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SMART AGRI-PRENEURSHIP AND FARM YIELD IN NIGERIA

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Abstract

The study investigated smart agripreneurship and farm yield in Nigeria. Survey research design was adopted and both stratified and simple random sampling methods were adopted. Duly registered agripreneurs in South-West Nigeria were selected, constituting the population of 2557. Adopted questionnaire was used to source primary data from a sample size of 558 agripreneurs. The multiple regression analysis demonstrated that the effect of drone agriculture, geo-mapping, greenhouse farming, hydroponics, and soil analysis on farm yield in Nigeria is positive and significant (Adj. $R^2 = 0.619$ *F (6, 551) = 151.798 p=0.000). The study concluded that climate friendly smart farming by agribusinesses is a crucial determinant for high farm yield in Nigeria. The study recommends that agripreneurs should focus more on hydroponics, geo-mapping and soil analysis than greenhouse farming and drone agriculture so as to experience high farm yield.*

Keywords: Drone Agriculture, Farm Yield, Greenhouse Farming; Smart Agripreneurship, Soil Analysis.

INTRODUCTION

The expansion in the world's economy and the rapid growth in population most especially in developing countries like Nigeria is expanding the poverty bracket. The challenges of starvation that was once restricted to rural areas are gradually becoming predominant in urban areas according to research. The new shift in developing economies from reliance on aids and donations, to tackling food security, has led to the generation of indigenous solutions that can help meet the challenges. Other macro factors such as unfavourable weather and political instability increase the pressure and demand for staple meals, hence farm yield is key in other to serve the populace.

New mmeasures taken by developing economies to tackle farm yield is a welcome development among nations and utilization of technology will be vital (Ashe, 2019). According to Pai, Shah and Bohara, (2020), smart farming is gradually being adapted due to the high demand for food and irregular weather conditions, arising from the global climate change and population growth. This gradual advancement in farming methods such as geo-mapping, greenhouse farming, hydroponics, nutrient cycling, and soil analysis, have been identified as dimensions of smart agri-preneurship that could address the issue of low farm yield in developing economies (Ariani, Hervani & Setyanto, 2018). Concurrently, the agribusiness industry is developing new measures to increase the output of farmers and enhance the efforts of Smart agripreneurs. According to Rehman and Shaikh (2014) smart agripreneurship enables the achievement of sustainable developments, reduction in starvation among the populace and actualization of the objectives of a responsible economy.

Smart agripreneurship is intended towards high farm yield which will enhance food security in a county. FAO (2011) Pointed that smart agripreneurship is well associated with growth in the agricultural sector. Smart agripreneurs can achieve high produce quality, high farm yield and larger quantity of produce with low wastages through the implementation of smart technologies, Pai, Shah and Bohara, (2020). In the opinion of Vermeulen (2012), one of the factors that could enhance smart agripreneurship is modern technology and nature friendly concepts such as windmills, solar farms, renewable energy-powered vehicles, solar-wind electricity production and bio energy-operated water pumps.

Furthermore, the increasing rate of hunger in the world has made researchers, academicians, practitioner and the government to be concern about food security which is directly linked to farm yield. The rate of hunger is predominant is under developed and developing economies like Nigeria. Adelowokan, Maku, Babasanya and Adesoye (2019) reported that there is decline in the performance of agribusiness in Nigeria from 2010 to 2019. This made Gates (2019) to report that there is a high level of hunger in Africa and poor farm seedling that lead to low produce in Nigeria. This is coupled with the increasing rate in indigenous population and in flock from neighboring nations.

The displacement of over 17 million people across the north-eastern part of Nigeria due to the prolonged Boko Haram insurgency was reported to be another factor responsible for the decline in national food production as the north-eastern part of Nigeria used to be one of the major farm belts for the nation. However, the farm yield in the south-western part of Nigeria is also pressured by herds men from the north which cannot engage in open grazing due to the insecurity and are eating up farmlands to feed their cattle, Adzenga, Umar, Olaleye, Ajayi and Onyenkazi, (2019). The study has been well-thought-out as follows: Introduction, Literature review, methodology, results and discussions and conclusions.

Objectives of the Study

The main objective of the study examined smart agri-preneurship and farm yield in Nigeria. Other objectives:

i. examined the role of greenhouse on farm yield in Nigeria
ii. examined the effects of hydroponics on farm yield in Nigeria
iii. examined the influence of geo-mapping on farm yield in Nigeria
iv. examined the effects of drone agriculture on farm yield in Nigeria
v. examined the influence of soil analysis on farm yield in Nigeria

Hypothesis of the Study

In line with the objectives of the study, the hypothesis is thus formulated:

$H0_1$: Smart agri-preneurship dimensions (drone agriculture, geo-mapping, greenhouse farming, hydroponics, and soil analysis) do not significantly affect farm yield in Nigeria

LITERATURE REVIEW - SMART AGRIPRENEURSHIP

Smart agripreneurship embodies three concepts-smart agribusiness, smart technology and entrepreneurship. Smart agribusiness deals with the use of technology for farming activities. Smart technology involves the use of new and modern technological devices for agricultural purpose. Entrepreneurship entails the means to create and develop a profitable agribusiness. Therefore, smart agri-preneurship – is the use of health-friendly technological procedures in sustaining innovative community-oriented and proactive agriculture and allied business (Carr & Rollin, 2016). Smart technology, denotes technology driven concepts, systems and gadgets that aid information tracking and sharing, efficiency improvement and are environmentally friendly (Osabohien, Osabuohien, & Urhie, 2018). Smart agripreneurship is defined by Cains and Henshel (2019) as the profitable union of agriculture, climate awareness, technology and entrepreneurship to turn farms into successful agribusinesses. Advanced sensing technologies can proffer solution to agricultural problems, making information gathering on soil, status of crops, and environmental conditions easier, thereby increasing farm yield and quality of farm produce (Saiz-Rubio, & Rovira-Más, 2020). Pai, Shah and Bohara, (2020) opined that passion for working and hard work needs to be complemented with more professional skills for agripreneurs to survive in the competitive and fast changing modern day agriculture space. This can be achieved through innovative farming.

Wekesa, Ayuya, and Lagat (2018) viewed greenhouse farming a sub-variable of smart farming as the performance of plants within a favourable environmental condition. Greenhouses could be framed or inflated structures but not limited to such, and could come with transparent or translucent material as covering to grow crops within a partial or fully controlled environment. Agribusinesses use the greenhouse to protect plants from adverse climatic conditions such as storm, dry weather conditions, rainfall, heat, insects and diseases. Imran, Asghar, Ashfaq, Hassan, Culas and Chunbo (2018) opined that greenhouse smart farming has a positive effect on farm yield with a 10-12 times higher output than that of outdoor crop growing. Such result is dependent upon the type of greenhouse, seedling or seed planted and environmental facilities installed.

Drone agriculture which is a sub-variable of smart farming can be viewed as an aerial technological instrument which can be used in keeping eye on crops and help detect diseases in plants, irrigation challenges, soil variation and fungal infiltrations (Alimuzzaman, 2015). According to Anderson (2014), the significance of drone in agribusiness can be appreciated from the fact that it can provide farmers with precision in decision making. Anderson (2014) opined that the advantages of drones in farming have paved a new means of increasing farm productivity. Also, the utilization of drones in smart farming can help agripreneurs to estimate farm yield, enhance prediction and optimize their production chain downstream (Lytos, Lagkas, Sarigiannidis, Zervakis, & Livanos, 2020). Shirwar, Swarnkar, Bhukya and Namwade (2019) stated that some of the demerit of drones in smart farming are based on cost of procurement and deployment. Hence they are more suitable for large agribusinesses when compared to the rural farmers who may be in the majority.

Capolupo, Pindozzi, Okello, and Boccia (2014) view hydroponic system of smart farming as a farming system that is soilless and needs a liquid nutrient solution with the presence of an artificial or natural supporting medium. Savvas and Passam, (2002) Soilless (hydroponic) culture, which was primarily established for studying plant mineral nutrition as one of the main elements of sustainable cropping systems under greenhouse conditions are resultful. Hydroponics is a viable method of producing vegetables (tomatoes, coriander, cucumbers and peppers) as well as ornamental crops such as herbs, roses, freesia and green plants in a climate friendly way (Carfagna & Gallego, 2005). They stated that hydroponics is developing plants in a nutrient solution with or without the use of a artificial medium and includes expanded clay. Hydroponics are flexible in such a way that it can be customized into modified versions to optimize growing conditions for effective crop production. According to Seungjum and Jiyoung (2015), hydroponics is splited into two forms dependent on the ability of the liquid nutrient solution and supporting media to be reused or recycled; nutrient solution and supporting media in an open system are not reused whereas, in a closed system they are recycled. Generally, the open system may be prone to a lower sensitivity to salt in water, but the closed system is more cost-effective when compared to the open system.

According to Romero-Olivares, Allison, and Treseder (2017), soil analysis delivers an examination of soil texture, pH, organic substance on three major plant nutrients (potassium, phosphorus and magnesium) for varied purposes. This is then followed up with comprehensive construal of the results as well as best fit fertilizer recommendations (RomeroOlivares et al., 2017). Soil analysis can also be seen as the verification and authenticating the status of soil nutrients relative to a target area over an estimated period to enhance productivity (Gruber, Zwieback, Crow, Dorigo, & Wagner, 2016). Another way to look at soil analysis is as the fortitude of the alignment and properties of soil in a specific geographical location from the mechanical, chemical, mineralogical, and microbiological content using professional scrutinization (Jordan-Meille, Rubæk, Ehlert, Genot, Hofman, Goulding, Recknagel, Provolo & Barraclough, 2012).

The concept of geo-mapping is viewed as an act of data analysis from several coordinates within a given geographic region which captures and utilizes the cultural features of residents with specifics, Pothuganti, Jariso, and Kale (2017). This definition implies that geographical documentation of metadata and codes from gathered information analyzed. Jekel, Sanchez, Gryl, Juneau-Sion, and Lyon (2014) referred to geo-mapping as geographic mapping and explained it as the precise geographic intelligence gathering of a specified location of land, farm and space, with the designing of a system for capture, stockpiling, analyzing, managing, deploying, and presenting all types of relevant data for future reference. These data can be harnessed by smart farmers using geospatial technologies which includes global positioning system (GPS), geographic information system (GIS) and remote sensing (RS) (Petja, Nesamvuni, & Nkoana, 2014; Praveen & Sharma, 2019).

FARM YIELD

Dinesh (2015) explained farm yield as the quantity and quality of what is produced as harvest from specific farm location. Liao, Vander and Salmon-Monviola (2015) viewed farm yield as the ratio of the quantity of farm produces. Farm yield is usually presented in kilograms (kg) or in metric tonnes (t) in terms of product per hectare (ha). Therefore, in getting the farm yield, farm product area and amount of farm produce will be estimated. Farm yield can be affected by Social-economic factors such as; access to inputs, seeds and fertilizers, access to land, demographics of the population where farm is located, education, income, increased population, labor and diseases affecting labor, (Tom, Rajab & Wamalwa, 2013).

The FAO, (2018), explained farm yield as the average of the total production weight by the land area harvested. The improvement experienced in farm yield research is enhanced by its direct effect on solving food security challenges affecting the world today. The spill over influence can be seen in pricing of staple food produce. Thus, changes in farm yield as a direct effect on the household in developing nations as well as at the global level. Other factor that can influence farm yield at the micro level are driven either by changes in the crop, quality and quantity harvested or by changes in the land area cultivated and harvested. Despite soil and water contributing to increase in farm yield, certain factors that hindered farm yield has been identified by Belay, Recha, Woldeamanuel and Morton (2018). According to Belay et al. (2018), Dinesh (2015); Russell (2013) non-use of high-yielding crop varieties, pests and diseases, global warming effect on pests and high use of pesticides all have effects on farm yield.

SMART AGRIPRENEURSHIP DIMENSIONS AND FARM YIELD

The inter-connection between smart agripreneurship and farm yield in different economies have been scrutinized and the result of smart agri-preneurship measures on agribusinesses overall performance. These studies empirically revealed that part of smart agri-preneurship measures like hydroponics, drone agriculture, and soil analysis have positive and significant effect on agribusiness output and guarantee food security (Adebiyi, Adeola, Osinowo, Brown & Ambi, 2018; Mamta & Shraddha, 2018; Scholes, Villers, Scholes & Feig, 2007). Furthermore, Biswas, Sinha and Khan (2012), Lin, Shaner, Wang, Huang and Huang (2015), Pandey, Tripathi and Shankar (2018) and Ponisio and Ehrlich (2018) showed that smart agri-preneurship indicators are the fastest growing sector of agribusiness, and could very well dominate food production in the future because of their abilities to strive in dry climate conditions and significantly increase farm yield and enhance food security. Similarly, Obiero (2013), Ponisio and Ehrlich (2018) and Rogers, Lassiter and Easton (2014) findings revealed that there is a positive and significant relationship between the smart agri-preneurship income and farm yield. This shows that accurate investments in the agribusiness sector would give better yields.

Furthermore, Abbo, Yadun and Gopher (2010), Berardi, Green and Hammond (2011), Cai and Leung (2006), Emenyonu, Nwosu, Lemchi and Iheke (2014), and Oyakhilomen and Zibah (2014) showed that there is positive and significant effect or relationship between smart agri-preneurship measures and farmer agricultural output and stability. They also revealed a positive and significant relationship between smart agripreneurship, farm yield, productivity, profitability, incomes and return on investment among agribusinesses. Wanyama, 2016 and JanWillem, Allison, Albert, Brooke, Lia and James (2018) revealed that soil analysis data and Geographical Information Systems (GIS) are important tools in farm land use planning (FLUP) and enhance positive and significant effect on farm yield.

However, Rehman and Young (2018) examine geo-spatial approach for temporal monitoring of loss of agricultural land to pests or disease. The study revealed that geo mapping approach in addition to drone agriculture techniques significantly increase farm yield. Aatif, Kaiser, Showket, Prasanto and Negi (2018) and Kropff, Pilgrim and Neate (2019) revealed that smart agri-preneurship positively contributes directly to the livelihoods and food security of almost a billion people and affects the diet and special health needs of many more who use nutritional supplements for medicare. On the other hand, Awojide, Simon, and Akintelu (2018) empirically revealed that fertilizers are applied to the soil by uneducated farmers as they lack funding for smart agri-preneurship techniques particularly making reference to the specific need of the plant or soil, thus reduced farm output.

Branca, McCarthy, Lipper and Jolejole (2011), Bello, Bello and Saidu (2015), Groot, Bolt, Jat, Jat, Kumar, Agarwal and Blok (2019), Jadhav and Rosentrater (2017) used survey research design with multiple regression method of analysis to inspect the combined effect of explanatory variables on the dependent variable. Also, studies of Mamta and Shraddha (2018), Solomon, Mungai and Radeny (2017), Torres (2017), and Wekesa, Ayuya and Lagat (2018) employed the descriptive survey research design to investigate how smart agri-preneurship measures sustained agricultural output, environmental analysis and agricultural business growth. The descriptive survey research design allows researchers to establish field information on study variables and the level at which these study variables like smart agripreneurship components are employed by different agriculture firms.

Similarly, Vermeulen, Wollenberg and Zougmoré (2013) and Solomon, Mungai and Radeny (2017) employed cross-sectional survey design in relation to smart agri-preneurship. The cross-sectional design survey enhances cross information on smart agri-preneurship measures and other related study variables. Adebiyi, Adeola, Osinowo, Brown and Ambi (2018), Adekunle (2013), Ahmad and Mahdi (2019), Alimi and Ayanwale (2005, Obiero (2013), Pandey, Tripathi and Shankar (2018), Ponisio and Ehrlich (2018), Rogers, Lassiter and Easton (2014) employed multiple regression method of analysis to determine the outcome of independent variables on dependent variable; as related to the study variables. Based on the methodological review of these past studies, multiple regression method of analysis will be employed which can determine the combined effects of more explanatory variables on the dependent variable.

Resource Based View (RBV) was expressed into a coherent theory by Wernerfelt in 1984. The theory asserted that the organizational resources and capabilities that are rare, imperfectly limitable, valuable and non-substitutable, form the basis for a firm's sustained competitive advantage. The resource-based view of the firm has provided a core theoretical rationale for human and firm technological resources' potential role as a precise asset in the firm (Eniola, Dada & Alo, 2018). The study anchored RBV as resources and capabilities of the firm form the foundation of the firm's long-term strategy of increased farm yield because the theory provides the basic direction for a strategy and constitute the primary source of profits for the agripreneur. The resource-based view suggests that valuable firm resources are usually scarce, imperfectly imitable, and lacking in direct substitutes (Tanya, 2019).

METHODOLOGY

Survey research design was adopted. Agribusiness firms that are registered within the south-west states of Nigeria which are Lagos, Ogun, Oyo, Osun, Ondo and Ekiti were selected for this research due to the region been the second most populous in the country Nigeria (World Population Prospect - WPP, 2019). In Lagos State, there are 438 registered agribusiness firm, 578, 212, 321, 621 and 387 are registered agribusiness firms in Ogun State, Oyo State, Osun State, Ondo State and Ekiti State respectively. Thus, making the total population for the study to be 2557. The study employed multi-stage sampling techniques. The study will focus on only the agri-preneurs who own or manage the agricultural firms and this could be the agri-preneur who may be the founder or senior management.

Primary data was used and structured questionnaire was the research instrument used to collect the data from the respondents. The items for smart agripreneurship were adapted from the studies of Al-Houti (2017); Kibiti and Gitonga (2017; Harrell (2014); Pettersen (2014) while items for farm yield were adapted from the studies of Kaur (2017) and Sanko (2017). The items were ranked on 6point likert scale from very high, high, moderately high, moderately low, low and very low. Multiple regression are used as data analytical technique for the study. Also, the

Cronbach Alpha and Kasier Meyer Olkin (KMO) shall be used to test the reliability and validity of the instrument.

Data Analysis and Interpretation

Table 1: Reliability and Validity Table

Variable	No of Items	KMO	Cronbach Alpha
Greenhouse Farming	6	559	0.731
Hydroponics	6	0.698	0.821
Geo-Mapping	6	0.636	0.861
Drone Agriculture	7	0.791	0.773
Soil Analysis	6	0.688	0.658
Farm Yield	7	0.630	0.755

Source: Researcher's Computation

The reliability and validity of the instrument was tested using Cronbach Alpha and Kaiser-Meyer-Oklin's (KMO) through statistical package for social science (SPSS). Cronbach Alpha was used to ascertain the internal consistency of the data while KMO was done to ascertain if the instrument measures what it is intended to measure. The results revealed that all the variables have validity results that is above 0.60. Thus, the items for each variable measure what they are intended to measure. According to Serbetar and Sedlar (2016), Cronbach Alpha value that is greater than 0.70 is considered to be good to conduct a study. Thus, all the variables employed in this study have Cronbach Alpha values that are greater than 0.70

Test of Hypothesis

H_0: - Smart agri-preneurship dimensions do not significantly affect farm yield in South-West, Nigeria.

Table 2: Smart Agri-preneurship Dimensions do not significantly affect Food Yield

	β	Std Error	t	P-value
Green House Farming	0.121	0.049	2.476	0.014
Hydroponics	0.190	0.049	3.953	0.000
Geo-Mapping	0.161	0.039	4.154	0.000
Drone Agriculture	0.033	0.019	1.762	0.078
Soil Analysis	0.248	.0.041	6.118	0.000

R^2 = 0.623 Adj. R^2 = 0.619
F (6, 551) = 151.798 (p=0.000)

Table 2 showed the result of the analysis on smart agri-preneurship dimensions (green house farming, hydroponics, geo-mapping, drone agriculture, and soil analysis) on farm yield.

The result revealed that green-house farming (β = 0.122, t = 2.476, $p<0.05$), hydroponics (β = 0.190, t = 3.953, $p<0.05$), geo-mapping (β = 0.161, t = 4.154, $p<0.05$), and soil analysis (β = 0.248, t = 6.118, $p<0.05$) have positive and significant effect on farm yield in South-West, Nigeria. Also, the result of the analysis revealed that drone agriculture (β = 0.033, t = 1.762, $p>0.05$) has a positive and insignificant effect on farm yield in South-West, Nigeria. This finding indicated that farmers should focus on green-house farming, hydroponics, geo-mapping, and soil analysis to improve farm yield in South-West, Nigeria. The coefficient of multiple determination, adjusted R^2 is 0.619 revealed that smart agri-preneurship explained 61.9% of the changes in farm yield in South-West, Nigeria. The F-statistics (df = 5, 551) = 151.798 at p = 0.000 ($p<0.05$) means that the model for

RESULTS, INTERPRETATION & DISCUSSIONS

Findings from the study revealed that smart agri-preneurship dimensions (greenhouse farming, hydroponics, geo-mapping and soil analysis) led to consequent increase in farm yield in South-West, Nigeria. It is established that smart agriculture practices are a crucial and determinant factor for high farm yield in Nigeria. It is revealed that as agripreneurs practice smart farming, more of agriculture productivity will be achieved. This implies that there will be high farm yield which will make food to be available for people thereby combating starvation and alleviating hunger. Further findings from the study indicated that greenhouse farming and hydroponics as a farming system gives a suited environment and nutrient to crops despite the absence of soil which aid crops to germinant.

Furthermore, the findings showed that geo-mapping makes the farmer to detect the location that is suitable for crops to germinant at high rate. The study has revealed that the use of drone in farming activities enables farmers to detect crops that are not growing as expected or have challenges. The more the agribusiness owner performs soil analysis, the more the farmers detect the content, texture and organic substance that will be good for improved farm yield. All these as smart agripreneurship dimensions will contribute greatly to the quantity and quality of farm produce. The results of the study have also been confirmed in the study of Benavidez, Jackson, Maxwell and Norton (2018); Corwin and Yemoto (2015) who demonstrated that smart agriculture dimensions positively affect the crops that lead to high farm yield. Similarly, Solomon, Mungai and Radeny (2017); Zaccardelli, Pane, Villecco, Palese and Celano (2018) and Nwibo and Okorie (2013); Asrat and Simane (2018) revealed that smart agri-preneurship measures, significantly improve farm yield.

CONCLUSION AND RECOMMENDATIONS

This study revealed that hydroponics, geo-mapping and soil analysis have a more significant and positive effect on farm yield than drone agriculture and greenhouse farming. Results from the test of hypothesis show that drone agriculture was however, not a statistically significant predictor of farm yield. The dimensions of smart agri-preneurship accounted for 61.9% of the variance observed in farm yield. This study concluded that smart agri-preneurship dimensions have statistically significant combined effect on farm yield in South-West, Nigeria. Interestingly the study showed that smart agri-preneurship constituents promoted farm yields in South-West, Nigeria and this is a strong indicator for decision making when it comes to addressing food security and the type of agribusiness investments that will positively influence farm yield. The study recommends that farm yield remains a major indicator of food security in a developing country as Nigeria and smart agripreneurs who can deliver on healthy food options from productive farmlands will enjoy leverage. These agribusinesses led by smart agripreneurs have the potency to be strategically positioned for hegemony as land is limited and farming upwards is now an additional option for agripreneurs who have acquired large farms and aim to achieve high farm yield.

REFERENCE

Aatif, H., Kaiser, I., Showket, A., Prasanto, M., & Negi, A. K. (2018). A review on the science of growing crops without soil (soilless culture) – A novel alternative for growing crops. International Journal of Agriculture and Crop Sciences, 7(11), 833-842.

Abbo, S., Lev-Yadun, S., & Gopher, A. (2010) Agricultural origins: Centers and noncenters (A near Eastern reappraisal). Crit Rev Plant Sci, 29, 317–328.

Adebiyi, O. A., Adeola, A. T., Osinowo, O. A., Brown, D., & Ng'Ambi, J. W. (2018). Effects of feeding hydroponics maize fodder on performance and nutrient digestibility of weaned pigs. Applied Ecology And Environmental Research, 16(3), 2415-2422.

Adekunle, I. O. (2013). Precision agriculture: Applicability and opportunity for Nigerian agriculture. Middle-East Journal of Scientific Research, 13(9), 1230-1237.

Adelowokan, O. A., Maku, O. E., Babasanya, A. O., & Adesoye, A. B. (2019). Unemployment, poverty and economic growth in Nigeria. *Journal of Economics & Management*, *35*, 5- 17.

Adzenga, J. I., Umar, I. S., Olaleye, R. S., Ajayi, O. J., & Onyenkazi, H. A. (2019). Farmers' perceived effects of communal conflicts on the delivery of agricultural extension services in north, Nigeria. *Journal of Agricultural Extension*, *23*(4), 39-47.

Ahirwar, S., Swarnkar, R., Bhukya, S., & Namwade, G. (2019). Application of drone in agriculture. *International Journal Current Microbiology & Applied Sciences*, *8*(01), 25002505

Ahmad, L., & Mahdi, S. S. (2019). Yield monitoring and mapping in satellite farming. Retrieved from https://doi.org/10.1007/978-3-030-03448-1_11.

Al-Houti, F. (2017). Evaluation of the effectiveness of Supplemental lights vs No supplemental lights on hydroponically grown lettuce (Doctoral dissertation), Colorado State University Libraries.

Alimuzzaman, M. D. (2015). Agricultural drone. *Journal of Food Security*, *3*(5), 12-27.

Anderson, C. (2014). Agricultural drones. *Technology Review*, *117*(3), 58-60.

Ariani, M., Hervani, A., & Setyanto, P. (2018). Climate smart agriculture to increase productivity and reduce greenhouse gas emission– a preliminary study. *IOP Conf. Series: Earth and Environmental Science*, *200*(8), 12-24.

Ashe, M. O. (2019). International agencies and the quest for food security in Nigeria, 1970-2015. *Ubuntu: Journal of Conflict Transformation*, *8*(Special Issue 1), 251-274.

Asrat P, & Simane B. (2018) Adaptation benefits of climate-smart agricultural practices in the Blue Nile Basin: Empirical evidence from North-West Ethiopia. In: Leal Filho W, Belay

S, Kalangu J, Menas W, Munishi P, Musiyiwa K, editors. Climate change adaptation in Africa: fostering resilience and capacity to adapt. London: Springer; p. 45–59.

Awojide, L., Simon, J., & Akintelu, S. (2018). Empirical investigation of factors affecting information and communication technologies (icts) in agric-business among small scale farmers in Esan Community, Edo State, Nigeria. Journal of Research in Marketing, 9(1), 714.

Belay, A., Recha, J. W., Woldeamanuel, T., & Morton, J. F. (2018). Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia. Journal of Agriculture and Food Security, 6(24), 1-12.

Bello, R. S., Bello, M. B., & Saidu, M. J. (2015). Small Scale Enterprises (SMEs) and Agricultural Transformation: The Nigeria Experience. Science Journal of Business and Management, 3(5-1), 11-15.

Benavidez, R., Jackson, B., Maxwell, D., & Norton, K. (2018). A review of the (Revised) universal soil loss equation ((R)USLE): With a view to increasing its global applicability and improving soil loss estimates. Hydrol. Earth Syst Sci., 22, 6059- 6086.

Berardi, G., Green, R., & Hammond, B. (2011). Stability, sustainability, and catastrophe: Applying resilience thinking to US agriculture. Human Ecology Review, 115-125.

Branca, G., McCarthy, N., Lipper, L., & Jolejole, M. C. (2011). Climate-smart agriculture: a synthesis of empirical evidence of food security and mitigation benefits from improved cropland management. Mitigation of Climate Change in Agriculture Series, 3, 1-42.

Cai, J., & Leung, P. S. (2006). Growth and stability of agricultural production in Hawaii: A portfolio analysis. Economics Issues; EI-9 series of the University of Hawaii, 11.

Cains, F., & Henshel, F. (2019). Exploiting plant volatile organic compounds (VOCs) in agriculture to improve sustainable defence strategies and productivity of crops. *Frontiers in plant science*, *10*, 264.

Capolupo, A., Pindozzi, S., Okello, C., & Boccia, L. (2014). Indirect field technology for detecting areas object of illegal spills harmful to human health: application of drones, photogrammetry and hydrological models. *Geospatial health*, S699-S707.

Carfagna, E., & Gallego F. J. (2005). The use of remote sensing in agricultural statistics, *International Statistical Review, 73*(3), 389-404.

Carr, S., & Rollin, A. (2016). An exploration of agri-preneurship scope, actors and prospects. *International Journal of Small Business and Entrepreneurship Research*, *4*(6), 53-66.

Corwin, D. L., & Yemoto, K. (2015). Methods of soil analysis. Soil Science Society of America, 10, 21-36.

Dinesh, D., Frid-Nielsen, S., Norman, J., Mutamba, M., Loboguerrero Rodriguez A.M., Campbell, B.M. (2015). Is climate-smart agriculture effective? A review of selected cases. CCAFS Working Paper no. 129. Copenhagen, Denmark: CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS).

Eniola, A. A., Dada, D. A., & Alo, E. A. (2018). Entrepreneurial peculiarity and financing sources. International Journal of Research, 7(1), 59-73.

FAO (2011). The global bioenergy partnership sustainability indicators for bioenergy. GBEP

FAO (2018). Climate-smart agriculture. Food and Agriculture Organization of the United Nations.

Gates, B. (2019). Examining inequality. Goalkeepers Report from Bills and Melinda Gates foundation survey. Retrieved from https://www.gatesfoundation.org/goalkeepers/report/2019-report?download=false

Groot, A. E., Bolt, J. S., Jat, H. S., Jat, M. L., Kumar, M., Agarwal, T., & Blok, V. (2019). Business models of SMEs as a mechanism for scaling climate smart technologies: The case of Punjab, India. Journal of cleaner production, 210, 1109-1119.

Gruber, A., Su, C. H., Crow, W. T., Zwieback, S., Dorigo, W. A., & Wagner, W. (2016). Estimating error cross-correlations in soil moisture data sets using extended collocation analysis. *Journal of Geophysical Research: Atmospheres*, *121*(3), 1208-1219.

Harrell, C (2014). Characterizing the rural opioid use environment in Kentucky using google earth: Virtual audit. Journal of Medical Internet Research, 21(10), 14-23.

Imran, M., Asghar, A., Ashfaq, M., Hassan, S., Culas, R., & Chunbo, M. (2018). Impact of climate smart agriculture practices on cotton production and livelihood of farmers in Punjab, Pakistan. *Sustainability*, *10*(6), 21-40.

Jadhav, H. T., & Rosentrater, K. A. (2017). Economic and environmental analysis of greenhouse crop production with special reference to low cost greenhouses.

JanWillem, A., Albert, B., Brooke, A., Lia, C., & James, G. (2018). An integrated approach to a nitrogen use efficiency (NUE) indicator for the food production consumption chain. *Sustainability*, *10*, 1-29.

Jekel, T., Sanchez, E., Gryl, I., Juneau-Sion, C., & Lyon, J. (2014). Learning and teaching with geomedia. Newcastle: Cambridge Scholars Publishing.

Jordan-Meille, L., Rubæk, G. H., Ehlert, P. A. I., Genot, V., Hofman, G., Goulding, K., Recknagel, J., Provolo, G., & Barraclough, P. (2012). An overview of fertilizer - recommendations in Europe: Soil testing, calibration and fertilizer recommendations. Soil Use and Management, 28(4), 419-435.

Kaur, J. (2017). Impact of Climate Change on Agricultural Productivity and Food Security Resulting in Poverty in India (Bachelor's thesis), Università Ca'Foscari Venezia.

Kibiti, J. G., & Gitonga, A. K. (2017). Factors influencing adoption of urban hydroponic farming: A case of Meru town, Meru County, Kenya. International Academic Journal of Information Sciences and Project Management, 2(1), 541-557.

Kropff, W., Pilgrim, V., & Neate, P. (2019). Overcoming challenges to digital agribusiness startups in ACP countries. Wageningen: CTA Publishers.

Liao, W., Vander, M. G., & Salmon-Monviola, J. (2015). Improved environmental life cycle assessment of crop production at the catchment scale via a process-based nitrogen simulation model. Environ. Sci. Technol., 49, 10790–10796.

Lin, T. C., Shaner, P. J., Wang, L. J., Shih, Y. T., Wang, C. P., Huang, G. H., & Huang, J. C. (2015). Effects of mountain tea plantations on nutrient cycling at upstream watersheds. Hydrology and Earth System Sciences, 19(11), 4493-4504.

Lytos, A., Lagkas, T., Sarigiannidis, P., Zervakis, M., & Livanos, G. (2020). Towards Smart Farming: Systems, Frameworks and Exploitation of Multiple Sources. *Computer Networks*, 107147.

Mamta, D., & Shraddha, V.A. (2018). A review on plant without soil-hydroponics. International Journal of Research in Engineering and Technology, 2(3), 299-304.

Nwibo, S. U., & Okorie, A. (2013). Constraints to entrepreneurship and investment decisions among agribusiness investors in Southeast, Nigeria. International Journal of Small Business and Entrepreneurship Research, 1(4), 30-42.

Obiero, E. O. (2013). Social economic factors affecting farm yield in Siaya District. Siaya County, Kenya (Doctoral dissertation).

Osabohien, R., Osabuohien, E., & Urhie, E. (2018). Food security, institutional framework and technology: Examining the nexus in Nigeria using ARDL approach. *Current Nutrition & Food Science*, *14*(2), 154-163.

Oyakhilomen, O., & Zibah, R. G. (2014). Agricultural production and economic growth in Nigeria: Implication for rural poverty alleviation. Quarterly Journal of International Agriculture, 53(892-2016-65234), 207-223.

Pai, A., Shah, S., & Bohara, R. (2020). *Smart Agriculture* (No. 2699). EasyChair.

Pandey, H. N., Tripathi, R. S., & Shankar, U. (1993). Nutrient cycling in an excessively rainfed subtropical grassland at Cherrapunji. Journal of biosciences, 18(3), 395-406.

Petja, B., Nesamvuni, E., & Nkoana, A. (2014). Using geospatial information technology for rural agricultural development planning in the Nebo Plateau, South Africa. Journal of Agricultural Science, 6(4), 10.

Pettersen, E. (2014). Soil phosphorus pools and their relation to land-use and soil physiochemical properties-A case study of an agricultural watershed in north-eastern China (Master's thesis).

Ponisio, L. C., & Ehrlich, P. R. (2018). Diversification, yield and a new agricultural revolution: Problems and prospects. Sustainability, 8(11), 1118.

Pothuganti, K., Jariso, M., & Kale, P. (2017). A review on geo mapping with unmanned aerial vehicles. International Journal of Innovative Research in Computer and Communication Engineering, 5(1), 4.

Praveen, B., & Sharma, P. (2019). A review: The role of geospatial technology in precision agriculture. Journal of Public Affairs, 19, 6-8.

Rehman, A., & Shaikh, S. (2014). Smart agriculture. *International Journal of Communication Networks and Information Security, 32*(2), 263- 270.

Rehman, T. U., & Chang, Y. K. (2017). Current and Future Applications of Cost-Effective Smart Cameras in Agriculture. In Robotics and Mechatronics for Agriculture 75-120.

Rogers, M., Lassiter, E., & Easton, Z. M. (2014). Mitigation of greenhouse gas emissions in agriculture. Retrieved from, https://www.usda.gov/energy/maps/resources/brochure/$file/renewable_energy_brochure.pdf.

Romero-Olivares, A. L., Allison, S. D., & Treseder, K. K. (2017). Soil microbes and their response to experimental warming over time: a meta-analysis of field studies. *Soil Biology and Biochemistry*, *107*, 32-40.

Russell, A. W. (2013). Enhancing innovation in agriculture at the policy level: The potential contribution of Technology Assessment. Land Use Policy, 31, 406-411.

Saiz-Rubio, V., & Rovira-Más, F. (2020). From Smart Farming towards Agriculture 5.0: A Review on Crop Data Management. *Agronomy*, *10*(2), 207.

Sanko, A. A. (2017). Environmental values from plantation forests: a study of Ghana's modified Taungya System in Dormaa Forest District (Doctoral dissertation), University of Ghana.

Saroni, B., Anirban, B., Sayani, S., & Khan, D. K. (2012). Major nutrient cycling of two different tropical dry deciduous forest of West Bengal, India. Journal of Ecology and Environmental Sciences, 3(3), 77-81.

Savvas, D., & Passam, H. (2002). *Hydroponic production of vegetables and ornamentals*. Athens, Greece: Embryo Publications.

Scholes, M. C., Villiers, S. D., Scholes, R. J., & Feig, G. (2007). Integrated approach to nutrient cycling monitoring. South African Journal of Science, 103(7-8), 323-328.

Serbetar, I., & Sedlar, I. (2016). Assessing reliability of a multi-dimensional scale by coefficient alpha. Journal of Elementary Education, 9(1/2), 189-195.

Seungjun, L., & Jiyoung, L. (2015). Beneficial bacteria and fungi in hydroponic systems: Types and characteristics of hydroponic and food production methods. *Scientia Horticulturae*, *195*, 206-215.

Solomon, D., Mungai, C., & Radeny, M. (2017). Climate-smart agriculture (CSA) for resilient agriculture, food security and inclusive business growth in East Africa. Retrieved from ,http://knowledge4food.net/wpcontent/uploads/2017/11/171201_theme7_csa_background-paper.pdf.

Torres A. (2017). Drones in agriculture: an overview of current capabilities and future directions. In Utah Water Users Workshop, Saint George, UT, USA (pp. 1-9).

Vermeulen, S. J., Campbell, B. M., & Ingram, J. S., (2012). Climate. *Annu. Rev. Environ. Resoures, 37*, 195–222.

Vermeulen, S., Wollenberg, E., & Zougmoré, R. (2013). Beyond climate-smart agriculture: toward safe operating spaces for global food systems. Agriculture & Food Security, 2(1), 12.

Wanyama, G. (2016). Analysis of total organic carbon and nitrogen by elemental combustion. Nairobi: ILRI.

Wekesa, B. M., Ayuya, O. I., & Lagat, J. K. (2018). Effect of climate-smart agricultural practices on household food security in smallholder production systems: Micro-level evidence from Kenya. Agriculture and Food Security, 7(1), 86.

Wernerfelt, B. (1984). A resource-based view of the firm. Strategic Management Journal, 5(2), 171-180.

World Population Prospect (WPP) (2019). Prepared by population division of the department of economic and social affairs of the United Nations secretariat. Retrieved from https://population.un.org/wpp/

Zaccardelli, M., Pane, C., Villecco, D., Palese, A. M., & Celano, G. (2018). Compost tea spraying increases yield performance of pepper (Capsicum annuum L.) grown in greenhouse under organic farming system. Italian Journal of Agronomy, 13(3), 229-234.