshed sweetpotato food security in Nigeria.

Four pillars sustaining food security (Simon, 2012; Committee on World Food Security, 2011; UN, 2015)includes ***Availability***(The availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports (including food aid)); ***Access*** (access by individuals to adequate resources for acquiring appropriate foods for a nutritious diet); ***Utilization*** (utilization of food through adequate diet, clean water, sanitation and healthcare to reach a state of nutritional well-being where all physiological needs are met); and ***Stability***(to be food secure, a population, household or individual must have access to adequate food at all times). This infers that a nation whose food production level is unable to satisfy these four aforementioned criteria is said to be food insecure.

Food security has become an issue of global concern in the recent time with multidimensional economic, environmental and social implications. Nigeria, with her huge endowed natural and human resources is not spared. Human global population is currently estimated at 7.9 billion. Predictably, this is expected to reach 8.6 billion by 2030 and 9.8 billion by 2050. Similarly, Nigeria with the largest population of over two hundred thousand people in Africa and growing at 3.2% per year is projected by year 2050 to become the third most populous country of 402 million people in the world, after China and India. These exponential increase in population and urbanization will have implications on the limited finite natural resources, including food and land use. *"While population increase is a common phenomenon and grows in arithmetic progression, food production is growing in geometric progression and therefore does not match population increases. This has led to what is known as a food crisis" (Igbokwe-Ibeto, 2019).*

Nigeria is ranked 98th out of 117 countries on the 2020 Global Hunger Index with a score of 29.2 (Figure 1). An estimate of about 3.7 million people, across 16 states in Nigeria are food insecure. Estimates suggest that the number of people pushed into extreme poverty in 2020 is as high as about 49 million people, with around half of this increase occurring in Sub-Saharan African countries. According to SWAC/OECD (2020), Nigeria ranked among the world's 10 worst food crises in 2019, with 5 million food insecure people which by 2020 has increased 7.1 million acutely food-insecure people (Figure 2). Food importation as a result of insufficiency have continued to be on the rise in Nigeria, a country once noted as the highest food producer in sub-Sahara Africa. Imagine the interception by Nigeria Customs Service of a 20ft container of Egusi soup, Ogbono soup, and yam porridge imported from India into Nigeria in 2016 and possibly still on going.

The United Nations **Food and Agriculture Organisation (FAO) and the** United Nations World Food Programme (WFP) on jointly published a report on **Hunger hotspots FAO-WFP early warnings on acute food insecurity August to November 2021 outlook. Based on this recent report which also coincide with the theme of this conference,** *covid-19, conflict and climate crises are expected to drive higher levels of acute food insecurity in 23 hunger hotspots* (Nigeria inclusive) *over the next four months* (Izuaka, 2021). This is just as acute food insecurity continues to increase in scale and severity.

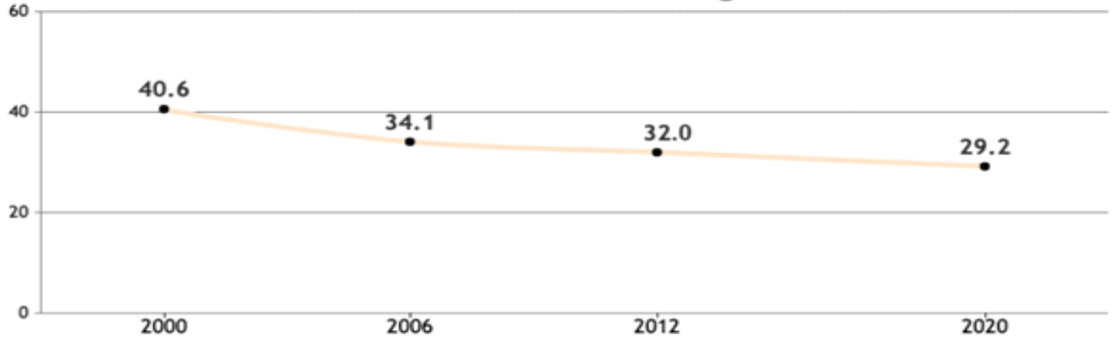

Figure 1: Global Hunger Index Score Trend for Nigeria
Source: https://www.globalhungerindex.org/pdf/en/2020/Nigeria.pdf

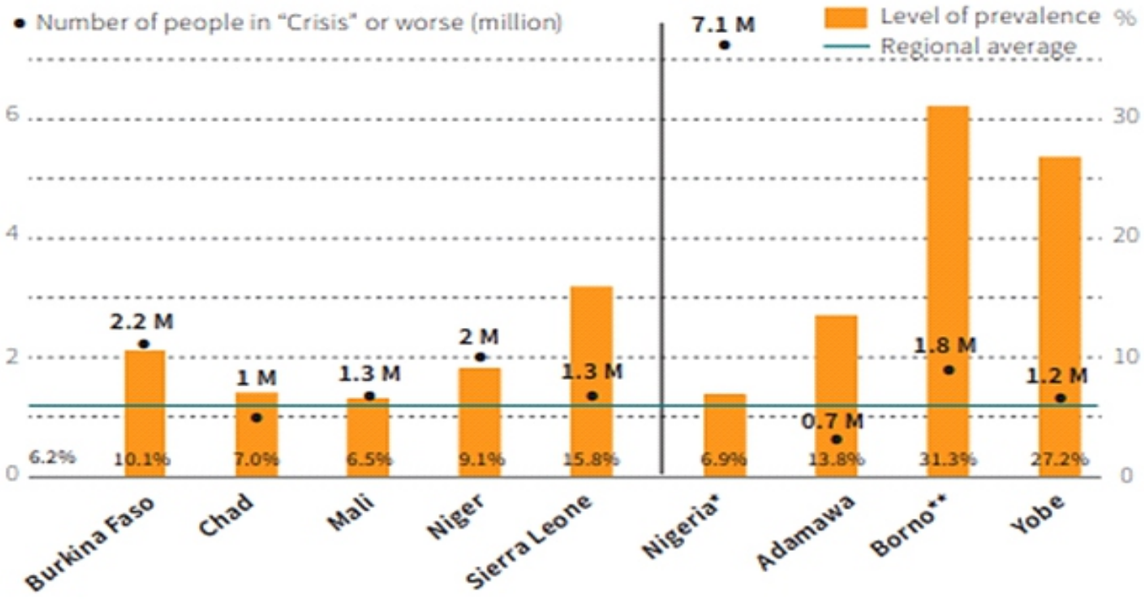

Figure 2: Prevalence of Severe Food Insecurity in Africa
Source: SWAC/OECD (2020)

The report further asserted that in 2020, 155 million people were estimated to be in acute high food insecurity across 55 countries. This is scaled up by 20 million from 2019. This deteriorating trend as driven by conflict dynamics, as well as the impacts of the COVID-19 pandemic and climate change is continuing well into year 2021. These deteriorating trends are mostly driven by conflict dynamics (particularly, rising violence and persisting nationwide inflation) as well as the impacts of the COVID-19 pandemic. This situation is evident by consistent spikes in food prices, restrictions of movement limiting market and pastoralists activities, increasing inflation, retrogressive purchasing power and an early and prolonged lean season. The COVID-19 pandemic outbreak and the control and mitigation measures enforced worldwide, combined with the massive economic impacts of these necessary measures further complicated the issue of food insecurity.

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Understanding the Drivers of Adoption of Climate Smart Agriculture (CSA) among Smallholder Crop Farmers in Agroecological Zone D Area of Kogi State, Nigeria: Policy Options for Improved Food Security By

Shaibu, U.M., Otaru, A.O. and Haruna, M.
Department of Agricultural Economics and Extension, Kogi State University, Anyigba, Nigeria

ABSTRACT

The adoption of Climate Smart Agriculture (CSA) in meeting the Sustainable Development Goal on zero hunger without damaging the environment cannot be overemphasized This study assessed the factors that influenced adoption of climate smart agriculture (CSA) among smallholder crop farmers in agroecological zone D area of Kogi State, Nigeria. Primary data obtained through questionnaire administration from one hundred and twenty (120) crop farmers were analysed using descriptive statistics and ordered logit regression model. The major CSA practices adopted by the crop farmers include; early planting (88.3%), minimum tillage (85.8%), mulching (85%), off-farm practices (83.3%), reliance on personal experience to predict weather events (82.5%), application of organic manure (81.7%), planting of covers crops (77.5), and farmer – farmers' knowledge sharing (75.8%). The major drivers of crop farmers' adoption of CSA practices include age, farming experience, cooperative membership, and extension visit. Age and farming experience Older crop farmers with high farming experience were less likely to be found in the low adoption category and more likely to fall under the medium and high CSA adoption category; while increased extension visits favour high adoption category. This study advocated for simulation between indigenous knowledge and modern agricultural practices to ensure a smooth transition to CSA in the study location. It is also important for the Kogi State government and the Kogi ADP to develop and execute more elaborate capacity building programmes at the local through extension service delivery on CSA practices.

Keywords: agriculture, climate, food security, knowledge smart, World Bank

Physicochemical properties of stored African Spinach (*Amaranthus Species*) Using Two Variants of NSPRI's Vegetable Basket

Bamishaiye E. I., Adu E. A., Saka H., Bala I., Jude J. Isiaka A. A. and Kamaldeen S.O.
Nigerian Stored Product Research Institute, Kano

Abstract
Vegetables are consumed because concentrations of vitamins, especially C and A; minerals and other phyto-chemicals in the form of antioxidants. NSPRI vegetable baskets were constructed and wrapped in two variants; one of foam and the other of jute and these variants were of two categories as large and small in terms of size. African spinach (*Amaranthus species*) were weighed and stored with different volume of water being sprayed at different time interval for a period of seven days in each of the vegetable basket. Storage temperature and relative humidity and Percentage weight loss were measured. Physicochemical parameters such as moisture, vitamin C, ß-carotene, total chlorophyll and weight loss were evaluated using standard protocols.

The results of Tobit model show that sigma (δ) was 0.137 (p<0.00). All the included explanatory variables had expected signs which imply that they follow the a priori expectation as regard to poverty status in the study area. It is concluded that artisanal fishery is a profitable venture engaged by majority of youthful populace in the fishing communities of Akwa IbomState, Nigeria. However, they are bedeviled by their socio-economic dispositions which had relegated them to low social stratum of the society as indicated by their high poverty incidence, depth and severity. It is recommended that artisanal fishermen in the study area should adopt technology capable of increasing not only the profitability of the enterprise and improvement in the quality of life of rural households but also make efficient use of the fishing resources. They should also engage in fish value addition activities in order to diversify and increase their income level.

Keywords: Artisanal fishery, Resource Use Efficiency, Poverty status, FGT and Tobit Models.

EFFECT OF BACTERIAL SEEDING AND SOIL AMENDMENT ON PERCENT BASE SATURATION OF CRUDE OIL POLLUTED ULTISOL OF SOUTHERN NIGERIA.

(1)Etukudoh, Ndarake Emmanuel (2) Roland Gbarabe(3) Chukwumati John
1, Department of Soil Science, Faulty of Agriculture., Rivers State University of Science and Technology, Port Harcourt. Nigeria. 2)Elechi Amadi Polytechnic, Romala, Rivers State, Nigeria.(3) Department of Soil Science, Faculty of Agriculture University of Port Harcourt, Nigeria.

Abstract

A pot experiment was conducted at the Rivers State University of Science and Technology, Port Harcourt, Nigeria to evaluate the effect of bacterial seeding, Urea and Poultry manure (PM) on percent base saturation (% BS) on crude oil polluted Ultisol of Southern Nigeria. Each port weighting 3kg was contaminated to 2, 5 and 10% (W/W) with Bonny Light crude oil of 0.835 relative density(specfic gravity). Seven (7) days after, each level was amended with Urea and PM, thereafter the pots were seeded with Acinetobacter clavatus, Bacillus subtilis, Pseudomonas aeruginosa and Conynebacterium diptheriae. Unamended and unseeded soils were also included to serve as controls. Treatments were replicated three times, completely randomized and arranged in a Green house. Results showed that % BS decreased with increased in crude oil percent applied. Higher % BS values were observed in the PM amended soil as compared to Urea and the unamended soil treatment options. At week 9, soil inoculated with Pseudomonas aeruginosa had higher %BS in all treatment options in 0-10% pollution levels, Thus, Pseudomonas aeruginosa biostimulated with PM are recommended as suitable agents for improving % BS of crude contaminated Ultitsol in Soutern Nigeria.

Key words: Biostimulated, Bacterial seeding, Inncuiation, Amended, Bonny Light, A naerobiosis, Metabolic.

Nexus between Climate change, Food Security and Environmental Resources Management

One of the greatest challenges of this century is recognized as climate change issue which is also identified as a predominant threat to agriculture and food security, particularly in Sub-Saharan African Countries. Over 59 million people in 24 countries in Africa were reported to have been affected by the impact of climate change variability on acute food insecurity and malnutrition (FAO; IFAD; UNICEF; WFP; WHO, 2018).

Climate change have direct effect on food productivity and performance at the agriculture end of the food chain. It influences the quantity as well as quality of agricultural production (Sowunmi & Akintola, 2010) as well as production-related income. Soil moisture, fertility and farming output are affected by climate climate variability and change which in turn translates to stability and sustainability of sufficient food from the agricultural sector. According to FAO (2020), the negative consequences of climate change on agriculture is expected to be more severe across all the countries of the world by year 2030.

Despite Nigeria's favourable climatic, agro-ecological, and cultural diversities and endowments, food insufficiency is still prevalent in the country. The discovery and dependency on oil has dealt a serious blow to the structure of the economy as it relegated agriculture, previously the mainstay of the Nigerian economy, to the background. Nigeria which should be an exporter of various food items in the world have unfortunately become a major food exporter arising from food insufficiency and not been able to meet up with demand. Sadly, the state of food production in the country is worsened by the phenomena of climate change and global warming (Igbokwe-Ibeto, 2019).

Most farmers particularly in Nigeria predominantly practice rain-fed agriculture, which makes them vulnerable and susceptible to continued unreliable and extreme climate issues including droughts, flooding, heat waves, consequently leading to soil degradation and low crop yield. Majority of these farmers who are smallholder farmers with relatively low-level of technologies are always at the mercy of extreme weather conditions and unpredictable rainfall trend. Variability in temperatures and weather conditions do have implications and long-term adverse effects on agricultural output which subsequently have direct effect on food supply resulting in national food crises.

We are all experiencing and noticing the evidence of climate change. Particularly, farmers worriedly look at the sky in anticipation of rain. They keenly wait for the onset of the prolonged rainy season for planting to no avail. However, the increased temperature and precipitation changes, and irregular weather fluctuations comes with attendant negative consequences. Climatic variability and changes have been associated with erosion, increased flooding, environmental degradation (Echendu, 2020) and a decrease in agricultural productivity (Teklewold et al., 2013; El-ladan 2014). The Northern states of the country is persistent with desert encroachment and extreme droughts. Similarly, gully erosion and periodic flooding crises are apparent in the Southern region of the country (Medugu et al., 2008; Abaje et al., 2013). Generally, loss of biodiversity, dwindling water resources and supplies, land degradation, erratic energy supply, heat stress, increase in pests and diseases of crops and livestock, rise in sea level and general decline in yields of agricultural produce are now common norms in the country. All of these are both direct and indirect consequences of climate change.

Climate change has been identified to be among the major causes of rising global hunger (FAO 2017; UN 2018). Intense weather events as a result of climate change are likely to impact the welfare and food security status of both the rural and urban populace through poor food production, poor land availability, and reduced opportunities (Firdaus, et al., 2019). Flooding and soil erosion is a major threat to continued agricultural productivity.

While optimum rainfall in some areas could be advantageous to food production, however, various reports from some northern states of the country have shown that 'torrential rains destroyed lives and 5,787 farmlands in Bauchi State in August 2009' (Akhakpe 2018). Similar occurrences happened in most coastal states of Nigeria usually referred to as the food basket of the nation in year 2011 and 2018. Equally, flooding in rice-producing Kebbi State in year 2020 destroyed over 25% of Nigeria's expected 8 million tons of rice harvests.
Also, interrelationships between conflicts and climate change have been established in the country. Deadly conflicts between farmers and herders, as well as resultant land displacement are usually worsened by climate change. Inhabitants whose means of livelihoods have been exacerbated by flooding, soil erosion, desertification and drought may resort to alternative means of livelihoods. The insurgency in the North is intricately linked with dwindling water resources in the Lake Chad which led to agricultural system failure made farmers to flee from their base.

In addition, the impact of climate change on the world's ecosystems and environmental resources cannot be quantified, as it threatens both world's economic system and human livelihoods. The unwholesome interaction of man and environment through deforestation, urbanization, burning of fossil fuels, population explosion and a host of others, contribute substantially to climate change issues. The consequential effects of these interactions pose grave danger to life, not only to human beings but also to plants/crops and animals. UN nature reports found out that over 1 million flora and fauna species face the risk of extinction, implying that we are losing critical parts of the earth system. Many of the species (both flora and fauna) going into extinction form the food chain for hundreds of thousands of other species. Unsustainable use or overexploitation of any of the ecosystem services creates a gap in the food chain, which ultimately affects all of humanity negatively. General assessments on climate change reveals that, without an effective adaptation, global harvests could decline by around 30 percent come 2050. This means that a country like Nigeria that is already surviving with pollution, flood, deforestation, and some other environmental challenges are likely to suffer the burden of these impacts.

Nexus between Covid-19 Pandemic, Food Security and Disruption of the Forest Ecosystem
The unprecedented scenarios, disruption and negative consequences of the novel Covid-19 global pandemic outbreak on all facets of human activities, ecosystems, biodiversity and world economy at large has reminded us that the earth is a complex and dynamic system. The pandemic has exposed several lapses, limitation, societal vulnerability and humbled humanity by a microorganism that has disrupted as well as destroyed, many lives around the world. The pandemic disproportionately impacted the poor, most vulnerable and marginalized in the society putting them at even greater risk of hardship Nigeria is faced with food security crisis that is heightened by the COVID-19 pandemic and its ripple effects on the food value chain in the country. The pandemic has seriously disrupted already friable value chains across the country, including people's ability to produce, process, and distribute food. Unfortunately, food insecurity has been a major longstanding challenge in Nigeria, as reflected by Nigeria's high Global Hunger Index (GHI), low Food Consumption Score (FCS), and high-calorie deficiency (Global Hunger Index, 2019; Amare et al., 2021), while the World Bank's recent forecasts showed that, globally, the pandemic is likely to push 49 million people into extreme poverty in 2020 (World Bank, 2020a).

According to the report of Global Alliance for Improved Nutrition (2020), Nigeria is facing several food security and nutrition problems, with 32.1 million food and nutrition deficient people, of which an estimated 3.65 million people are deficient as a direct result of Covid-19. Food and nutrition security was significantly impacted amongst households more exposed to Covid-19.

Assessment of Some Physicochemical Properties of Palm Oil Mill Effluent Dumpsite Soils in South Eastern Nigeria

Simeon, Samuel D.[1] Ijah, Christiana J.[2] and IkpeAkamimo M.[1]

UNIVERSITY OF UYO, UYO
Department of Soil Science and Land Resource Management[1]
AKWA IBOM STATE UNIVERSITY, OBIO AKPA CAMPUS
Department of Soil Science[2]

ABSTRACT
Profile pits were dug in five selected palm oil milleffluent dumpsitesin five villages in MkpatEnin Local Government Area of AkwaIbomStateIbomState. The study was aimed at assessing some physicochemical properties inthese dumpsites and control soils. Two profile pits were dug in each of the five locations,samples were designatedand collected at depths namely; 0 - 20, 20 – 40, 40 – 60, 60 – 80 and 80 – 100 cm, respectively. The samples were analysed for physicochemicalproperties. Data obtained were statistically analysed using descriptive statistics, analysis of variance and Duncan's multiple range test (DMRT). Results showed thatpalm oil mill effluent soil also had a significant higher physicochemical properties than the control soil ($p<0.05$). It was also shown from the study that palm oil mill effluent soil also gave higher level among soil properties than the control soil implying that application of palm oil mill effluent has improved nutrient status in the soil. It was therefore concluded that application of palm oil mill effluent has adequately increased soil macronutrients and biomass diversity which are vital for improved crop production especially among the poor farmers who cannot afford inorganic fertilizers in adequate quantity for their crops.

Liver quality indicators among heritage turkey toms administered aqueous *Moringa oleriferia* leaf and seed extracts.

RESOURCE USE EFFICIENCY AND ITS EFFECT ON HOUSE HOLD POVERTY OF ARTISANAL FISHERY IN AKWA IBOM STATE, NIGERIA

[(1)]Eteyen E. Nyong [(1)] Matthew Ekaette [(2)]Nnadi Peace Chigere
[1,] Department of Agricultural Economics & Extension, Faulty of Agriculture., Akwa Ibom State University, Nigeria. [2)] Department of Forestry and Environment, Faculty of Agriculture University of Port Harcourt, Nigeria.

Abstract
The study analyzed the artisanal fishery resource use efficiency and poverty status of fisher folks in Akwa Ibom State, Nigeria. A multi stage random sampling technique was used to select 110 fisher folks from the fishing communities. Primary data were obtained with the aid of structured questionnaire and interview schedule. Descriptive statistics, Net Margin, FGT and Tobit regression models were employed in the analysis of the data. The mean age of the distribution was 41.5 years with production level of 23.05kg/hr and efficiency of 65.44%. The total revenue of N54,334.00 per fisher per month, variable cost and fixed cost are N13,200.70 and N3,821.50 respectively. The gross and net margin were calculated to be N45,340.40 and N39,243.20 respectively with rate of return on Investment of 2.20. The per capita expenditure per adult equivalent (PCEAE) and poverty line were N3,200.43 and N1,421.120 per month respectively. The poverty headcount, depth and severity were 0.8492, 0.455 and 0.2827 respectively.

The result showed that socio-economic variables such as education level (44.1%), age (29.2%), farming experience (35%), and gender (75%) played significant role on cassava production in the area. The cost and returns showed that N240,000 could be generated as net return in every N820,000 invested in cassava production. The profitability indicator revealed 0.413 as return on investment signifying that cassava is a profitable venture in the study area. In spite of all these, 85% of cassava farmers strongly agreed that their productivity was reduced because of covid-19 pandemic, 75% agreed that marketing their produce was a major constraint since access was restricted to markets as a result of the pandemic. Other constraints faced by cassava farmers include; lack of accessible roads, high cost of labour and lack of price information. It was recommended that, young and active population should be encouraged to participate and promote cassava farm productivity and other areas in the cassava value chain.

Key words: Cost and returns, Cassava, production, Covid-19

EFFECT OF PHYTOREMEDIATION GRASSES ON SOIL MICRO-ORGANISMS IN CRUDE OIL CONTAMINATED SOIL IN SOUTH-SOUTH NIGERIA

Chukwumati, J. A and Nengi-Benwari, A. O
Department of Crop and Soil Science, University of Port Harcourt. PMB 5323, Port Harcourt.

ABSTRACT

Soil micro-organisms (bacteria and Fungi) are known to play major roles in nutrient cycling and fertility status of soil, when soil is polluted with crude oil, it negatively impacts on their viability. Against this backdrop, a field experiment at Rivers State University teaching and Research Farm Port Harcourt was conducted to investigate the effect of phytoremediation grasses on soil micro-organisms in crude oil polluted soil. The soil was contaminated with fresh Bonny light crude oil at 0 and 2% v/w; vetiver (Vetiveria zizanioides), guinea grass (Panicum maximum) amended with organic manures (Poultry and Rabbit) were used to remediate the soil for a period of twelve months in two season (wet and dry) seasons. Poultry and rabbit manures were applied at 0,10,20 and 30 tons/ha respectively two weeks after contamination, two weeks later, vetiver and guinea grass splits were planted at a spacing of 20×30cm and 30×30cm respectively. A total of 24 treatment combinations were laid in a factorial fitted into a split plots randomized complete block design. Results showed the population of total heterotrophic bacteria (THB) total heterotrophic fungi (THF) in the soil ranged from 2.3×10^5 to 4.4×10^6 cfu/gand 1.6×10^4 to 1.64×10^5cfu/g respectively for dry season while hydrocarbon utilizing bacteria (HUB) and fungi (HUF) were $1.3\times10^4$to 8.8×10^5 cfu/g respectively. Conversely, the microbial count for rainy season increased from 2.8×10^5 to 2.19×10^8cfu/g and 1.06×10^4 to 1.48×10^5cfu/g for THB and THF respectively while that of HUB and HUF were 3.2×10^4 to $7.2\times10^6$and 7.0×10^3to4.2×10^4cfu/g respectively. There was significant decrease in microbial activities in contaminated soil for THB, HUB, THF and HUF over control in both seasons. Thereafter, the population of the micro-organisms increases more in contaminated over those of control plots especially in rainy season. Remediation of the soil with the grasses increased the proliferation of hydrocarbon degrading organisms. The population of THB and HUB were more than those of THF and HUF in both seasons. Higher population of micro-organisms were observed in rainy season over dry season period. Amendment of the soil with organic manures significantly increased the population of the micro-organisms. The higher the rate of amendment, the higher the microbial population. The number of microbial population were observed to be higher on soil amended with poultry than rabbit manure.

KEYWORDS: crude oil, pollution, micro-organisms, vetiver, guinea grass, poultry, rabbit manures.

The COVID-19 pandemic is a multiplier of vulnerability, compounding threats to food security and nutrition (FSN), while exposing weaknesses in food systems. Before the outbreak of the COVID-19 pandemic, there was already an existing vacuum in the Nigerian food system, resulting in the import of food items to supplement local production and consumption in order to meet up with demand.

An estimate by the United Nations World Food Program (WFP) indicated that the number of people globally facing acute food insecurity would almost double by the end of 2020 due to income and remittance losses, and disruption of food systems associated with the pandemic (WFP, 2020a; WFP, 2020b). Sadly, about 5 million Nigerians are projected to be pushed into poverty because of the COVID-19 pandemic and associated mobility restrictions and lockdown measures (World Bank, 2020a; IMF, 2020).

The agricultural sector dominates the economic force and contribute up to 25.2% (N10.50 trillion) to national GDP as at 2019 before the outbreak of Covid 19 pandemic. However, the country has lost up to $10 billion (ten billion United States Dollars) in annual export opportunities from groundnut, palm oil, cocoa and cotton alone, due to continuous decline in the production of those commodities (FAO, 2020). Agricultural production has not been stable in Nigeria (Figure 3). Demand for food is more than supply hence the gap created has been filled through food exportation, though the country has opportunity to be self-sufficient in staple food production.

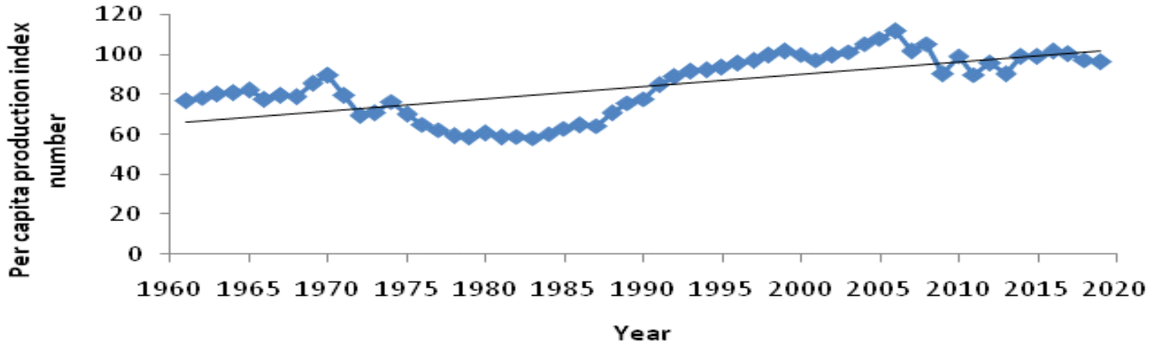

Figure 3: Nigeria Agricultural Production Index
Source: FAO, (2020)

Covid-19 did not have direct effect on food production because it didn't spread through agricultural products but the restriction imposed by many countries of the world to curtail it badly distorted food production system and food distribution dropped by more than half in the pandemic. A vacuum was also created as a result of social distancing that must be maintained by the workforce which undermines food production processes, farm activities and agricultural in whole. Lockdowns and social distancing measures associated with the pandemic are widely believed to have adverse impacts on incomes, through downward economic activity and weakened livelihood options (Barrett, 2020; Reardon et al., 2020). This consequently destabilized the food supply chains and created instability in food supply and food prices (Torero, 2020; Akter, 2020; FAO, 2020). In Nigeria, estimates have indicated that the economy will have contracted by 3.5 to 5 percent in 2020, during the government-imposed restrictions on economic activities and mobility (World Bank, 2020b; IMF, 2020).

The report of GAIN, (2020) further stated that the pandemic exposed the lapses that exist in terms of storage. Some farmers complained that crops were rotting in the fields such that unavailable storage resulted to spoilage of perishable goods, such as tomatoes, peppers, and onions. While this was also the situation prior to the COVID-19, the pandemic further hindered the ability of supply chain actors to react, and a lack of storage facilities compounded the existing issues.

Specifically, food Inflation has been steadily increasing since the border closure in August 2019. As at April 2020, food inflation rose to 15% compared to 14.7% in December 2019. The composite food index rose to a two-year high of 17.4% in October 2020 compared to 16.7% in September 2020 (Figure 4). The highest food price index increases were recorded for bread and cereals, fish, potatoes, yam and other tubers, vegetables, meat, oils and fats and fruits (GAIN, 2020). The production of pulses and oilseeds was hardest hit by COVID-19, but the GDP contribution of production of meat and eggs, dairy, and fruits and vegetables was 15-16% lower in April/May 2020 (Figure 5) than in the comparable period in 2019 (GAIN, 2020).

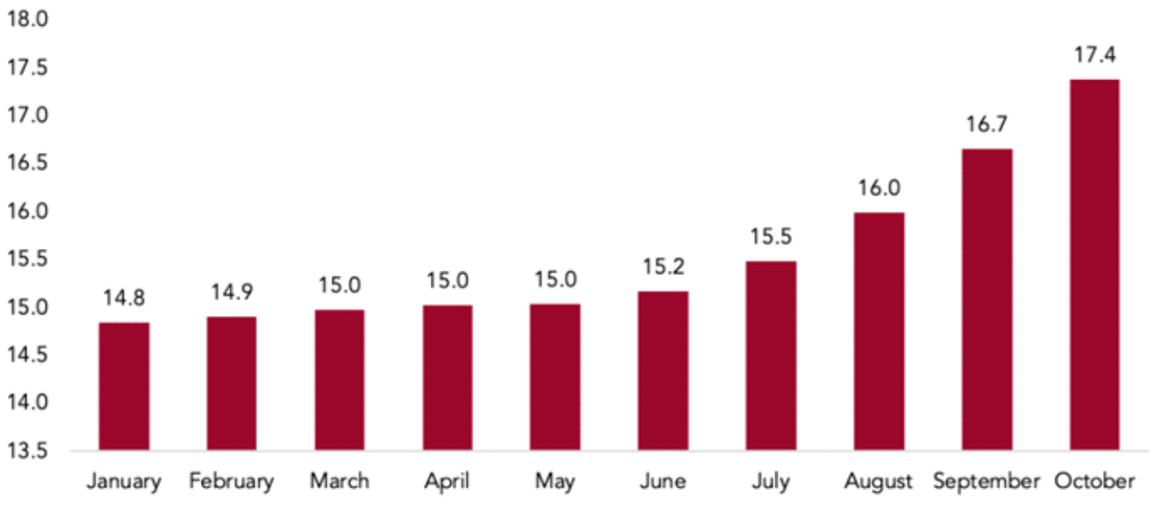

Figure 4: Nigerian Composite Food Price Index (%) (NBS 2020)
Source: GAIN, 2020

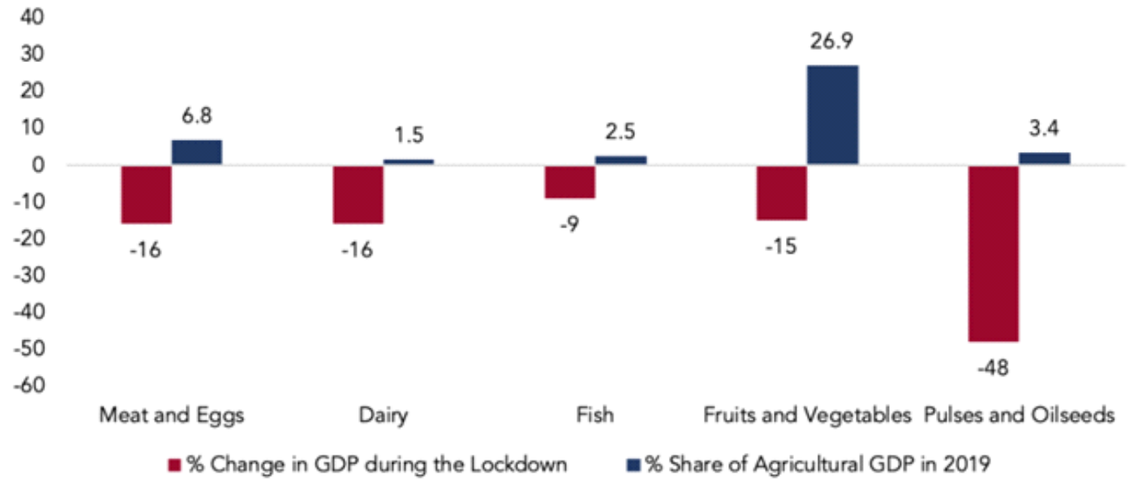

Figure 5: Change in Contribution to GDP during the April/May Lockdown Across Agricultural Output by Subsector, % Year-on-Year in Nigeria (World Bank 2020)
Source: GAIN, 2020

Assessment of Postharvest Management Practices of Millet handlers in Yobe State, Nigeria

Bamishaiye Eunice[1], Ibrahim Muhammad Abdul[1], Adu Emmanuel[1] and Bamishaiye Martins[2]

Nigerian Stored Products Research Institute (NSPRI), Kano.

Federal College of Agriculture Produce Technology (FCAPT), Kano

Abstract

Millets are gaining popularity due to their nutritional and phytochemical properties.This study was conducted to assess the postharvest losses and management practices employed by 350 millet farmers from 17 Local Government areas of Yobe State. Data were obtained by using semi-structured questionnaires and analysed using descriptive statistics. Majority (79.2%) of the farmers interviewed were male, the mean age of respondents was 36 years and 89.2% had formal education. Eighty per cent (80%) of the farmers were married with an average household size of 11 people, and 10 years farming experience. The post-harvest management practices as reported by farmers include sun drying (100%), winnowing (98.6%), threshing (100%), and cleaning (91.4%). Majority of the farmers (68.3%) are aware of moisture content. In addition, 66% of farmers mentioned the usage of chemicals such as cypermethrin, dusting powder etc. as pest management measures during storage. Majority (57.5%) of farmers use local bags/sacks, while 32.5% uses PICS hermetic bags for storage. Extension agents were cited as the main source of postharvest information by 31.9% of respondents. Majority (70.8%) stated that insect/pests and disease followed by high cost of farm labour (35%) and inadequate marketing pricing (24.2%) were the main constraints affecting their crop's performance. Most of the responding farmers (70%) indicated moderate to high levels of postharvest loss with majority (33.3%) experience income losses of NGN 15,001-20,000 per harvest season. These findings provided an avenue for relevant organisations to put more effort by training handlers in the state and to disseminate their storage technologies to improve food security and sustainability.

Keywords: Millet, Farmers, Postharvest, Management, Yobe

IMPACT OF COVID-19 ON COST AND RETURNS OF CASSAVA PRODUCTION IN CENTRAL CROSS RIVER STATE, NIGERIA

Ovat, Kelly E., Oniah, Monday O. and Agbor, Peter E., Edem, Tete O.
[1]Department of Agricultural Economics and Extension, Cross River University of Technology Calabar, Nigeria

Abstract

This research was motivated in view of the inherent challenges perpetrated by the Covid-19 pandemic and an information gap on the cost/returns on investment of cassava production as a sustainer of livelihood in Central Cross River State. The major objectives were to examine the perceived impact of Covid -19 pandemic and determine the cost and returns on investment of cassava production. The study examined the socio-economic variables influencing cassava production, the perceived effect of Covid- 19 pandemic, and determined the returns on capital invested in cassava production as well as the challenges militating against cassava production in the spike of the pandemic in the study area. 120 cassava farmers were sampled and data collected with the aid of questionnaires. Descriptive statistical tools, budgetary analysis approach, Cost and Returns analysis as well as Likert scale technique were used to analyze the data.

FARMERS-HERDSMEN CLASHES:
IMPLICATIONS FOR FOOD SECURITY IN BENUE STATE

BY

*OKO, P.E[1]; ABETIANBE, C.A[1]; ASAASUEN[2], T & AGORYE, A.O[3]

1Department of Environmental Resources Management, University of Calabar, Calabar.
2Department of Geography, College of Education, Katsina-Ala.
3Department of Architecture, University of Calabar, Calabar.

Abstract

Over the last couple of years, Benue state's territory has increasingly become a battle field for agricultural contenders basically of herdsmen and crop farmers. This scenario which has rocked the state's security system and its operation represents a spectacular landmark in the phenomenal down turn of general socio-economic development. This paper using documentary sources and personal field observation as a basis for analysis takes a look at the farmers-herdsmen clashes in the state and among other unfortunate odds, the brutal killing of farmers, massive fleeing of farmlands by farmers, destruction of crops and cattle, the former in higher magnitudes as well as other properties and active colonization of farmlands by herdsmen. The paper notes sharp falls in agricultural productivity, poverty intensification and a general rise in crime rates. The paper accordingly suggests compulsory ranching, agricultural mechanization, adequate rehabilitation and compensation and general poverty eradication drives by all stakeholders particularly government and harsh punitive measures against criminals as a prelude to food security and economic development.

Key Words : Farmers, Herdsmen, Food security, Crops and Benue State

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Impacts of COVID-19 on Food Security: Panel Data Evidence from Akwa Ibom State

Esthella Ekong[1], Iniodu Kierian[2] and Hasadiah Bassey[1]

1Department of Science technology, Akwa Ibom State Polytechnic, Ikot Osurua Nigeria
[2]Department of Public Administration, Akwa Ibom State Polytechnic, Ikot Osurua Nigeria

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Abstract

This paper combines pre-pandemic face-to-face survey data with follow up phone surveys collected in August-September 2021 to quantify the overall and differential impacts of COVID-19 on household food security, labor market participation and local food prices in Akwa Ibom state. Three major food markets in Akwa Ibom state were surveyed. The food prices before the lockdown and after the lockdown period were compared.it was observed that there was a remarkable percentage increase in the prices of the food stuff considered. More details about this are presented in the research paper. These findings can help inform immediate and medium-term policy responses, including social protection policies aiming at ameliorating the impacts of the pandemic, as well as guide targeting strategies of governments and international donor agencies by identifying the most impacted sub-populations.

Keywords: COVID-19, Pandemic, Food security, Percentage, food price.

It's important to note that all food processes and stages in supply chain are inter-related to each other, which means that a slight delay or anomaly in one can trigger a multiplier effect on others resulting in a big loss in the expected result and output. While some left their output unattended, some others have to burn theirs.

In addition, changes in biological interactions among both fauna and flora species can lead to unduly irreversible, and often undesirable alterations of ecosystem processes. Human alterations of the natural ecosystem which harbours varying flora and fauna species have broken or even removed the natural barriers of pathogens/zoonotic diseases naturally circulating within the forest ecosystems. And because of this disruption, viruses and evolving diseases are losing their natural hosts and searching for new hosts. Thus, humanity becoming the victim and new host.

The consequences of our actions and inactions are derivative of

- unsustainable use or overexploitation of any of the ecosystem services which has created a gap in the food chain, ultimately affecting all of humanity negatively;
- anthropogenic activities including deforestation, landscape fragmentation, habitat encroachment and destruction, and unsustainable or illegal wildlife trade which has further disrupted the balance of nature and raised the risk of disease transmission.
- human-induced environmental crises and disruption of the zoonotic host habitat which has modified wildlife ecological structure and caused biodiversity imbalance, consequently creating a gap and challenge in the ecosystem with attendant increase in animal to human risk of transmission and more viral epidemics.

Nexus Between National Insecurity and Food Security

National security is intrinsically linked to human security. Human security and survival are guaranteed when everyone have access to the basic necessities of life, in which food is an integral component. As such, when there is insufficiency of food in a society, it could result into all forms of insecurities (Notaras, 2011; Berazneva & Lee, 2013). Human security "primarily focuses on protecting the integral worth of people against insecurities" by dealing with "the circumstances that threaten the well-being and survival of the people" (Louw and Lubbe, 2017). Consequently, human security is hinged on the "establishment of food and water security, economic and political security for the general population as critical mechanisms to achieve a more stable level of state security" (Lanicci et al, 2017). According to FAO (2017), conflict-affected countries have on average higher rates of food insecure people than countries not affected by conflict.

In Nigeria, food insecurity is worsened by civil conflicts such as insurgency, militancy, banditry and farmers/herders' clashes which are leading causes of food insecurity, affecting food and agriculture particularly in Nigeria. This level of insecurity has increased in early 2021 across the Northern States, predominantly in Borno, Yobe, Zamfara, Kaduna, Katsina, Niger and Sokoto States. While in the Southern States, farmer/herder conflict is also reported in Ondo, Ogun, Oyo, and Ebonyi states. These nefarious activities have resulted in the invasion and sacking of farming communities and thus creating acute food insecurity. The state of insecurity in the country have further led to increased population displacement, disruption to market function, restriction of market and trade activities. It has practically made it difficult for farmers to continue to engage in optimal agricultural production, thus affecting food productivity with attendant food price shocks (Fadare et al, 2019).

According to 2020 global report on food crises, In the north-eastern states, over 1.8 million people were internally displaced by intensified violence and insecurity. Insecurity prevented households from accessing land to sow crops and stopped people from engaging in livelihood activities. Around 800 000 displaced people were cut off from humanitarian aid in north-eastern Nigeria due to conflict.

In north-western and north-central states, banditry, kidnappings and communal clashes damaged livelihoods and displaced over 540 000 people. Farmers have had to abandoned their lands, forced to leave, fled voluntarily, or were involved in the resultant insecurity.

However frequent clashes between herdsmen and farmers in the predominantly farming areas of the Middle Belt region of the country which has resulted in destruction of lives and farmlands, have become drawn back efforts towards ensuring food security in the country. From Benue to Taraba, Nasarawa and Plateau in the North Central region and Zamfara and Kaduna States in the North West, clashes between farmers and herdsmen have left in its trail heavy losses of lives and property. with adverse effects on farming activities. This has resulted in a drastic reduction in farm outputs, a development that has heightened the fear of hunger. This has consequently led to increase in prices of essential commodities and food products, making them unaffordable to the common man (Adelaja et al., 2019).

Overtime, the protected areas (forests and forest reserves) in the country became safe havens as well as centers of illicit and criminal activities. They are now being used as operational bases, hideouts and inhabitation camping sites for insurgency, banditry, kidnapping, cattle rustling, armed robbery, ritual killing, cannabis cultivation and militancy, consequently posing grave threats to the country's national security as well as food security. United Nations estimated that over 2.4 million people have so far been displaced as a result of conflicts (UNHCR, 2018). The displacement of farming communities as a result of attacks by armed groups, criminal violence and banditry is associated with an alarming rise in food and nutrition insecurity due to non-availability of food. Therefore, a peaceful environment is synonymous to productive agricultural engagement, which results in food security. Food insecurity, on the other hand, builds pressure on national security and invariably worsen national insecurity. Thus, sustainable food security under peaceful environment is an indispensable requisite to ensuring national security (Nwozor et al., 2019).

WAY FORWARD

Adoption of the Green Economy Model: A sustainable food production, alternative livelihood option and climate change mitigation option

Green economy concept is a good innovative nature-based solution for environmental challenges as well as balancing sustainable food production and consumption in Nigeria through improved and efficient utilization of resources, conservation of biological resources, renewable energy, reusing, reducing and recycling of materials. Green economy is concerned with improvement of human well-being with social equity while ensuring significant reduction in environmental risks and ecological degradation. It is associated with ensuring growth and development that enhances efficient utilization of environmental resources, sustainable food production, maintain biodiversity, reduce pollution and greenhouse emission, waste minimization and ensure ecological security. Green economy is the only means of achieving environmental and livelihood sustainability. It requires eliminating environmental pressures from economic growth. Economic incentives (Figure 6) for community involvement in sustainable food production, forest and resource management are concerned with making it more worthwhile in financial and livelihood terms for communities' participation in natural resource management.

showed the availability of phytate, saponin, polyphenol and flavonoid in both varieties. Three fungal organisms (Saccharomyces cerevisiae, Rhizopus stolonifer and Aspergillus flavus) were isolated and found to be responsible for the spoilage of M. paradisiaca. However, S. cerevisiae and A. flavus only occurred in the long variety at incidence of 60% and 40% respectively. R. stolonifer and S. cerevisiae were associated with the spoilage of the short variety at 30% and 70% incidence respectively. Generally, both varieties possess appreciable nutrient and phytochemicals and as such should be included into daily diet.

Keywords: *Musa paradisiaca*, variety, nutrient and fungal pathogens

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Liver quality indicators among heritage turkey toms administered aqueous Moringa oleriferia leaf and seed extracts.

[1]Ogbu, Onyinye C. and [2]Okafor, Cecilia N.

[1]Department of Agricultural Technology, Federal Polytechnic Oko Anambra state Nigeria.

[2]Department of Agricultural Engineering Technology and Bio-enviromental, Federal Polytechnic Oko Anambra state Nigeria.

Abstract

The liver is an essential organ in the body, its efficiency in carrying out basic body functions is very important. Most times liver quality is greatly damaged by what one takes in. Hence there is great need to ensure that the liver is at its best by routinely checking the indicators via serum biochemistry, especially when new feed materials are introduced. The study therefore sort to access the quality of the liver of heritage turkey toms that were given aqueous Moringa extracts. Thirty six turkey toms were used for the study these toms were randomly assigned into four treatment groups. Liver quality indicators that were checked includes, Alanine Amimstransferase (ALT), Aspartate Aminotransferase (AST) Gamma-Glutamyl Transferase (GGT), cholesterol, total protein, globulin, bilirubin and albumin. All these parameters differed significantly (P<0.05) among the treatment groups. These differences were not in any way higher than the recommended turkey levels rather the extracts improved the liver function as was witnessed in the study. It therefore safe to conclude that Moringa olerifera leaf and seed extracts were not detrimental to the health status of heritage turkey toms' liver; rather they improved the liver qualities of these turkeys through the indicators examined. Future study on the liver histology will help to buttress these facts.

Keywords, Liver, turkey, leaf and seed extracts.

conditions. Colour varied from dark brown (10YR 3/4) to dull yellowish orange (10 YR 7/2); the textures varied from clay loam, silty clay to clay; structure varied from weak, fine, angular blocky to strong, medium, subangular blocky. Physical and chemical characteristics such as bulk density varied from 1.30g/cm^3 – 1.70g/cm^3; particle density, 2.31g/cm^3 – 2.65g/cm^3; total porosity, 1.00% - 34.00%; silt, 10.00% - 48.00%; clay 38.00% - 82.00%; soil pH, 5.01 – 6.40 (moderately – slightly acidic); total nitrogen, 0.05% - 0.24% (low – medium); organic carbon, 0.12% - 2.34% (very low – medium); organic matter, 0.21% - 4.05% (very low – moderate); available phosphorus, 0.12g/g - 3.15ug/g (low); exchangeable potassium, 0.05cmol/kg - 0.37cmol/kg (very low – moderate); exchangeable sodium, 0.02cmol/kg – 0.04cmol/kg (very low); exchangeable calcium, 4.00cml/kg - 11.70cmol/kg (low – high); exchangeable magnesium, 1.12cmol/kg – 3.12cmol/kg (moderate); cation exchange capacity, 13.40cmol/kg – 24.51cmol/kg (high); base saturation, 77% - 94% (high – very high); exchangeable sodium percentage, 0.10% - 0.36% (very low). The soils are deep and fertile but very poorly drained. They are classified into the order 'Inceptisol'; suborder, 'Aquepts'; great group, 'Endoaquepts'; subgroup, 'Typic Endoaquepts' (USDA) and Eutric Gleysol (WRB). Integrated soil management practices such as drainage will make these soils more available for cultivation thus stimulating higher agricultural productivity.

ASSESSMENT OF THE NUTRITIONAL COMPOSITIONS OF TWO VARIETIES OF PLANTAIN AND THEIR ASSOCIATED FUNGAL PATHOGENS

CHUKU E. C., AGBAGWA S. S. and CHUKU O. S.

Department of Plant Science and Biotechnology, Rivers State University.

Abstract

Studies on the nutrient quality and post-harvest fungal pathogens of two varieties of Musa paradisiaca : false hron (long variety) and cardaba (short variety) were carried out in the Department of Plant Science and Biotechnology, Rivers State University. Proximate analysis showed that the long variety had higher values of moisture (58.0±0.01%), lipid (1.70±0.00%), fibre (1.61±04%) and protein (3.50±02%) while the short variety had higher contents of ash, (3.5±0.00%) and carbohydrate (34.40±0.03%). Mineral assessment revealed the presence of calcium, iron, magnesium, phosphorus, potassium and sodium. However, higher concentration of calcium (39±0.02mg/100g) was recorded for the long variety. Higher values of potassium (205±0.04mg/100g) and sodium (34±0.01mg/100g) were observed for the short variety. Nevertheless, both varieties had equal contents of iron (4.0±0.00mg/100g), magnesium (36mg/100g) and potassium (300mg/100g). Determination of vitamins revealed only the presence of thiamine in both varieties while no values were seen for vitamins A, C and naicin. Phytochemical screening

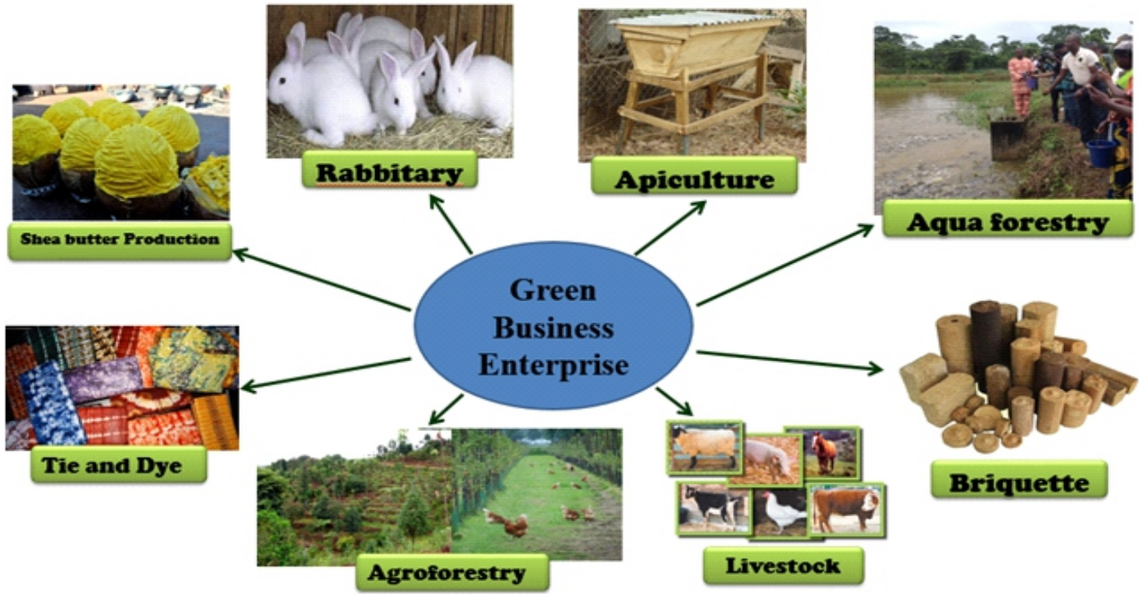

Figure 6: Examples of Green Business Enterprises

Green Economy in Biosphere Reserve (GEBR) Model Case Study: Community Economic Incentives

Forestry Research Institute of Nigeria's mandate and research activities focuses on ensuring sustainable environment through sustainable food production, biodiversity conservation, ecosystem recovery and reclamation, climate change intervention, forest management, production of forest-based industrial raw material provision and poverty alleviation of significant importance to realizing SDGs. The FRIN GEBR project sponsored by Korea International Cooperation Agency (KOICA) and United Nations Educational Scientific and Cultural Organisation (UNESCO) proposes people-centred solutions towards a more sustainable development. The GEBR project was established in Omo Biosphere Reserve for the diversification of the economy through improved and alternative biodiversity related livelihoods to reduce the pressure on forest as a result of fuel wood extraction for heating and cooking purposes, and build the capacity of communities in a holistic manner to ensure the sustainability of the biodiversity businesses and to conserve the resource-base of their business in line with the SDGs. The implementation of the project involved the selection of four alternative livelihood project activities after the need assessment and based line studies in collaboration with potential participants and stakeholders. These include Grasscutter domestication, Snailery, Fishery and Mushroom production (Figure 7).

Figure 7: Green Business Enterprises in Omo Biosphere Reserve

Outcomes and success stories of the FRIN GEBR Model

The project success stories and outcomes include:

- Formation of cooperative association for effective management of the fish farm by the beneficiaries.
- Over N5.6m was realized from the fish farming business by the beneficiaries.
- The profit realized was used to procure fish feed worth N3.4m and fish fingerlings worth N460,000
- The farmers re-stocked 13,000 fish fingerlings in third quarter of the year and 6,000 fingerlings in first quarter of the following year.
- The harvested fish were processed, dried, packaged and labelled for marketing by the beneficiaries themselves
- 200 farming families benefitted directly and over 1,500 people indirectly from the GEBR alternative livelihood activities.
- Some of the beneficiaries started new businesses in the community and expanded their own livelihood businesses, establishing 5 private fish farms, etc.
- The use of harmful chemicals for fishing in the streams and rivers within the biosphere reserve was drastically reduced and consequently led to reduction in health hazard in the rural community.
- The interaction of the rural dwellers with the Biosphere in terms of bush burning for hunting and wilful extraction of wood products were reduced minimally.
- The project exposed the rural community to the importance of Biosphere Reserve and conservation of forest biodiversity.

EFFECT OF FUNGI FLORA IN THE NUTRIENT QUALITY OF *Artocarpus camansi* (BREADNUT)

WEKHE E. O., CHUKU E. C. and OKOGBULE F. N. C.

Department of plant science and Biotechnology, Rivers State University.

Abstract

Research on the effect of fungi Flora on the Nutrient quality of Artocarpus camansi was carried out in the department of Plant Science and Biotechnology and food science and Technology Laboratory respectively in the Rivers State University fungal isolates from disease seeds of A.camansi were inoculated into healthy and matured A.camansi seeds and allowed for a period of seven days at room temperature, the samples were re-analysed to check the effects of the fungal pathogens on the Nutrient quality of the seeds is comparison with the control. It was observed that Rhizopus oryzae had the highest moisture value(41.5 ± 0.00) while the least was found in Penicillin italicum (16.2 ± 0.1).Lipid value was the highest in the control (9.1±0.1)and least in R. oryzae (1.4±0). Fibre was highest in P. italicum and R. oryzae (2.5±0.1) respectively and least in the combined fungi (0.8±0) carbohydrate value was highest in Aspergillusflavus (55.5±0.1) and least in combined fungi (30.7±0).The protein content recorded highest value in the R. oryzae (19.5±0.1)and least in the control(15±0).The various fungal isolates also showed varying effects on the mineral composition of the seeds of A.camansi. Calcium values was highest in the control (7.4±0) least in Aspergillusniger (1.4±0.1) Iron was highest in the compared fungi and least in control(0.5+0). Potassium was highest in the A. flavus (14.2±0.1) and least in the control (1.8±0). Result of the vitamin content revealed that the various fungal isolates increased the vitamin A and thiamin values of A.camansi.

Keywords: *Artocarpuscamansi*, nutrient quality and fungi flora

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Effective and Efficient Utilization of the Backswamps – 'Typic Endoaquepts' hydric soils in the Niger Delta for Sustainable Agricultural Productivity

Authors:

Wenibo, A[1].; Onweremadu, E. U.[2]; Mgbonu, K.[3]; and Kosuowei, M.[4]

1 & 2 Department of Soil Science and Technology, Federal University of Technology, Owerri, P. M.B. 1526, Owerri, Nigeria

3 Department of Agric. Education, Federal College of Education, Kontagora, Niger State.

4 Dept. of Crop and Soil Science, Niger Delta University, Wilberforce Island, Amasoma, Yenagoa, Bayelsa State

Abstract

This research was conducted in Okolobiri-Gbarain, Akaibiri-Ekpetiama, Epie-Zarama, Ikarama-Okordia and Tein-Biseni in the Yenagoa Local Government Area of Bayelsa State, Niger Delta, Southern Nigeria to ascertain the agricultural potentials of the soils of the backswamp ('Typic Endoaquepts'). Five profile pits (OG4, AE4, EZ4, IO4 and TB4) one each were sited in the backswamp of the study sites. Soils samples were collected from identified pedogenic horizons of the profiles for laboratory analysis. Morphological properties were examined insitu under moist soil

African Star Apple Seed Processing into Activated Carbon for Copper and Iron Removal from Wastewater

Esthella Ekong and Hasadiah Bassey
Department of Science Technology, Akwa Ibom State Polytechnic, Ikot Osurua Nigeria

Abstract
Environmental pollution will severely affect the quality of life and the ability of local communities and the larger society to thrive therefore, activities performed in the environment should always drive towards maintaining a clean environment while meeting our various needs. One of the major sources of environmental pollution is municipal waste water which is produced everyday domestically, this will be expanded upon in the full article. For this reason, the treatment of waste water must be environment friendly. There are several waste water treatment methods but the processing of non-edible parts of plants into activated carbon for waste water treatment is in vogue due to its addition of nothing environmentally detrimental to the treated water. In the course of this research, activated carbon produced from the processing of African star apple seed to absorb iron and copper ions from municipal waste water was studied. Column adsorption technique was adopted to examine the effects of packing length on the adsorption of of Fe and Cu from the waste water. The results obtained show that the activated carbon is a good adsorbent and that adsorption of the two metal ions depends on the packing length of the carbon.

Keywords: *Absorption, Carbon, Contaminant, Determination, Wastewater.*

CROP FARMERS'ADAPTATION STRATEGIES TO CLIMATE CHANGE IN RIVERS STATE, NIGERIA

Tasie, Chimezie Michael

Department of Agricultural Science, Faculty of Vocational and Technical Education, Ignatius Ajuru University of Education, Rumuolumeni, Port Harcourt, Rivers State, Nigeria

Abstract
This study appraised crop farmers adaptation strategies to climate change in Rivers State, Nigeria, using survey design. The study answered the following research questions: What are the socio-economic characteristics of farmers in the study area? Are farmers aware there is climate change? What are farmers' sources of information on adaptation strategies to climate change? What are farmers perceived effects of climate change? Whataretheadaptationstrategiestoclimatechangeusedbyfarmers?Whatconstraintsmilitateagainstth euseofadaptationstrategiestoclimatechangeby farmers? The study used descriptive statistics to analyse survey data. Results of the study indicated that majority of the farmers are females (56.7%) and are 40yearsand above, with an average age of 44 years. The survey result also showed that most of the farmers (83%)haveformal education. Access to extension service was low in the study area (29.2%).Thestudy revealed showed that farmers have the knowledge of climate variability and always use adaptation strategies in the study area. Constraints that militated against the use of adaptation measures include Poor extension services, low farm income, High cost of farm inputs, inadequate weather information, etc. Based on the result of this study, the following recommendations are made:(1)extensionservices should be streng thened to enlighten farmers about climate change adaptation strategies (2) In addition, affordable climate change adaptation technologies should be appropriated and developed for resource-poorfarmersto adopt (3) credit facilities should be extended to the farmers to enable them purchase appropriate technology necessary for climate change adaptation.

FRIN efforts towards ensuring increased food production, climate change mitigation and the use of medicinal plants against Covid-19

FRIN's research mandates by and large provide answers to issues such as environmental resource management and protection; food security; biodiversity conservation strategies; sustainable production of individual raw materials; health care delivery and small-medium scale entrepreneurial projects. Research breakthrough in tree breeding and genetics by reducing the gestation period between 5 to7 years of some indigenous economic tree species (Figure 8) such as *Vitellaria paradoxa* (Shea butter tree), *Garcinia kola* (bitter kola), *Irvingia wombulu, Irvingia gabonensis* (Bush mango), *Parkia biglobosa* (Locustbean), *Anona muricata* (soursop), *Plukenetia conophora* (walnut), *Dacryodes edulis* (African pear), *Chrysophyllum albidum* (star apple), *Spondias mombin* (plum apple), among others.

Figure 8: Grafted Garcinia kola under weaning shed

Adoption of Agroforestry Practices as a Panacea to Food insecurity

Solving the problems of food security requires among other interventions a range of interconnected agricultural approaches, including improvements in staple crop productivity. Up until recently, there is extensive consensus that we need to move away from the current, narrow focus on yield towards a more "multifunctional" agriculture **– Agroforestry -** that enhances broader societal and environmental goals. Appropriate combinations of crops, animals and trees in agroforestry systems (in the form of Agri-silviculture (Crops + Trees); Silvo-pastoral (Pasture/animal + Trees); and Agro-silvopastoral (Crops + Pasture + Trees)) can not only increase farm yields, they can promote ecological and social resilience to change because the various components of a system, and the interactions between them, will respond in differing ways to disturbances. This will further enhance food security using socially and cost-effective management techniques (Figure 9).

Agroforestry has real potential to contribute to food security, climate change mitigation and adaptation, while preserving and strengthening the environmental resource base of the country. For millions of farmers whose livelihoods are threatened by climate change and land degradation, agroforestry offers a pathway toward more resilient livelihoods. It is one the few land use strategies that promises such synergies between food security and climate change mitigation. In the light of recurring food shortages, projected climate change, and rising prices of fossil fuel-based agricultural inputs, agroforestry has recently experienced a surge in interest from the research and development communities, as a cost-effective means to enhance food security, while at the same time contributing to climate change adaptation and mitigation.

- Agroforestry can increase food availability by;
  i. directly providing tree foods (e.g. fruits and leafy vegetables) for increased macronutrient and micronutrient intake,
  ii. supporting staple crop production,
  iii. increasing farmers' incomes through the sale of tree products and surplus staple crops, and

iv. supporting various ecosystem services (e.g. pollination) that are essential for the productivity of certain crops.

- It can reduce problems associated with food accessibility by providing scarce products that are usually restricted by market access.

- It can improve food utilisation by
  i. providing fuelwood for cooking,
  ii. reducing the need for harmful pesticides and herbicides that affect food safety, and
  iii. potentially reduce micronutrient deficiencies that cause diseases which affect the ability to consume or efficiently use food and nutrients, or obtain a steady income.

- It can increase food stability by
  i. providing food from different species during periods of food scarcity,
  ii. ensuring consistent income through product diversification, and reducing the risks of focusing on one or few crops,
  iii. maintaining soil structure and soil fertility for long-term productivity, and
  iv. improving resilience to climate change induced shocks.

Figure 9: A typical Agroforestry system

FRIN has successfully trained over five thousand youths and women across all the agroecological zones of Nigeria on different agroforestry options in order to boost local food production and self-employment in agriculture/forestry.

FRIN efforts in the use of medicinal plants against covid – 19

The challenge posed by COVID-19 cases stimulated Forestry Research Institute of Nigeria to develop a Poly-Herbal Mixture and Remedy from herbal plants for the management of COVID-19 related ailments and immune booster (FRIN C-TONE). This herbal product was officially certified by National Agency for Food and Drug Administration and Control (NAFDAC) with the issuance of a registration number for commencement of post marketing surveillance and general usage.

Commendably, FRIN is the first Institution in Nigeria to be granted this certification by NAFDAC for its COVID-19 ailment related herbal product. Other preventive measure against covid-19 developed in the institute includes the production of herbal – based hand sanitizer to help tackling the spread of the disease which is in line with the World Health Organization (WHO) Standard (Figure 10).

ECONOMIC ANALYSIS OF VALUE CHAIN ADAPTATION AMONG COCOYAM FARMERS IN NSUKKA LOCAL GOVERNMENT AREA, ENUGU STATE, NIGERIA

NWANGWU KELVIN NNAEMEKA.[1*], ONAH OGOCHUKWU GABRIELLA[1], ONAH LYNDA TOCHUKWU[1], ORAZULIKE OZIOMA FAITH[1] AND ASOGWU BENSON UWAKWE[1]

Department of Agricultural Economics, University of Nigeria Nsukka[1]

Abstract

The study investigated the economic analysis of value chain adaptation among cocoyam farmers in Nsukka Local Government Area, Enugu State, Nigeria. The objectives of the study were to describe the socio-economic characteristics of cocoyam farmers, describes different value chain adaptation among cocoyam farmers, determine factors influencing choice of value chain adaptation and estimate the cost and return from investing on the value chain adaptation among cocoyam farmers in the study area. Primary data emanated from 60 respondents were collected through multistage sampling technique. Descriptive statistics, multinomial logit regression and gross-margin analysis were used to analyze the data. About 70% of the farmers were female and that 77% of them adapted value chain of processing cocoyam into chips (Achicha). The study showed that household size, farm size, level of education, cost of input and cost of processing procedure significantly influenced the decision for adapting the value chain of processing cocoyam into chip (Achicha) as against cooking raw cocoyam. Therefore, the following recommendations were made; there is need for the mechanization of cocoyam processing, there is need to consider the socio-economic characteristics of the cocoyam farmer when providing input, information, training and modern technology of processing cocoyam by both governmental and nongovernmental organization and since this enterprise is profitable, the youth need to engage on the value chain of cocoyam as it would boost their interest on cocoyam enterprise and also their income.

Keywords: cocoyam, value chain, adaptation and Enugu State

African Star Apple Seed Processing into Activated Carbon for Copper and Iron Removal from Wastewater

Esthella Ekong and Hasadiah Bassey

Department of Science Technology, Akwa Ibom State Polytechnic, Ikot Osurua Nigeria

TS 2021/UNIABUJA/018	EFFECT OF DEHYDRATION METHODS ON LYCOPENE AND VITAMIN C CONTENTS OF TOMATO VARIETIES GROWN IN KANO, NIGERIA.	*Ibrahim Bala [1], Farida U. Ahmad [2], Abdullahi T. Ibrahim [3], Ahmad K. Yerima[4] and Khadija M. Aminu[5]
TS 2021/UNIABUJA/019	RESOURCE USE EFFICIENCY AND PROBLEMS OF VEGETABLE PRODUCTION IN AKWA IBOM STATE, NIGERIA	[(1)]Eteyen E. Nyong [(1)] Matthew Ekaette [(2)] Esther B. Enaregha
TS 2021/UNIABUJA/020	People Awareness, Perception and Coping Strategies to Covid 19 Pandemic in Nigeria.The Case Study of Kuje Area Council Abuja.	Paul, A. H., Hauwa, B. and Joy, A. P.
TS 2021/UNIABUJA/021	BIOREMIDIATION POTENTIAL OF *Pleurotusostreatus* (Jacquin; Fries) P. Kummer: A CASE OF AGRO-WASTESIN UMUDIKE ABIA STATE.	A. C. Amadioha and E. N. Nosike

Figure 10: FRIN Covid-19 Herbal Remedy and Herbal Hand Sanitizer

Engagement of Forest Guards as Panacea to National Insecurity.

Protection and conservation of the forests forest reserves can be intensified through reconstitution, engagement and recruitment of Forest Guards. Training and integration of the Forest Guards into the Nigerian Security Architecture as paramilitary (like National Parks Rangers) and empowered by law to carry ammunition will go a long way in keeping our forest reserves as safe haven from illicit activities. They can work with local hunters and other relevant government law enforcement agents. They can be vetted and recruited by the Department of State Security (DSS) desk in each LGA and supervised by Federal Security Agencies.

Practical and lasting security options and solutions to National Insecurity is particularly hinged on engagement and recruitment of locals in rural communities living adjacent to forests and protected areas in protection and conservation of the forests.This will go a long way in reducing and curbing the various nefarious criminal activities in the forests and its surroundings. Ensuring a symbiotic relationship between the Grassroot Community and the Governmentis a way out to ameliorating National Insecurity. Local communities depend on the forest for their livelihood and therefore have an interest in protecting it. Thus, rural community engagement and participation in forest protection and management can bring substantial benefits in terms of improving national security, reducing poverty (income generating activities), combating idleness and risk factors, promoting a sense of usefulness and optimism about the future and ultimately enhancing sustainable food production and security

Concluding Remarks

Covid 19 pandemic has exposed the weakness and vulnerability of food production system initially affected by climate change and national insecurity. The impact is already being felt in form of continuous increase in food prices. In order to reduce the distortion and additional effect created by Covid 19 pandemic in food sector there is need for the provision of palliatives to farmers in the form of improved seedlings, basic farm implements at highly subsidized prices, and free or more affordable farm extension services. Increase budgetary allocation to agriculture and forestry subsector of the economy.

Also, there is need for re-introduction of farm settlement scheme, this could be financed under public private partnership arrangement. Adoption of climate smart agricultural technologies is necessary as climate change mitigation and adaptation strategies. Rural infrastructural development is important to enhance farm production activities and reduce postharvest losses.

We also need to understand and underscore that fact that we learn to live in harmony with nature, by valuing, conserving, restoring, maintaining and utilizing sustainably, ecosystem services provided by the ecosystem and forests environment at large.

Distinguished Personalities, Participants, Ladies and Gentlemen, I wish you all well in the various presentations during this conference and do hope that the expected outcomes and communique would benefit not only the stakeholders present but also serve as reference point, in posterity, to the country and world at large.

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TECHNICAL SESSION: SOCIETY FOR AGRICULTURE, ENVIRONMENTAL RESOURCES AND MANAGEMENT

VENUE: ONLINE ZOOM
DATE: MONDAY 15TH NOVEMBER 2021
TIME: 10:00AM – 4:30PM
CHAIRMAN: PROF. EDITH CHUKU
RAPPORTEUR: DR. I. OGBONNA

ABSTRACT NO.	TITLE OF ABSTRACTS	AUTHOR(S)
TS 2021/UNIABUJA/001	Economic Analysis of Value Chain Adaptation Among Cocoyam Farmers in Nsukka Local Government Area, Enugu State, Nigeria	Nwangwu Kelvin Nnaemeka.[1*], Onah Ogochukwu Gabriella[1], Onah Lynda Tochukwu[1], Orazulike Ozioma Faith[1] And Asogwu Benson Uwakwe[1]
TS 2021/UNIABUJA/002	African Star Apple Seed Processing into Activated Carbon for Copper and Iron Removal from Waste water	Esthella Ekong and Hasadiah Bassey
TS 2021/UNIABUJA/003	CROP FARMERS'ADAPTATION STRATEGIESTOCLIMATE CHANGEIN RIVERSSTATE, NIGERIA	Tasie, Chimezie Michael
TS 2021/UNIABUJA/004	Effect Of Fungi Flora in The Nutrient Quality Of *Artocarpus Camansi* (Breadnut)	WEKHE E. O., CHUKU E. C. and OKOGBULE F. N. C.
TS 2021/UNIABUJA/005	Effective and Efficient Utilization of the Backswamps – 'Typic Endoaquepts' hydric soils in the Niger Delta for Sustainable Agricultural Productivity	Wenibo, A[1].; Onweremadu, E. U.[2]; Mgbonu, K.[3]; and Kosuowei, M.[4] 1 & 2 Department of Soil Science and Technology, Federal University of Technology, Owerri, P. M.B. 1526, Owerri, Nigeria
TS 2021/UNIABUJA/006	Assessment of the nutritional compositions of two varieties of plantain and their associated fungal pathogens	CHUKU E. C., AGBAGWA S. S. and CHUKU O. S.
TS 2021/UNIABUJA/007	Liver quality indicators among heritage turkey toms administered aqueous Moringa oleriferia leaf and seed extracts.	[1]Ogbu, Onyinye C. and [2]Okafor, Cecilia N.
TS 2021/UNIABUJA/008	FARMERS-HERDSMEN CLASHES: IMPLICATIONS FOR FOOD SECURITY IN BENUE STATE	OKO, P.E [1]; ABETIANBE, C.A[1]; ASAASUEN[2], T & AGORYE, A.O[3]
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TS 2021/UNIABUJA/010	Assessment of Postharvest Management Practices of Millet handlers in Yobe State, Nigeria	Bamishaiye Eunice[1], Ibrahim Muhammad Abdul[1], Adu Emmanuel[1] and Bamishaiye Martins[2]
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TS 2021/UNIABUJA/012	EFFECT OF PHYTOREMEDIATION GRASSES ON SOIL MICRO-ORGANISMS IN CRUDE OIL CONTAMINATED SOIL IN SOUTH -SOUTH NIGERIA	Chukwumati, J. A and Nengi-Benwari, A. O
TS 2021/UNIABUJA/013	Assessment of Some Physicochemical Properties of Palm Oil Mill Effluent Dumpsite Soils in South Eastern Nigeria	Simeon, Samuel D.[1]Ijah, Christiana J.[2] and IkpeAkamimo M.[1]
TS 2021/UNIABUJA/014	RESOURCE USE EFFICIENCY AND ITS EFFECT ON HOUSE HOLD POVERTY OF ARTISANAL FISHERY IN AKWA IBOM STATE, NIGERIA	Eteyen E. Nyong, Matthew Ekaette, Nnadi Peace Chigere
TS 2021/UNIABUJA/015	EFFECT OF BACTERIAL SEEDING AND SOIL AMENDMENT ON PERCENT BASE SATURATION OF CRUDE OIL POLLUTED ULTISOL OF SOUTHERN NIGERIA.	[(1)]Etukudoh, Ndarake Emmanuel [(2)] Roland Gbarabe[(3)] Chukwumati John
TS 2021/UNIABUJA/016	Understanding the Drivers of Adoption of Climate Smart Agriculture (CSA) among Smallholder Crop Farmers in Agroecological Zone D Area of Kogi State, Nigeria: Policy Options for Improved Food Security Physicochemical properties of stored African Spinach (*Amaranthus Species*) Using Two Variants of NSPRI's Vegetable Basket	Shaibu, U.M., Otaru, A.O. and Haruna, M. Bamishaiye E. I., Adu E. A., Saka H., Bala I., Jude J. Isiaka A. A. and Kamaldeen S.O.
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SUAEREM Annual Conference (Virtual):
Theme: Challenges of Climate Change, Covid-19 Pandemic and Insecurity on Food Security, Livelihood and Environmental Resources

The Triple Helix Challenges of Climate Change, Covid-19 Pandemic and Insecurity: Impacts on Agriculture, Food Security and Total Environment

Prof. Agele, Samuel Ohikhena
Department of Crop, Soil & Pest Management,
Federal University of Technology, Akure, Nigeria
Email:soagele@futa.edu.ng: Phone: +234 8035784761

It gives me great pleasure to present one of the Lead Papers at this year's SUAEREM Annual Conference (Virtual). The theme is Challenges of Climate Change, Covid-19 Pandemic and Insecurity on Food Security, Livelihood and Environmental Resources.
The Topic of my presentation is " ***The Triple Helix Challenges of Climate Change, Covid-19 Pandemic and Insecurity: Impacts on Agriculture, Food Security and Total Environment*** "

*The tripartite challenges **Climate change, Covid-19 Pandemic and Insecurity** has exacerbated the endemic and characteristically low agricultural productivity, insecurity of food and nutrition, poor livelihood and environment degradation in Nigeria and Sub-Saharan Africa in general. The impacts of these topical issues on agriculture, food security, livelihood and the total environment were highlighted, and some solutions suggested for ameliorating and mitigating these challenges.*

The narratives and global reactions

The United Nations (2018) reported the "Shrinking Natural Resources, Rising Insecurity Leading to Dire Situation in Nigeria and the Sahelian West Africa" The report examined the "Linkages between Climate Change and Challenges to Peacebuilding and Sustaining Peace". The report affirmed that, in Sub-Saharan Africa, the general rise in inter-boundary and communal conflicts over resources depleted by desertification, drought and other challenges of climatic extremes has created a dire situation for people, livelihood, food security and the total environment. Drought, desertification and scarcity of resources have led to heightened conflicts between crop farmers and cattle herders and weak governance to social breakdowns.

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The report described the Sahelian West Africa as region as one of the world's most vulnerable victims of climate change, with 300 million people affected. The reported concluded that the Sub-Saharan Africa is facing complex challenges, including prevalent insecurity, armed conflict, human suffering and escalating humanitarian needs. Continuing deterioration in the region is due to poverty, lack of access to basic social services, rising inequalities, dwindling economic activities, growing unemployment and poor natural resource management (Economic and Social Council of the UN, 2018)

Underscoring the region's environmental deterioration and vulnerability to climate change, temperature increases are projected to be 1.5 °C times higher than the rest of the world. Largely dependent on rain-fed agriculture and regularly hit by droughts and floods, some 33 million people in the region are currently food insecure, along with 4.7 million children suffering acute malnutrition. On a more positive note, speakers also noted that 60 per cent of the planet's unexploited land lies in Africa, emphasizing the need to scale up on existing solutions to climate change. The report noted that 70 per cent of Africa depends on rain-fed agriculture and that six of 10 countries most affected by climate change are in that continent and the Sahel.

The burden of insecurity on food security, livelihood and the environment

Insecurity in Nigeria manifests in various dimensions and magnitudes from insurgency (Boko Haram, ISWAP, DaruSalam), Banditry, Kidnapping, Armed herdsmen-Farmers Clash etc. Humans and wild animals face new challenges for survival due to the challenges imposed by climate change, Insecurity and COVID 19 pandemic. *It is widely reported that Nigeria's food crisis was exacerbated by COVID19 and armed herders and farmers conflicts and the climate change challenges.* The wave of insecurity rocking Nigeria manifest in form of insurgency, banditry, communal clashes, militancy, farmers-herdsmen conflict, has further threatened developments in the agricultural sector, ***water resources, food and nutrition security, livelihood and the total environment.*** *Due to insecurity, many people including* farmers have been killed, displaced from the native lands and their farm with resultant spike in Internally displaced people (IDPs)

The World Bank and FAO (2021) reports on Nigeria stated that: "On the supply side, a combination of unfavourable weather, insecurity and conflict, and COVID 19 pandemic-related shocks affect food production and is pushing food prices up. Insecurity has put the country on the brink of famine, because farmers, (smallholder farmers who constitute the major block in particular) have stopped going to farms. The report also added that despite agriculture serving as an employer of last resort, family farms absorbed excess labour during economic downturns, however, the periodic influx of displaced urban workers into the rural economy kept agricultural wage rates low, generating uncertainty that discouraged investment in productive capital. *"Limited employment opportunities pose both economic and security challenges, the report further stated* that due to the nature of the economy, marginally employed workers became prime recruiting targets for criminal organizations and insurgent groups. *In addition to their negative economic consequences, rising levels of unemployment and underemployment are both a cause and a consequence of conflict and insecurity.* Basically, Nigeria's rising economic inequality has created an ecosystem where recruitment into non-state violent groups is seen as an easy escape from poverty, which has created an insecurity situation affecting citizens. With smallholder farmers scared of going to their farms due to rising insecurity related to kidnappings and killings by non-state violent actors, Nigeria is clearly heading for a food crisis that needs to be stemmed or the effects would be even more insecurity. Food insecurity continues to be a major developmental problem across the globe, thus undermining people's health, productivity and often their survival (FAO, 2021). Nigeria has high percentage of undernourished people, which has been on the increase with the rate of violence increasing by 55%.

Consequences of growing insecurity on economic development of Nigeria:

Armed Conflicts lead to destruction of lives and livelihood, and displacement of thousands of people (Adebayo et al., 2016). In the words of Kuku and Liverpool (2010), conflict, terrorism, drought, famine, degradation, deforestation, land tenure system, water stress, global climate change, extension gap, and low agricultural productivity are some of the factors restricting access to food or constraints to food production and food security in sub-Saharan Africa. The alarming level of insecurity in Nigeria has increased the crime rate and terrorists attacks in different parts of the country, leaving unpalatable consequences for the nation's economy. The continued security challenges in Nigeria and had drawn attention from scholars, practitioners, international communities and the federal government who had attempted to give solutions to forestall the growing occurrence of insurgency, insecurity, corruption, killings, bombings, kidnapping, armed robbery and operations.

Insecurity challenges have negative and significant effect on the Nigerian economy and development. The state of security of a nation can have collateral impact on every other development index. National security, is an essential prerequisite for true and lasting economic growth to take place. Therefore, economic security of a nation is intricately linked to its national security. The epidemic proportion of criminality and violence in Nigeria has ramifications for the economy with salient consequences. Insecurity presents a unique development challenge in areas characterised by a combination of acute poverty, vulnerability to drought, poor infrastructure and basic social services delivery, limited marketing opportunities, natural resource degradation, social and cultural marginalisation, long-standing dependency on external aid.

The protracted insecurity in Nigeria among others has manifested as: ***Disruption of Economic Activities, Decimation of Consumer Confidence, decreases in foreign direct investment (FDI), high defense spending, poor innovation due to struggle for personal survival, brain drain, declining productivity and possibility of national isolation etc.***

Insecurity and livelihood

Insurgency affect local, regional and national development due to inaccessibility especially farmers, vulnerable people (women and children) and businesses Insecurity effect on the livelihood of communities, and has resulted in dire humanitarian and economic situation as evident in human casualties, human right abuse, the continued bombings, killings and destruction of lives and properties, population displacement and refugee debacle, livelihood crisis and public insecurity. People are affected by insurgency because most can no longer continued with their work due to the insurgency attack and kidnapping. Other negative effect on national development is the closure of most businesses and total relocation of the businesses owners to other states. A strong and stable economy fosters long-term national security, whereas insecurity is a hindrance to long-term economic prosperity. Therefore, efforts should not be speared in bringing under control the spate of general insecurity that currently afflicts most parts of the country.

It is posited that government should embark on formulation of policies and effective implementation of programmes which are capable of addressing the root causes of insecurity in the society such as poverty, unemployment, ethnic conflict, religious conflict, illiteracy in order to protect lives and properties of the citizens by equipping the military with state of the art gadgets to confront insurgency.

Government at all levels should continue to reinforce efforts in the fight against insurgency so that a safe environment will be created and activities will be carries out without any fear of uncertainty.

It is necessary for the Federal Government to sit up in the fight against insecurity. A strong and stable economy fosters long-term national security, whereas insecurity is a hindrance to long-term economic prosperity.

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Specific recommendations include:

- Invest in more agroecological research-action projects.
- Support the development of an agroecology curriculum at schools of agriculture in a range of countries.
- Given that the majority of agricultural development assistance projects support conventional or industrial agricultural approaches, work to support more projects that encourage agroecology and other sustainable forms of agriculture.
- Include support for individual and community responses, such as home and community gardens.
- Ensure sustainable fisheries and aquaculture, as well as animal production and forestry, are integrated in policy responses to COVID-19 so as to reap their full potential in terms of nutrition and livelihoods.

Thank you for listening.

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Therefore, efforts should not be speared in bringing under control the spate of general insecurity that currently afflicts most parts of Nigeria. The federal and state government should continue to reinforce efforts in the fight against insurgency so that a safe environment will be created and activities will be carries out without any fear of uncertainty.

Job creation and skill acquisition will reduce insecurity, it is therefore recommended that policies that will ensure the immediate creation of jobs, acquisition of specialized skills, infrastructure and industrial growth be put in place so as to complement the short-term security measures.

The huge expenditure on security should be properly utilized for the purpose appropriated and sanction any embezzlement as well as reassess its militarized strategy and embrace dialogue when necessary

Coronavirus disease 2019 (COVID-19)

Coronavirus disease 2019 (COVID-19) has emerged as a significant public health emergency in recent times. COVID-19 was declared as a global health emergency (and a global threat) by the World Health Organization (WHO, January 30, 2020). COVID 19 is a respiratory illness caused by the novel virus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which was initially reported in late December 2019, and COVID 19 pandemic spread across the globe leading to high morbidity and mortality rates. The causative virus was identified, questions concerning the impact of environmental factors on the dissemination and transmission of the virus, its persistence in environmental matrices, and infectivity potential had emerged (Kumar et al., 2021). The containment measures limit environmental effects on COVID-19 early outbreak dynamics (WHO, 2020). To contain the virus, the governments of the Coronavirus affected countries enforced lockdowns to ensure social distancing among the people. Additionally, people have been asked to use non-pharmaceutical protocols such as hand sanitizers, face masks, and gloves, etc. to prevent the spread and of the disease. The lockdowns and excessive utilization of medical supplies around the globe has resulted in numerous positive and negative ecological impacts (Ali et al., 2021)

The menace of climate change, variability and extremity of weather events

The Intergovernmental Panel on Climate Change (IPCC, 2013) broadly defined climate change as any change in the state of climate which persists for extended periods, usually for decades or longer (IPCC, 2009). Climate change may occur due to natural processes (including volcanic eruptions) and human activities such as anthropogenic emission of greenhouse gases to the atmosphere.

Climate change is thus attributable to human contribution to atmospheric composition and resultant climate variability and change (extreme weather events)

The increasing episodes and intensities disasters linked to climate change such as intense drought, storms, heat waves, rising sea levels, melting glaciers and warming oceans can directly harm animals, destroy the places they live, and wreak havoc on people's livelihoods, food and nutrition security, biodiversity and the total environment. Sustainable food systems must embrace GHGs reduction, carbon sequestration, biodiversity conservation, waste and nutrient cycling/reuse, food and nutrition security and health of the ecosystem in the frame of changing climate, variability and extremity of the weather.

The primary causes and the wide-ranging effects of global warming and resulting climate change had been variously reported in the literature. Some effects constitute feedback mechanisms that intensify climate change and move it toward climate tipping points. The effects of climate change span the physical environment, ecosystems and human societies. They also include the economic and social changes which stem from living in a warmer world. Human-caused climate change is one of the threats to sustainability.

Many physical impacts of climate change are already visible, including extreme weather events, glacier retreat, changes in the timing of seasonal events (earlier flowering of plants), sea level rise, and declines in Arctic sea ice. The ocean has taken up between 20 and 30% of human-induced atmospheric carbon dioxide since the 1980s, leading to ocean acidification. The ocean is also warming and since 1970 has absorbed more than 90% of the excess heat in the climate system. Climate change has also contributed to desertification and land degradation in many regions of the world. This has implications for livelihoods as many people are dependent on land for food, feed, fibre, timber and energy. Rising temperatures, changing precipitation patterns and the increase in extreme events threaten development because of negative effects on economic growth in developing countries. Climate change already contributes to migration in parts of the world.

Food and Agriculture Organization (FAO) Report, 2021

The Food and Agriculture Organization (FAO) (2021) report shows that the increasing frequency and intensity of extreme weather disasters such as floods, droughts and megafires as a result of climate change is having a devastating effect on food security and livelihoods. According to the report, the annual occurrence of disasters is now more than three times that of the 1970s and 1980s as a result of our warming climate. The report also highlights the need for stronger disaster risk reduction policies and intensified efforts to build resilience to the adverse impacts of climate change to ensure agriculture's crucial role in achieving a sustainable future. Agriculture absorbs the disproportionate share of 63% of impact from natural and man-made disasters, with the least developed countries (LDCs) and low- and middle-income countries (LMICs) bearing the major brunt of these scourges. Thus, between 2008 and 2018, the impacts of natural disasters cost the agricultural sectors of developing country economies over USD 108 billion in damaged or lost crop and livestock production (FAO, 2021). Such damage can be particularly detrimental to livelihoods of smallholder and subsistence farmers, pastoralists, and fishermen.

The major threats of climate change

Agriculture is extremely vulnerable to climate change. Higher temperatures are associated with crop yield reduction while encouraging weed and pest proliferation. Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines (IPPRI, 2009, 2020). Although there will be gains in some crops in some regions of the world, the overall impacts of climate change on agriculture are expected to be negative, threatening global food security. Nearly half of the economically active population in developing countries rely on agriculture for its livelihood. Drought has been identified as the single greatest culprit of agricultural production loss, followed by floods, storms, pests and diseases, and wildfires. Drought causes over 34% of crop and livestock production loss with attendant cost of about USD 37 billion. Although, drought impacts agriculture almost exclusively, agriculture sustains 82% of all drought impact, compared to 18% in all other sectors. Crop and livestock pests, diseases and infestations have also become an important stressor for agriculture. Such biological disasters caused about 10 percent of crop and livestock production loss in the period from 2008 to 2018. The potential threat of disasters of this category was rendered evident in 2020 when huge swarms of desert locusts ravaged across the Greater Horn of Africa, the Arabian Peninsula, and Southwest Asia, destroying crops and jeopardising food security (FAO, 2021).

Impacts of climate change on ecosystems and natural resources

Climate change affect biodiversity, wildlife habitat, other ecosystem services, and land values (Alig, 2011). Potential social impacts of climate change in terms of health effects on rural communities and climate change sensitivity of indigenous communities. Climate change has social-economic impacts especially on rural communities, agriculture, forestry, recreation and tourism, fisheries, water resources, and energy. However, there is need to better understand how adaptation to and policies for addressing climate change may affect landscapes, ecosystem services, and local economies. Forest ecosystems can transfer carbon from the air as part of the greenhouse gases (GHGs) and sequester it into plant tissue through the process of photosynthesis during growth of plants (trees) and in other ecosystem components such as the understory and soil.

- Include food system workers and agricultural producers' organizations in COVID-19 decision processes at national and international levels.

iii. Support More Diverse and Resilient Distribution Systems, Including Shorter Supply Chains and Territorial Markets

The widespread disruptions to food supply chains resulting from the pandemic indicate a need for more resilient food distribution systems. Although various types of supply chains have been disrupted by the pandemic, those that are elongated and complex-especially for perishable and specialized agricultural crops-have been particularly affected. Producers and consumers in low-income countries are most vulnerable to these disruptions.

In all specific actions along these lines include:

- Invest in enhanced territorial market infrastructure at the regional, national and local levels.
- Carefully review policies that may unjustifiably privilege formal retail food outlets over more informal markets that provide points of connection between small producers and lower income consumers, including periodic rural markets and street vendors.
- Consider adopting stronger regulation, including competition policy, to empower small and medium agrifood enterprises (SMEs) to participate in national, regional and global supply chains.

iv. Support more Resilient Food Production Systems Based on Agroecology and other Sustainable Forms of Food Production

Strengthening food system resilience is critical for an effective response to the COVID-19 pandemic. As international supply chains are strained by COVID-19, relocalizing food production, or seeking a better balance between imported and locally produced food, is a sound strategy for building robustness and resilience. While some have advocated for industrial food production techniques as the best way to boost food production at home, this approach is limited because it is inaccessible to the poorest of the poor due to cost; often requires purchased external agricultural inputs that are similarly subject to supply chain disruptions; and may be unsustainable in terms of waste and environmental impacts (Moseley, 2017; Gengenbach et al., 2018). Research suggests that agroecology is just as effective as conventional methods for improvements over the long run, especially when the system is examined in terms of energy input versus output (Badgley et al. 2007; Brzozowski and Mazourek, 2018). Smart plant combinations, and mixed cropping strategies, may also reduce or spread out labour demands. There is a strong need for more research and training to support a transition to more agroecological production systems that can build food system resilience. In the current context, because of the risks posed by COVID-19 to in-person training, such efforts would require masks and physical distancing, and in some cases could be supported with digital communication technologies, provided those technologies are centred on the needs of poor farmers and the data is openly accessible. Home gardens and urban agriculture can also prove more resilient to shocks and disruptions and ensure access to more varied and nutritious food for the urban poor (Lal, 2020). Sustainable fisheries and aquaculture provide important sources of nutrition and are key for livelihoods and employment (Love et al. 2020; Bennett et al., 2020).

At the same time, for those countries that have the capacity to do so within their ecological boundaries, improving domestic food production capacity, including in crops in which they wish to reduce their reliance on imports, can be a way to reduce price risks and build local market resilience in the medium and longer-term. Improving domestic storage capacity also increases countries' ability to ensure food availability through crises (Viatte et al. 2009).

Specific recommendations include:

- Discourage food export restrictions to protect countries reliant on food imports.
- Provide policy space and support to countries seeking to improve their domestic food production capacity within their ecological boundaries in the medium and longer-term.
- Encourage countries to build up better long-term grain storage capacity.

ii. Strengthen and Coordinate Policy Responses to the COVID-19 Pandemic Impact on Food Systems and Food Security and Nutrition, Including at the International Level

The HLPE's Report 15 stresses that the urgent and deteriorating conditions resulting from the COVID-19 crisis "demands measures to improve food systems to make them not only more resilient to crises, but also more equitable and inclusive, empowering and respectful, regenerative, healthy and nutritious, as well as productive and prosperous for all" (HLPE, 2020b). Yet thus far, there has been a lack of international policy coordination and response to the COVID-19 pandemic's impact on food security and nutrition. The pandemic clearly illustrates the interconnected nature of food systems with health systems, economic systems and environmental systems, and as such, policy responses require coordination across different governance systems- including at the international level-that address the various ways in which the crisis is affecting food security and nutrition. The CFS is the obvious and appropriate policy coordinating body at the international level to lead in the development of a global policy response to COVID-19 and its impact on food security and nutrition. In 2009, the Committee on World Food Security (CFS) underwent reforms to make it a more inclusive international governance body whose purpose is to be the foremost body in the establishment of international norms and guidance on food security and nutrition policy (McKeon, 2015). To accomplish this role, the CFS has, as a core function, a role in facilitating the sharing of national experiences among its members, as well as developing guidelines that outline best practices for achieving FSN goals. The CFS has established guidelines for monitoring CFS decisions and guidance (CFS, 2013), and as such could serve as an important focal point for information on policy responses regarding the impact of the pandemic on FSN, in order to better facilitate policy coordination across different governance areas and among governments.

Specific actions to support this recommendation include:

- Recognize the role of the CFS as a lead body in coordinating an international governance response to the impact of COVID-19 on FSN.
- Create a task force led by the CFS to track the food security impacts of COVID-19.
- Establish a reporting system for CFS member states to share information and experiences with respect to the impact of COVID-19 on FSN in local and national contexts.
- Develop a global campaign to educate and inform the public on nutrition-sensitive practices to prevent and manage COVID-19 infections at household and individual levels.

Such forest sinks have a significant potential to help in mitigating climate change. Thus, policy formulation and implementation to promote carbon sequestration as an ecosystem service, and as a mitigation strategy against climate change.

The effects of climate change on land productivity and values, including influences on provision of ecosystem services. Climate change policies may in turn affect land and resource markets, thereby modifying land values, land use, and forest cover distribution. The effects of climate change on rural communities in particular, climate-sensitive livelihood activities characterized by fewer resources and social support systems compared to urban populations. Rural communities may face large potential impacts from future climate change events. Forest-based carbon offset projects have better competitiveness, relative to other offset options in agriculture, clean transportation, carbon capture and sequestration, and other advanced technologies, increasing energy efficiency, renewable energy, and other options.

Interaction between climate change and the biosphere.

Climate change is impacting ecosystems through changes in mean conditions and in climate variability, coupled with other associated changes such as increased ocean acidification and atmospheric carbon dioxide concentrations. It also interacts with other pressures on ecosystems, including degradation, deforestation and fragmentation. Increased heat, drought and insect outbreaks, wild fires are linked to climate change in addition to declining water supplies, reduced agricultural yields, health impacts in cities due to heat, and flooding and erosion in coastal areas are additional concerns. Ecosystems respond to climate change, how ecosystem resilience can be enhanced and how ecosystems can assist in addressing the challenge of a changing climate. It is necessary maximize the potential for maintaining a diverse, resilient and well-functioning biosphere under the challenging conditions of the twenty-first century. Climate change can alter where species live, how they interact, and the timing of biological events, which could fundamentally transform current ecosystems and food webs. Climate change can overwhelm the capacity of ecosystems to mitigate extreme events and disturbance, such as wildfires, floods, and drought.

Climate impacts, forest-dependent rural livelihoods and adaptation strategies

Climate impacts such as changes in temperature and rainfall patterns resulting in drought, flooding, all exert significant effect on forest ecosystems and their provision of goods and services, which form the safety nets for many African rural poor. Climate change will alter many of the relationships between people and forests The long term contribution of forests to the livelihoods of the rural poor had been long appreciated. More than half of Africa's fast-growing population rely directly and indirectly on forests for their livelihoods. As the continent faces stresses from poverty and economic development challenges. Climate change and other looming uncertainties could alter many of the relationships between people and forests. Climate impacts such as changes in temperature and rainfall patterns resulting in drought, flooding, all exert significant effect on forest ecosystems and their provision of goods and services, which form the safety nets for many African rural poor. Building adaptation strategies becomes an option for forest-dependent households and communities.

Impacts of disasters (climate change and Covid 19 Pandemic) on food security and nutrition: the possibility of a disaster-resilient future

In the frame of climate change and associated challenges, COVID-19 pandemic is placing an additional burden on agri-food systems exacerbating existing, systemic risks with cascading effects on lives, livelihoods, and economies worldwide (FAO, 2021).

"The upheaval due to COVID-19 may push even more families and communities into deeper distress (FAO, 2021). Disasters and challenges of climate change and COVID 19 pandemic have deleterious consequences for food security and nutrition (economic losses interms of caloric and nutrition equivalents). For example, it is estimated that crop and livestock production loss in LDCs and LMICs between 2008 and 2018 were equivalent to a loss of 6.9 trillion kilocalories per year. This equals the annual calorie intake of seven million adults (FAO, 2021).

Investing in resilience and disaster risk reduction, especially data gathering and analysis for evidence-informed action, is of paramount importance to ensure agriculture's crucial role in achieving a sustainable future concluded the FAO 2021 reports. Holistic responses and cross-sectoral collaboration are key in the disaster response. Countries must adopt a multi-hazard and multi-sectoral systemic risk management approach to anticipate, prevent, prepare for and respond to disaster risk in agriculture. Strategies need to integrate not only natural hazards, but also anthropogenic and biological threats, such as the COVID-19 pandemic (FAO, 2021). Innovations such as remote sensing, geospatial information gathering, drones and disaster robotics, and machine learning are powerful new assessment and data gathering tools. These have much to offer in the quest to reduce disaster risks in agriculture and natural resources degradation. Added is efficient governance, it is crucial to promote public-private partnerships to address the urgent need for investment in reducing agriculture's susceptibility to disasters and climate change. Generally, the future impact of climate change depends on the extent to which nations implement prevention efforts, reduce greenhouse gas emissions, and adapt to unavoidable climate change effects. Policy decisions made in the next few decades will have profound impacts on the global climate, ecosystems and human societies, not just for this century, but for the next millennia, as near-term climate change policies significantly affect long-term climate change impacts. Stringent mitigation policies might be able to limit global warming to around 2 °C or below, relative to pre-industrial levels. Without mitigation, increased energy demand and the extensive use of fossil fuels may lead to global warming of around 4 °C (IPCC, 2020).

Climate change impacts on water resources

Climate change is disrupting weather patterns, leading to extreme weather events, unpredictable water availability, exacerbating water scarcity and contaminating water supplies. Such impacts can drastically affect the quantity and quality of water that children need to survive. Climate change is already affecting water access for people around the world, causing more severe droughts and floods which has been linked to increasing global temperatures.

Water resources face a host of threats, which include sedimentation, pollution, climate change, deforestation, landscape changes, and urban growth. Climate change related consequences on water resources may arise due to increases in temperature, shifts in precipitation patterns and snow cover, and a likely increase in the frequency of flooding and droughts. Climate change may also markedly change the seasonal variation in river-flow. Climate change impacts the water cycle by influencing when, where, and how much precipitation falls. With climate change, the water cycle is expected to undergo significant change. For example, a warmer climate causes more water to evaporate from both land and oceans; in turn, a warmer atmosphere can hold more water – roughly four percent more water for every degree rise in temperature. One of the most serious threats to water resources is the degradation of ecosystems, which often takes place through changes to landscapes such as the clearance of forests, the conversion of natural landscapes to farmland, the growth of cities, the building of roads, and surface mining. Each type of change to a landscape will have its own specific impact, usually directly on natural ecosystems and directly or indirectly on water resources.

- Allow for adequate access to health care, including access to mental health services, in the design and implementation of social safety nets.

ii. Ensure Better Protections for Vulnerable and Marginalized Food System Workers and Farmers who are Disproportionately Affected by the Crisis

The COVID-19 pandemic has clearly revealed that food system workers are critical to the response to the emergency. However, despite being essential workers, food system workers often lack labour rights, as legislation in this area is weak in many countries (Yeshanew, 2018). Given the extent to which food systems depends on a variety of types of labour, from small scale family farm labour, to food processing workers, to migrant farm labour, it is essential to ensure that all food system workers, including migrant labour, are granted clear and protected rights within legislation at the national level, in line with internationally recognized standards. This includes access to safe working conditions and paid sick leave, access to social protection and adequate living conditions that ensure their safety and wellbeing, including for migrant workers (World Bank, 2020b). Expanding access to social protection, including health insurance, transfers to mitigate income losses and measures to support production (e.g. seeds distribution) to small-scale farmers is key to reduce their vulnerability (FAO, 2020d). Such protections would strengthen the resilience of food systems in the face of crises such as that unleashed by COVID-19.

Specific recommendations include:

- Ensure food system workers' rights are recognized and integrated in national legislation; promote and enforce compliance with established norms.
- Ensure food systems workers have access to full protection from hazards and risks (in terms of personal protective equipment, distancing measures, clear health and safety guidelines, paid sick leave, adequate sleeping, eating and sanitary facilities, quarantine shelters).
- Pay special attention to migrant workers in the food system to ensure they are protected from health risks, have access to health services and social protection.
- Implement mechanisms to protect farmers and small-agricultural producers from uncertainties and income losses, such as specific insurances, transfers and inputs distribution.

iii. Provide Better Protections for Countries that Depend on Food Imports

Countries that depend on food imports are especially vulnerable to international supply chain disruptions caused by COVID-19. Some of these countries may have the opportunity to better balance their food sourcing portfolios, while others may face real ecological limitations to producing more food at home (Clapp, 2017). In particular, it is important that international food trade not be constrained in a crisis or weaponized by those countries that are exporters. Export restrictions, for example, have been associated with higher food prices, and put food import reliant countries in a difficult situation (Laborde et al., 2020). Given that circumstances in each country with respect to their capacity to produce and/or import food vary, it is important to provide adequate policy space for governments to pursue policies that best minimize risks associated with reliance on imported food in order to build greater food system resilience.

The third shift is to incorporate greater understanding of the complex interaction of different forms of malnutrition occurring simultaneously within societies, including not just hunger and under-nutrition, but also obesity and micronutrient deficiencies. The pandemic has made the need for this shift abundantly clear, as those experiencing malnutrition-in any form-are more vulnerable to the disease.

Finally, transformative food policies must also be flexible to allow for diverse approaches, to fully take into account the specificity of each context. The variable impact of the pandemic on food security and nutrition in different locations and for different populations and groups highlights why this fourth shift is so important, including the variable impact on food system workers, farmers in different countries and for different crops, gender-differentiated impacts and populations in crisis contexts.

The recommendations below support these broad shifts. While some of these recommendations address concerns that have emerged in the short, medium and longer term, in general we move from those addressing short-term problems to those necessary for building longer-term resilience.

i. Implement more Robust Targeted Social Protection Programmes to Improve Access to Healthy and Nutritious Foods

While governments may be facing budgetary constraints, now is not the time to be cutting back on social safety net programmes, especially those that improve household access to healthy and nutritious food. Income assistance, vouchers for household food purchases, renter eviction protections, housing assistance, and school lunch programmes have all been shown to be effective means of support in some social contexts (Gerard et al., 2020). Vouchers for food purchases should function in formal and informal markets and allow for adequate fruit and vegetable purchases. In cases where schools are closed for extended periods due to COVID-19, governments need to think creatively about how to deliver alternatives to school lunch (WFP, 2020b). In other cases, public works employment programmes have allowed governments to build or maintain vital infrastructure and provide employment during an economic recession. However, agencies should recognize that food-for-work programmes have been problematic in rural areas if they interfere with agricultural work calendars. In those areas facing significant food supply disruptions, emergency food aid is vital. Unfortunately, the international community has fallen short in providing the necessary assistance needed for this year (Khorsandi, 2020).

Priority actions include:

- Provide adequate emergency food aid, wherever possible with local and regional purchase of foods for food assistance.
- Provide debt relief to governments struggling to maintain necessary social safety nets.
- Maintain robust social safety nets recognizing that household food expenditures rise and fall in relation to other expenditures (e.g. on housing, health care, education, etc).
- Design food assistance programmes that offer adequate access to healthy food, not just sufficient calories.
- Whenever possible, provide alternatives to school lunch programmes when schools are closed.

Research also suggests that climate change increases existing stress via reduction in runoff in areas already suffering from water shortages.

Climate change is having a multitude of immediate and long-term impacts on water resources in African countries. These include flooding, drought, sea-level rise in estuaries, drying up of rivers, poor water quality in surface and groundwater systems, precipitation and water vapour pattern distortions. These effects have compounded devastating impacts on ecosystems and communities, ranging from economic and social impacts to health and food insecurity in many regions in Africa.

Water is an essential and central resource , Water is life. This is a popular axiom in Africa, underpinning the high level of importance the people place on the resource. All forms of water resources: rainwater, aquifers, streams, ponds, springs, lakes, rivers, ocean water, snowpack ice and water vapour) are importan. The African continent, with a land area of nearly 30 million square kilometres, holds a wealth of natural resources which few other parts of the globe can match, including minerals, forests, wildlife and rich biological diversity. This natural wealth is largely unexploited, and is not reflected in measures of the welfare of the region's inhabitants (Agele, 2021 quoting UNEP, 2000). The continent also has some of the driest deserts, largest tropical rain forests and highest equatorial mountains in the world.

Human activities are rated to have significant effects and while African countries have contributed little to the magnitude of the global problem they stand to bear some of the serious consequences. Climate change consequences on water resources, water resources alterations are already having serious impacts on the economy of several African countries, on food security, as well as on social welfare and the health status of vulnerable citizens. The impacts of climate change on water resources in Africa appear huge especially when they co-occur with a range of other stress factors such as population growth, unequal access to resources, food insecurity, poor health systems and poverty. These conditions will increase the vulnerabilities of many people in Africa. Further, Africa's low capacity in science, technology and innovation will further deepen the vulnerability and impacts of climate change on water resources.

Coping, adaptation and resilience building capacities of African countries towards the impacts of climate change on water resources requires an holistic approach involving systems thinking and risk management strategies. Solutions pivot on taking urgent action to utilize science technology and innovation, policies relevant to water audit and management, and engagement of private, civil and international sectors if a major crisis is to be averted (Agele, 2021)

Climate change impacts on soil and water resources

Climate change impacts on soil and water resources while the hydrological processes respond to climate change. Various studies had presented overview of impacts on soil and water resources as consequence of change in climate and summarizes the measures/adaptation options to minimize the risk of climate change on water resources. Numerous scholars reported that climate change affects hydrological cycle or water cycle components, especially precipitation, evapotranspiration, temperature, stream flow, ground water and surface runoff. A change in climate can alter the spatial and temporal availability of soil and water resources. These changes will result in increased floods and drought, which will have significant impacts on the soil and water resource availability. Soils are complicatedly linked to the climate system through nitrogen, the carbon,and hydrologic cycles. Because of change in climate soil processes and properties will affected. Along with changes in temperature, climate change will bring changes in global rainfall amounts and distribution patterns.

The impacts of climate changes on soil and water resource mainly due to change in temperature and rainfall. Temperature and water both have large influence on the processes that take place in soils, climate change will therefore cause changes in the world's soils. Water resources management can help to counter balance effects of climate change on stream flow and water availability until a certain level. Soils are complicatedly linked to the climate system through nitrogen, the carbon, and hydrologic cycles. Because of change in climate soil processes and properties will affected. Along with changes in temperature, climate change will bring changes in global rainfall amounts and distribution patterns. Temperature and water have a large influence on the processes that take place in soils, climate change will therefore cause changes in the world's soils. Water resources management can help to counter balance effects of climate change on stream flow and water availability until a certain level.

The impacts of climate warming on global and local scales and water resources.

1. Overall changes in large-scale hydrologic cycles are observed based on spatiotemporal scales. Increases in precipitation in high northern latitudes since the 1970s, increased frequency in heavy precipitation events, runoff patterns, reductions in snow cover,and shifts in the amplitude and timing of glacial runoff.
2. Based on global climate models, precipitation is likely to increase in high latitudes and decrease in lower mid-latitude regions during the twenty-first century. The risks of flooding and drought are likely to increase in many parts due to increases in precipitation intensity and variability. Water availability and annual river runoff are likely to increase at high latitudes by the middle of the twenty-first century, whereas many arid and semiarid areas are projected to suffer a decrease in water resources.
3. The basic food sector (i.e., availability, stability, and access), which will likely be affected by changes in the quantity and quality of water resources, will be vulnerable in the arid and semiarid tropics and Asian and African mega deltas.
4. Water quality, which will likely be affected by climate change due to higher water temperatures, precipitation extremes, flood and drought events, and pollution, will decrease because of imbalances in several factors, including sediments, nutrients, dissolved organic carbon, pathogens, pesticides, salt, and thermal pollution.
5. The quantity and quality of water resources will have a severe impact on ecosystems and human health, which will be further impacted by sea-level rise that will extend areas of salinization of groundwater and estuaries, resulting in a decrease in freshwater availability for humans and ecosystems in coastal areas.

Suggested are some measures/adaptation options to minimize the impact of climate change on soil and water resources. Implementation of Integrated Water Resources Management approaches in highly vulnerable basins, promotion of water conservation practices to reduce the amount of water needed for irrigation, municipal, and industrial users and to improve basin-wide water supply, development in irrigation infrastructure should be carried out in all vulnerable countries to cope with climate change risk, groundwater development such as rainwater harvesting, watershed management and rainwater implementation on a large scale in all vulnerable areas, development of watershed and upgrading rain fed agriculture through rainwater harvesting (watershed based integrated water resource management approach), construction of water storage structures to store excess water flowing during rainy season, and advocacy, awareness creation and implementation in communities of the future climate change on water resources and the need and relevance of development of ground water and effective rainwater harvesting technologies.

Food price increases have also resulted from disrupted supply chains that have affected the cost of shipping (FAO, 2020c). These localized price increases directly impact food security and nutrition by making food more expensive and thus more difficult to access, especially for people with limited incomes.

- **Possible for Changes in Production**

As noted above, global cereal stocks were at near record levels at the start of 2020, and food supplies generally were not in short supply. The dynamics outlined above, however, could change due to the high degree of uncertainty surrounding the virus and its evolution and societal impact. It could potentially affect production levels going forward, depending on how long the pandemic lockdown measures last, whether they are repeated, and the uncertainty regarding the timing and extent of these measures.

Labour-intensive crops, often cultivated with a migrant workforce in some countries, particularly horticultural products such as fresh fruits and vegetables, are likely to be more affected by the disruptions noted above. Horticultural production, processing and export has expanded dramatically in many developing countries over the past several decades (Van den Broeck and Maertens, 2016), and these countries could experience production shocks due to labour shortages and transportation issues, which could affect incomes and thus food access. Cereal production, especially in industrialized countries where the use of highly capitalized equipment is common, is less likely to be impacted (Schmidhuber and Qiao, 2020). Supply chains for agricultural inputs, such as seeds and fertilizer, has also been affected by lockdown measures, making them both scarce and more expensive, as has already been reported in both China and West Africa (Arouna et al., 2020; Pu and Zhong, 2020).

Way Forward (Panacea to COVID-19 impacts)

The first policy is a **transformation of food systems as a whole**. In practical terms, this means moving from a singular focus on increasing food supply through specialized production and export to making fundamental changes that diversify food systems, empower vulnerable and marginalized groups and promote sustainability across all aspects of food supply chains, from production to consumption. As is clear from the nature of the food security and nutrition impact of the pandemic, increased food production alone is not sufficient to address this crisis.

The second aspect is to **shape food policies in ways that recognize inter-system linkages**, ensuring, for example, that food systems, ecological systems, and economic systems create positive synergies, rather than working at cross-purposes. The pandemic has made clear that appreciation of intersystem linkages is vital, as we are seeing complex dynamics resulting from ecosystem-food system linkages that resulted in an increased incidence of zoonoses, which, in turn, resulted from an expansion of industrial agriculture. The disease itself is interlinked with food systems in complex ways. Furthermore, lockdown measures are resulting in huge economic shifts that directly affect food security and nutrition.

As the COVID-19 pandemic unfolded, many countries moved to shut down informal food markets, which governments saw as spaces for potential disease transmission, reflecting a 'formality' bias in public health and food policy (Battersby, 2020). Informal markets are extremely important as sources of food and livelihoods in developing countries (Young and Crush 2019). In South Africa, formal food retail outlets, which sell processed and packaged foods, were allowed to remain open while informal and open air food markets, which typically sell more fresh fruits and vegetables, were shut down (even though open air markets are actually safer in terms of person to person transmission (Moseley and Battersby, 2020)). This move was especially detrimental to poor people who are more reliant on such markets for food because they can buy produce and foodstuffs in smaller quantities. After lobbying from academics and civil society, these markets were eventually allowed to reopen.

Differentiated responses to these changes have emerged. A recent study suggests that poor households are likely to shift their spending away from fresh fruits and vegetables with high micronutrient content to less nutrient-rich staple foods as a direct result of the pandemic (Laborde, Martin and Vos, 2020). Other studies also showed a shift towards consumption of more processed foods (Bracale & Vaccaro, 2020). At the same time, in North America, there was a resurgence of interest in community supported agriculture (CSA) subscriptions, as people increasingly grew concerned about the safety of shopping in supermarkets and desired more direct access to fresh fruits and vegetables (Worstell, 2020), meat and fish products. CSA farms, however, were unable to meet all of this demand. There was also increased interest in home and community gardening as people sought to grow their own food to ensure their food security and nutrition (Lal, 2020). These changes to food environments had variable impacts on food diversity and nutrition.

➢ Increase in Localized Food Prices

Global cereal stocks are at near record levels and world food commodity prices overall fell in the initial months of the pandemic. However, the overall food price index trends mask wide variability in food commodity prices in the wake of the lockdowns. Initially, prices for meat, dairy, sugar and vegetable oil fell sharply, while prices for cereal grains remained steady. As the pandemic deepened, price trends have shifted, with meat prices rising, for example, as meatpacking workers experienced high rates of illness in some countries and meat-processing plants closed temporarily in order to halt transmission of the disease in worker communities (Waltenburg et al., 2020; EFFAT, 2020).

Further, there have been localized price changes affected by the dynamics of the pandemic, with some countries seeing localized food price increases, including countries that depend on food imports (Espitia et al., 2020). For example, Venezuela and Guyana saw food price increases of nearly 50 percent as of late July 2020, whereas Kenya saw food price rises of only 2.6 percent (FAO, 2020c). This uneven food price impact is the product of several complex factors, including export restrictions initially placed on some cereal crops such as rice and wheat by several exporting countries, as noted above (Laborde et al., 2020). In the case of rice, for example, prices increased in Thailand, Vietnam and the US by 32, 25 and 10 percent respectively, between February and mid-April 2020 (Katsoras, 2020). Currency depreciation in countries affected by the global recession also contributed to higher localized food prices for countries that rely on imported foods (UNCTAD, 2020a).

Climate change adaptation

African countries need to face the challenge holistically through science, technology and innovation, and establish appropriate governance, policies, regulations and measures to adapt to the challenges posed by climate change, especially as they affect water resources. It is essential to ensure greater resilience by keeping an audit or inventory of water resources with the aim of tracking the effects of climate change. This will directly aid and inform the development of strategies to cope with the effects and impacts of climate change. Early warning and preparedness to respond to immediate humanitarian emergencies, government need to set up special risk management units to assist people displaced and affected by climate change impacts to enable them to live their lives normally again. In the global arena, Africa needs to have a cohesive agenda and strategy for achieving favourable negotiations at international meetings for example, to avoid earlier failures experienced by African nations at the Conference of the Parties (COP). Finally, there should be a culture of systems thinking in Africa that will engage expert in science technology and innovation experts, policy makers, private sector organizations and civil society organizations. The continent should be ready to utilize the collaborative and partnership opportunities available with inter national agencies and organizations in order to respond to the multitude of complex impacts of climate change, especially on water resources. Need for improve understanding and research focusing on climate simulations, specially of precipitation, and develop a better understanding of the managed and unmanaged responses of agriculture to changes in climate, diseases, pests and atmospheric constituents.

Conclusions

Some perspectives on " ***The Triple Helix Challenges of Climate Change, Covid-19 Pandemic and Insecurity: Impacts on Agriculture, Food Security and Total Environment*** " is presented.

The tripartite challenges Climate change, Covid-19 Pandemic and Insecurity has exacerbated the endemic and characteristically low agricultural productivity, insecurity of food and nutrition, poor livelihood and environment degradation in Nigeria and Sub-Saharan Africa in general. It is concluded that the "Explosive Mix" of ***Climate change, Covid-19 Pandemic and Insecurity Challenges has various dimensions and magnitudes of impacts on agriculture, water resources, food and nutrition security, livelihood and the total environment in Nigeria and Sub-Saharan West Africa.*** *The impacts of these topical issues on agriculture, food security, livelihood and the total environment were highlighted, and some solutions suggested for ameliorating and mitigating these challenges.*

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Economic Utilization of Livestock Waste: A Panacea for Environmental Health, Resource Management and Food Security in Nigeria

Prof. C.I. Ebenebe
Department of Animal Science,
Nnamdi Azikiwe University, P.M.B., Awka
Anambra State

Introduction

Livestock waste has continued to constitute environmental and health hazards in all areas where large scale farms are sited. Ekunwa *et al.,* (2006) noted that livestock production greatly increased in Nigeria due to ban on the importation of poultry products, more so many people now see livestock production as a means to poverty alleviation. Martinez et al. (2009) posited that intensification of livestock operations benefited production efficiency, but has introduced a number of environmental issues. Livestock wastes includes solid waste such as manure and organic materials in the slaughter house, urine, cage wash water, waste water from washing of animal pens and slaughter houses, air pollutants such as hydrogen sulphide and methane rom enteric fermentation of ruminants, Globally solid waste generation levels are approximately 1.3 billion tons per year and this is expected to increase by 2.2 billion tons per year by 2025. This represents a significant increase in per capital solid waste

Gender inequities have also been exacerbated by the crisis, as women face additional burdens during COVID-19-as frontline health and food system workers, unpaid care work, community work, which has increased during lockdowns (McLaren et al., 2020; Power, 2020). Women are also at risk of an increase in domestic violence due to the recession and confinement at home when lockdown measures are in place (FAO, 2020b; WHO, 2020a). These inequities affect women and their prominent roles in food systems, including as primary actors ensuring household food security and nutrition, as well as being food producers, managers of farms, food traders, and wageworkers. According to FAO, the agricultural activities of rural women have been affected more than those of men (FAO, 2020b). This gender dimension is important because women, in their caregiving roles for the sick, children, and the elderly, are likely at greater risk of exposure to COVID-19, with knock-on implications for food production, processing and trade (Moseley, 2020).

- **Disruptions to Social Protection Programmes**

Social protection programmes have been disrupted by the pandemic, which affects food security and nutrition. When the lockdowns began, most schools were closed, resulting in the loss of school meal programmes in both high-and low-income countries. It was estimated that 370 million children have lost access to school meals due to school closures in the wake of the pandemic (WFP, 2020a). In Nigeria, governments developed alternative means by which to reach school-aged children with food assistance, including take-home rations, vouchers, and cash transfers (WFP, 2020b). While alternative school lunch arrangements (such as in Cameroon (WFP, 2020c) may close the gap in some instances, in other cases such options are not in place, adding to the financial burden of poor households struggling to feed their families (Moseley and Battersby, 2020).

The global economic recession that resulted from the pandemic and measures to contain it have also strained governments' capacities to provide social protection for those most affected by the crisis (FAO and WFP, 2020). In April, the G20 governments offered to freeze the debt service payments for 73 of the poorest countries, an initiative endorsed by the G7 governments, in order to free up funds to address the fallout from the pandemic. Fully implementing this initiative has been challenging, however, affecting the ability of the poorest countries to provide social protection for their populations through this crisis. According to the UN Commission for Africa (ECA), Africa needs $100 billion to finance its health and safety net response (Sallent, 2020). Most countries may have or will need to borrow money to finance their response, but unfortunately several countries are constrained in how much they can borrow by already high debt to GDP ratios (Sallent, 2020).

- **Altered Food Environments**

Food environments have been deeply altered by the pandemic. Lockdown measures and supply chain disruptions outlined above have changed the context and thus the way people engage and interact with the food system to acquire, prepare and consume food. The closure of restaurants and food stalls meant people who relied on foods prepared outside the home for their meals suddenly found themselves preparing food at home. But because of rigidities in supply chains, foods that previously were produced and packaged specifically for food service were not easily repackaged for retail sale and home use.

Global growth is expected to fall dramatically in 2020, with various estimates showing a drop in the range of 5 to 8 percent for the year (IMF, 2020; OECD, 2020). Global remittances-a major source of finance in developing countries-are expected to drop by around 20 percent (World Bank, 2020a).

According to World Bank estimates, an additional 71 to 100 million people are likely to fall into extreme poverty as a direct consequence of the pandemic by the end of 2020 (World Bank, 2020a). The World Food Programme estimates that an additional 130 million people will face acute hunger as a result of the crisis, nearly doubling the 135 million people already facing acute hunger (Khorsandi, 2020). Already, a number of severe hunger hotspots have emerged. As the UN reports, some 45 million people have become acutely food insecure between February and June 2020, mainly located in Asia and Sub-Saharan Africa (UN, 2020b).

As food demand has contracted due to declining incomes, food producers' and food systems workers' livelihoods are further affected: food systems are estimated to lose 451 million jobs, or 35 percent of their formal employment (Torero, 2020). Similarly, the UN estimates that around one third of food system livelihoods are at risk due to the pandemic (UN, 2020b).

- **Societal Inequities**

The global economic slowdown triggered by the pandemic, as well as the spread of the disease itself, has exacerbated existing societal inequities in most countries (Ashford et al., 2020). These inequities are affecting rights as well as access to basic needs such as food, water, and health care, and access to jobs and livelihoods, all of which have implications for food security and nutrition. Food insecurity already disproportionately affects those people experiencing poverty and who face societal discrimination, and it is these very people who are at higher risk of contracting COVID-19 and who have less access to health care services (Klassen and Murphy, 2020). COVID-19 has also exacerbated inequities in access to safe sources of water and basic sanitation. According to the WHO, one in three people lack access to safe drinking water and basic hand-washing facilities (WHO, 2020b). People without access to these services, which are vital for health and safe food preparation, are more likely to contract the disease, compounding existing inequities (Ekumah et al., 2020).

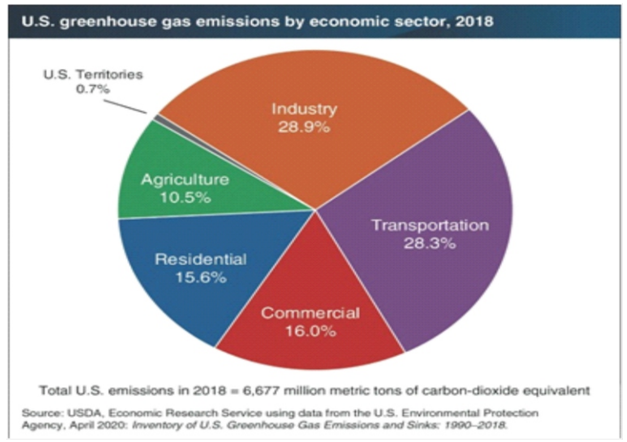
Many food system workers face precarious and unsafe work conditions, which have been exacerbated by the COVID-19 crisis. These workers are often paid low wages and lack protective equipment (Klassen and Murphy, 2020), and in some regions, such as in sub-Saharan Africa, South and South-East Asia and some countries in Latin America, the majority work under informal arrangements (ILO, 2020b). Agriculture in many countries depends on migrant workers, many of whom work under casual employment arrangements where they have few rights and are vulnerable to exploitation (FAO, 2020a). As such, migrant labourers frequently face poverty and food insecurity and have little access to healthcare and social protection measures. Migrant food system workers have experienced higher incidences of COVID-19 infection as compared to other populations (Klassen and Murphy, 2020), including because they are more exposed to the virus due to cramped work, transport and living conditions (Guadagno, 2020). In some countries, lockdown measures have been coupled with temporary suspensions of workers' rights (European Parliament, 2020; IFES, 2020, online).

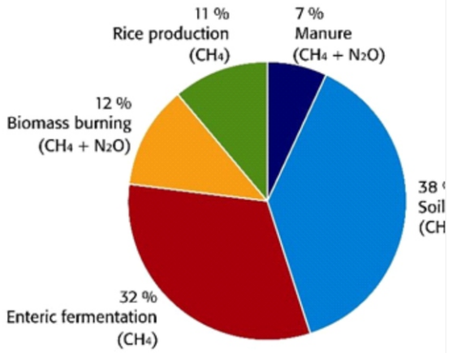
generation rates, from 1.2 to 1.42 kg per person per day in the next fifteen years (Igbinomwanhia, 2011a; Igbinomwanhia et al., 2011b; Hoornweg et al., 2013). Solid wastes generation in Sub-Saharan Africa is approximately 62 million tonnes per year and it spans a wide range from 0.09 to 3.0 kg per person per day with an average of 0.65 kg/capital/day (Hoornweg et al., 2014).Like other solid wastes, livestock wastes, animal manure and from bedding /litter materials, animal carcasses, hatchery wastes (feather materials from hatching chicks, hatched and unhatched eggs), damaged feeding and watering trough appears quite voluminous visibly and constitutes large tonnage of solid waste in large scale poultry andpig farms. Recent research has estimated that by 2030, the planet will be generating at least 5bn tons of poo each year, with the vast majority being deposited by livestock (Cox, 2019).Wastes when not properly managed, especially excreta, other liquids and solid wastes from households and the community, constitutes serious health hazard and could lead to the spread of diseases (UNEPA, 2006)/ Direct dumping of untreated wastes in rivers, seas, and lakes, results in the accumulation of toxic substances in the food chain through the plants and animals that feed on it (Medina, 2002).Animal waste, especially excessive nutrient concentrations, is being linked tosome environmental problems, especially air and water pollution. The growing number of large scale poultry and other livestock farms and the resultant tonnage of dung, poultry droppings and other farm waste demand some level of regulation on livestock waste management as well as waste conversion to other useful resources. This paper discusses the economic utilization of animal wastes as a strategy in preventing environmental problems associated with livestock wastes.

Livestock Production in Nigeria and Environmental Pollution

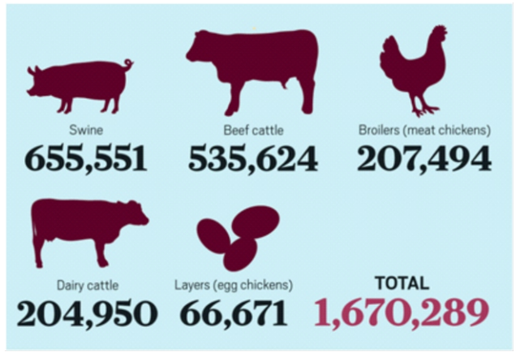
i. Methane

Science news from University of Adelaide published in the journal Science Advances showed that cattle and other ruminants are significant producers of greenhouse gas: methane, contributing 37% of the methane emissions resulting from human activity. The report also stated that a single cow on average produces between 70 and 120kg of methane per year and worldwide there are 1.5 billion cattle. Broucek (2014) posited that methane production in dairy cows represent values from 151 to 497g/day. Lactating cows produce more: 354g/day than dry cows (269g/day) and heifers (223g/day). Mature beef cows emit 240-396g/day. The negative effect of methane is 23 times higher than the effect of CO2. Therefore the release of about 100 kg methane per year for each cow is equivalent to about 2, 300 kg CO_2 per year.





ii. Ammonia and Nitrous oxide Emissions



Ammoniaemitters

Animal waste contributes 50 to 85% of ammonia emissions in the U.S., according to EPA estimates. Here's a look at the top five sectors by metric tons of NH3 emissions per year.

Source: EPA 2014 National Emissions Inventory

Oenema *et al.* (2005) noted that animal waste management are important sources of nitrous oxide (N_2O), while earlier report of Mosier et al (1998) showed that animal waste management (AWM) contribute about a third of the total N $_2$O emission from agriculture which amounts to about 6Tg N_2O. Oenema (2001) posited that AWM contributes about 14% to the estimated total global emissions o about 14Tg N_20- N into the atmosphere. According to them, AWM originates from microbial processes of nitrification and de-nitrification, nitrification is the microbial transformation of ammoniacal nitrogen (NH $_4$+ -N) into nitrate nitrogen (NO $_3$- -N) while de - nitrification is the transformation of NO_3- into nitrogen gas. De Klein and Eckard (2008), animal agriculture potentially contribute up to 50% of total agricultural nitrous oxide.

iii. Odorous Gases and Air pollution

Waste generation rate in Nigeria is estimated at 0.65-0.95 kg/capita/day which gives an average of 42 million ton s of wastes generated annually. This is m ore than half of 62 million to ns of waste generated in sub -Sahara Africa annually and where and how to channel these wastes becomes a huge problem for the nation (Hoornweg et al., 2014).). Livestock waste is a great contributor to this large tonnage of was te, but apart from the volume of solid waste generated in large scale livestock farms, the rate of air pollution from such waste is of immense concern to scientists. The greater proportion of livestock waste are mainly solid waste capable of affecting

animal waste management including volatile organic compounds (VOCS), ammonia (NH $_3$), hydrogen sulphide Concentrated Animal Feeding Operations (CAFO) can affect air qua lity through emission of gases such as ammonia (NH $_3$), hydrogen sulphide (H_2S), particulate matter, volatile organic compounds, hazardous air pollutants and odour. Erickson (2018) stated that the air near large -scale industrialized pig, chicken and dairy co w operations not only stinks but is also hazardous to public health. According to Zhang (1998), when manure is stored, microorganisms in manure decompose the organic matter and release a number of pollutants. Yuan et al (2017) showed that the main VOCs emi tted from CAFOs include carboxylic acids, alcohols, phenolic species, Sulphur and

Nitrogen containing species. According to them, alcohols and carboxylic acids dominate VOC concentrations, sulphur –containing and phenolic species become more important in terms of odour activity values and NO3 reactivity respectively.

➢ **Disruption in Supply of Food**

There have been major disruptions to food supply chains in the wake of lockdown measures, which have affected the availability, pricing, and quality of food (Barrett, 2020). The closure of restaurants and other food service facilities led to a sharp decline in demand for certain perishable foods, including dairy products, potatoes and fresh fruits, as well as specialty goods such as chocolate and some high value cuts of meat (Lewis, 2020; Terazono and Munshi, 2020). As the pandemic-related lockdowns took hold in many countries in March-May of 2020, there were widespread media reports of food items being dumped or ploughed back into the fields because of either collapsed demand or difficulties in getting these foods to markets (Yaffe-Bellany and Corkery, 2020). Farmers without adequate storage facilities, including cold storage, found themselves with food that they could not sell.

Again, the movement of food through the channels of international trade was especially affected by lockdown measures. As borders closed and demand for certain food items dropped, food producers reliant on selling their crops via distant export markets were highly vulnerable, particularly those producers that focused on perishable food and agricultural products, such as fresh fruits and vegetables or specialty crops, such as cocoa (Clapp and Moseley, 2020). In the early months of the outbreak of COVID-19, some food exporting countries also imposed export restrictions on key staple food items like rice and wheat, which led to some disruptions in the global movement of these staples food crop as well as higher prices of these crops relative to others (Laborde et al., 2020). Certain countries, with particular reference to Africa, including those with high prevalence of food insecurity, are highly dependent on imported food and on commodity exports (FAO et al., 2019), which may make them particularly vulnerable to these types of supply chain disruptions. Many of these export restrictions were lifted by August 2020, in some countries, although the risk remains that such restrictions might be re-imposed, depending on the severity of any future spikes in the disease and the re-imposition of lockdown measures.

These disruptions to supply chains affected food availability in some cases, especially where foods were not able to reach markets, which in turn put upward pressure on prices of some scarce goods. The quality of food environments was also affected, leading to some shortages in fresh fruits and vegetables, also discussed below.

➢ **Economic Recession and Associated Income Losses**

The COVID-19 pandemic triggered a global economic recession which has resulted in a dramatic loss of livelihoods and income on a global scale (World Bank, 2020a). The resulting drop in purchasing power among those who lost income has had a major impact on food security and nutrition, especially for those populations that were already vulnerable. Those in the informal economy are especially affected. In Latin America, for example, over 50 percent of employment is in the informal sector (FAO and CELAC, 2020). According to the International Labour Organization (ILO), more than the equivalent of 400 million full-time jobs have been lost in the second quarter of 2020 with a number of countries enforcing lockdown measures (ILO, 2020a). Developing countries in particular have been deeply affected, as they were already entering recession by late 2019 (UNCTAD, 2020a).

A PENECEA TO THE IMPACT OF COVID-19 PANDEMIC ON FOOD SCARCITY IN THE 21ST CENTURY

LEAD PAPER PRESENTED BY: PROF. U. S. OFFOR

INTRODUCTION

World Health Organization (2021) defined coronavirus disease (COVID-19) as an infectious disease caused by a newly discovered coronavirus. Most people infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without requiring special treatment. Older people and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness.

The COVID-19 pandemic has spread rapidly and extensively around the world since late 2019 has had profound implications for food scarcity. The unfolding crisis resulting from this incidence has affected food systems1 and threatened "countries (of which Nigeria is among) that rely on food imports (Torero, 2020)-will experience food insecurity as a direct result of the pandemic. At least 25 countries, including Lebanon, Yemen and South Sudan, are at risk of significant food scarcity because of the secondary socio-economic impacts of the pandemic (FAO and WFP, 2020). In Latin America, the number of people requiring food assistance has almost tripled in 2020 (UN, 2020a). Food productivity could also be affected in the future, especially if the virus is not contained and the lockdown measures continue.

It is vital that the global community continue to monitor the situation closely, respond in necessary ways to avert the worst outcomes with respect to food security and nutrition, and carefully consider how to build more resilient food systems and ensure the right to food, in order to achieve maximum food security.

HOW COVID-19 IS AFFECTING FOOD SCARCITY

COVID-19 is a respiratory illness and there is no evidence that food itself is a vector of its transmission (ICMSF, 2020). However, the virus, and measures to contain its spread, have had profound implications for food security, nutrition and food systems. At the same time, malnutrition (including obesity) increases vulnerability to COVID-19. Initial and ongoing uncertainty surrounding the nature of the spread of COVID-19 led to the implementation of strict lockdown and physical distancing policies in a number of countries. In Nigeria these measures caused a serious slowdown in economic activity and disrupted supply chains, unleashing new dynamics with cascading effects on food systems and people's food security and nutrition. Concurrently, there are 6 dimensions of food scarcity as proposed by HLPE. In its 15th report in which this paper will address as to how COVID 19 affects them viz: availability, access, flexibility, stability, agency and sustainability. All these insure the right to food security if well managed under COVID 19 pandemic.

a. Dynamics Unleashed by the Pandemic are Affecting Food Scarcity

A number of overlapping and reinforcing dynamics have emerged that are affecting food systems and food scarcity and malnutrition thus, leading to disruptions to food supply chains; loss of income and livelihoods; a widening of inequality; disruptions to social protection programmes; altered food environments; and uneven food prices in localized contexts (see, e.g. Klassen and Murphy, 2020; Clapp and Moseley, 2020; Laborde et al., 2020). Moreover, given the high degree of uncertainty around the virus and its evolution, there may be future threats to food scarcity and malnutrition, including the potential for lower food productivity and production, depending on the severity and duration of the pandemic and measures to contain it. Below is a brief overview of these dynamics, which are also depicted in Figure 1.

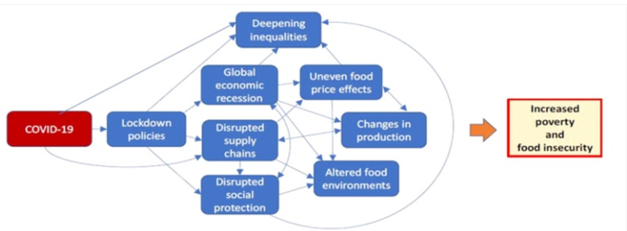


FIGURE 1 | The dynamics of COVID-19 that threaten food scarcity.

Table 1: Emissions inventory of manure management in Canada 2005 -2008 (Environment Canada)

	NH_3 (kt)	VOC (kt)	TPM (kt)	PM 1.0 (kt)	PM 2.5 (kt)	CH_4 (Mt CO_2 eq)	N0 (Mt CO_2 eq)
2005	368.8	300.5	334.2	213.3	32.3	3.1	5.0
2006	326.5	291.1	338.2	215.5	32.0	3.1	4.9
2007	324.1	291.1	338.2	215.5	32.0	3.0	4.8
2008	308.2	312.9	344.8	220.4	33.9	2.8	4.7

Earlier works by a number of authors (Filipy *et al*., 2006; Rabaud *et al*., 2002, Hobbis *et al*., 2004; Schiffman *et al.,* 2001) identified species of VOC contributing to odour problems inside various animal houses and in ambient air (Rabaud *et al*., 2003, Hobbis *et al*., 1998).

- ***A Japanese study showed that producing a kilogram of beef leads to the emission of greenhouse gases with a global warming potential equivalent to 36.4 kilograms of carbon dioxide (CO2).***
- ***Around 1.6-2.7 billion tonnes of greenhouse gases each year, mostly methane, are produced from livestock digestion.***
- ***Another 1.3-2.0 billion tonnes of nitrous oxide come from producing feed for livestock.***
- ***The final 1.6 billion tonnes comes from land use changes, such as clearing for animal pastures.***
- ***Emissions from livestock production vary across the globe. The developing world accounts for 70% of emissions, mainly because of the large numbers of animals used for a variety of purposes beyond production of meat, milk and eggs.***

Economic Utilization of Livestock Waste

i. Improvement of soil fertility

a). Poultry droppings

Shiyam and Binang (2011) cited in Oyedeji et al (2014), noted that the hazardous environmental consequences and high cost of inorganic fertilizers has led farmers to alternative cheaper and environmentally friendly organic manure. According to Oyedeji et al (2014) chicken manure is an excellent soil amendment that provides nutrient for the growing crops and also improves soily quality when applied wisely. Chicken manure is relatively high quality organic fertilizer, of which the content of pure nitrogen, phosphorus (P_2O5) and potassium (K_2O) are about 1.63%, 1.54% and 0.08%. The manure consists not only the poultry droppings but also wasted feed, broken eggs, feathers and litter material. Ali (2005) reported that poultry manure has been reported to have more plant nutrients that any other organic manure. Adeyemo et al (2019) reported that application of poultry manure at 10Mg/hectare can improve the soil water infiltration rate and the biomass. To be useful as organic fertilizer, the chicken manure must be decomposed, so that parasites, eggs of parasitic organisms and infectious agents are killed, the product is then deodorized by the process of decomposition. The production process of chicken manure as organic fertilizer is composed of fermentation system, drying system, deodorant and dust removal system pulverizing system, batching system, mixing system, granulation system, screening system and product packaging system.

The high nitrogen and balance of other nutrients makes chicken manure the best kind of manure, but the high nitrogen in chicken manure is dangerous to plants, so composting of chicken manure mellows the nitrogen and makes the manure suitable for garden use. Composting of chicken manure involves inclusion of bedding material into the manure heap, it is then watered and turned every few weeks to get air into the pile. It takes about six to nine months on the average for the manure to be properly done. However, the chemical composition of poultry manure varies with factors such as source of manure, feed of birds, age, condition of birds, storage, handling of manure and type of litter used

EM has the great role to reduce the toxic effect of the ammonia and the reduction in the acidity of the soil. The foul odour due the tri-methyl is also reduced by EM. Agricultural production mainly depends on the health of soil, which is a measure of a complex set of biological, chemical and physical interactions driven by microorganisms. Effective microorganism enhances the beneficial microbial population in the soil for sustainable crop production as well as the maximization in the yield along with the positive impacts on the environment.

Compost has a high content of organic matter and important nutrients and is very useful for soil conservation and improving and maintaining soil fertility, however, and with coarse material, the process **of composting can be quite slow**. **The EM composting method uses effective microorganisms and molasses to speed up the composting process and provide an improved compost product (ICIMOD.org)**. Vegetation, especially weeds from cropping alleys and unwanted (exotic) forest weeds like banmara (*Euphatorium adenophorum*), is chopped and mixed with a small amount of goat manure and fermented organic matter containing beneficial microorganisms, and 1% of a solution of EM in molasses. The mixture is placed in piles on the ground. In the summer, it transforms into mature compost in 5-6 weeks.

ii. Vermiculture



The usefulness of earthworm in the improvement of soil structure and stability, better drainage, increased nutrient availability in the soil as well as the use as a bait in the fishing industries is well documented in literature. Bhadauria and Saxena (2009) reported that earthworm activity enhance soil nutrient recycling through rapid incorporation of detritus into mineral soils, concentration of large quantities of nutrients (N, P. K and Ca) that are easily assimilable by plants. The horizontal and vertical burrows they make create pores for water and air circulation, and mixing up of soil layers. In the archival copy of the University of Florida (IFAS Extension) technical report studies titled "Culture of Earthworms for Bait or Fish Food" the authors Williams et al, noted that the earthworms:

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West African night crawler (*Eudrilus eugeniae*) and the brandling worm (*Eisenia foetida*) have been used in North America as bait worms since 1940 and also for composting of sewage sludge and organic manure. The report also noted carp fish fed night crawlers supplanted with sardine oil grew better than those fed with manure worms. Ebenebe (2021) also summarized research report on the use of earthworm in the production of fish feed. Zhang et al (2018) showed the benefits of supplementing diet of pullets with 5% earthworm powder. Jang Ho (2009) observed that using earthworm to feed broiler chickens improved feed intake, protein digestibility and weight gain. It is on the basis of these important uses of earthworm that large scale farming of earthworm (Vermiculture) has become as profitable business venture. Earthworm farming involves large amount of organic manure upon which the earthworm feeds. The process of decomposition of organic waste by worms is called vermicomposting while the rearing of worms for this purpose is called vermiculture

Table 3: Nutrient Composition of earthworm meal compared to Fishmeal

Composition	Earthworm meal	Fish meal (Clupeid)
Crude protein %	63.04[b]	71.46[a]
Ether extract %	5.90[d]	7.97[c]
Crude fibre %	1.90[d]	1.18[d]
Ash %	8.90[c]	18.22[b]
Nitrogen free extract %	13.76[b]	3.17[a]
Moisture %	8.60	8.89
Dry matter %	91.40	90.21
Gross Energy kJ/100 g	1968.24[c]	2074.09[b]
Sodium (g/100 g)	0.43[d]	0.91[b]
Calcium (g/100 g)	0.53[d]	3.53[a]
Potassium (g/100 g)	0.62[c]	0.96[b]
Phosphorus (g/100 g)	0.94[b]	2.40[a]
Magnesium (g/100 g)	NA	0.08

Source:Sogbesan et al., 2007

Table 4: Amino acid Profile of Earthworm meal compared to fish meal

Essential amino acids composition/animal protein sources	Earthworm meal	Fish meal (Clupeids)
Arginine	2.83[a]	5.34[b]
Histidine	1.47[a]	4.19[b]
Isoleucine	2.04[a]	2.62[a]
Leucine	4.11[a]	8.31[b]
Lysine	6.35[a]	10.96[b]
Methionine	5.30[a]	2.26[b]
Phenylalanine	6.26[a]	5.52[a]
Threonine	4.43[a]	5.28[a]
Valine	4.43[a]	5.88[b]
Tryptophan	0.88[a]	0.97[a]
Total essential amino acids	37.99[a]	51.33[b]
Crude protein %	63.04[a]	71.64[a]
EAAI (%)	71.50[b]	96.70[c]
Cs/Ps (%)	36.10[a]	48.80[b]
E:P	0.60	0.72

Source: Sogbesan et al., 2007

iii. Production of insect larva used for replacement of fish meal in livestock feed

Meat and meat products has remained the most widely consumed animal protein sources despite all the claims of crusaders of vegetarian diet Lucke (2000).Meat production is limited by high cost of feed ingredientsespecially the animal protein ingredient, thus the lingering problem of animal protein shortage in the diet of most Nigerians. FAO/WHO recommended 35g per caput animal protein consumption per day for sustainable growth and development (FAO 1991) but consumption level in Nigeria is between 7 to 10g /person/day (Ebenebe, 2005. Niang and Jubrin, 2001).There is need for alternative animal protein ingredient, as feed remains a key factor in that constitutes 60% of production costs in monogastric animal production (Adebisi and Bunmi 2017). Black soldier is a cheap alternative animal protein cherished by livestock. Besides, large scale livestock production that will meet the animal protein demand of Nigerians is also associated with large tonnage of animal manure, which constitute environmental hazard to the locality and the State.

Black soldier fly (*Hermetia illucen*) larva is capable of solving these two problems, converting animal manure into useful larval protein capable of reducing cost of production in livestock industry. Zhang et al (2021) noted that concurrent developments in biotransformation of these wastes with black soldier fly larva is a demonstration that these problems can be abated, while at the same time producing valuable products (protein, chitin, biodiesel and fertilizer). Bortolini et al (2020) discussed black soldier fly larvae as chicken manure management tool for circular economy. The gluttonous nature of the BSF larvae endows it with the ability to digest organic compounds before they decompose thus eliminating odor (Odor colour) (Mutafela 2015).Mutafela (2015) reported on the pollution reduction potential of BSFL to the tune of 50-60%. van Huis et al. (2013) posited that nitrogen was reduced by 71%, phosphorus and potassium 52% each, while aluminum, boron, cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, molybdenum, nickel, sodium, sulphur and zinc were reduced by 38-39%.

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Table 5: Nutrient Composition of Black Soldier Fly Larvae

Black Soldier Fly Larvae

Black Soldier Fly

Composition (%)	**Larvae**	**Pupae**
Crude Protein	43.16	44.36
Crude Lipid	27.75	32.12
Crude Fibre	7.47	7.62
Crude Ash	9.41	7.63
Calcium	2.88	2.68
Phosphorus	0.81	0.62

Source: Kwancho Park (2013)

Table 6: Amino Acid Profile of Black Soldier Fly Larva and Pupae

Composition (%)	**Black Soldier Fly**	
	Larvae	**Pupae**
Alanine	2.78	2.56
Arginine	2.28	2.14
Aspartic acid	3.98	4.29
Cysteine	0.43	0.31
Glutamic acid	5.85	5.01
Glycine	2.22	2.51
Histidine	1.39	1.48
Isoleucine	2.12	2.30
Leucine	3.10	3.37
Lysine	2.81	2.78
Methionine	0.60	0.71
Phenylalanine	1.73	1.95
Proline	2.39	2.45
Serine	1.96	1.95
Threonine	1.76	1.83
Tyrosine	2.63	3.07
Valine	2.40	2.55
Total	40.50	41.30

Source: Kwancho Park (2013)

iv. Biogas Production

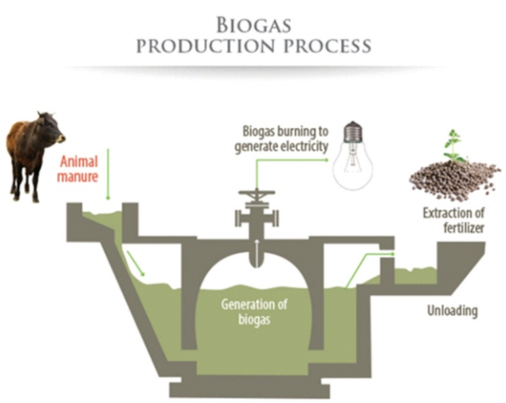
Technical article of Penn State Extension clearly demonstrated the use of anaerobic digester in conversion of animal manure to energy in the form of biogas which contain methane. According to the authors, Pennsylvania cows produce 5.5 million tons of reclaimable manure each year. Afolabi (2021) noted that large quantities of manure wastes from livestock operations can pose a threat to the environment if not properly managed; owing to the fact that these waste contains nitrogen and phosphorus in quantities that are harmful to human health and to aquatic animals if they meet water bodies (eutrophication problems). Conversion of animal waste to biogas is one sure way of preventing this environmental risk. Imam et al (2013) investigated biogas production from fermentable materials like cow dung, poultry manure and water hyacinth and found that percentage methane content in the biogas produced are similar. Castrillon et al (2013) studied biogas production from cow dung by adding food waste and crude glycerine from biodiesel industries, and discovered 78% of methane in the biogas generated. According to AgSTAR (2011), biogas recovery from animal waste may hold the key to unlocking the financial and environmental benefits of managing manure generated from livestock operations and organic wastes from food bioprocessing factories. Afolabi (2021) explaining the importance of conversion of animal manure to useful energy stated that manure cannot be applied in the field immediately after it is produced, manure is therefore stored until there is opportunity for its use. In the interval between production and utilization biogas can be extracted from the manure. According to Afolabi (2021), anaerobic digestion involves microbial fermentation of the substrates, resulting in a mixture of gases: Methane (55-65%), carbon dioxide 30-35% and other gases such as nitrogen, sulphur as impurities. Pakistan Weekly Technology Times of 15th Novemeber, 2015 reported that Germany has become the largest biogas producing country in the world. By properties, biogas is very similar to natural gas and is composed of Methane (50-75%), Carbon dioxide (25-50%), Nitrogen (0-10%), Hydrogen (0-1%) and Hydrogen Sulphide (0-3%). Biogas is also being used in power generators for electricity production around the world as renewable fuel source.

Table 7: Daily Biogas Production Quantity

Waste	Total Wet Manure Quantity (Kg/day)	DM (%)	ODM (%)	Biogas producing rate	Biogas quantity (m^2/day)	Fertilizer (Kg/day)
						m^3/Kg_{ODM}
Bovine animal manure	175	8.44	72.39	0.05	6.33	145
Poultry manure	50	71.92	23.7	0.07	0.83	47.5

DM= Dry matter, ODM= Organic Dry matter

Source: Recebli et al (2015)



Source: Weekly Technology Times, Pakistan, 15th November, 2015

Theuse of livestock manure for electricity generation appear the most awe inspiring result of research especially for developing countries where power outage is a constant menace. Yasser et al (2020) cited in Xinyuan et al (2021) reported that animal manure is a cheap source of electricity generation. According to them animal manure can directly be used for electricity generation after mixing with sea sand. However exposure to sunlight is essential to produce electricity from animal manure. Such electricity generation resulted in high removal percentage of COD and TKN. Animal manure to power technology is already documented as a means of alleviating environmental problems from large animal operations / Kyle Meisterling of the University of California reported that electricity generating capacity from manure in the US is approximately 5.4 GW, with 2.7 GW coming from manure handled as solids (incineration or gasification) and 2.7 GW from anaerobic digestion of liquid manure. Pakistan WeeklyTechnology Times of 15th November, 2015, reported thatone cow can produce enough manure in one day to generate 3 KWh of electricity; while only 2.4 KWh of electricity is needed to power a single 100 watt light bulb for one day. The paper also stated that in the US 13% or 95000 tons of waste is being used to produce about 2500 MW of electricity that suffices for 2.3 million households. In Nepal, where 80 percent population lives in rural areas with no electricity, an NGO has installed around 210,000 biogas plants to provide biogas for cooking and lighting. In North America, utilization of biogas can generate enough electricity to meet up almost 3% of the continents electricity expenditure.