Smart Agri-preneurship: Can food security be resolved in Nigeria

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Abstract— Hunger in Nigeria has questioned agricultural practices and this paper argued that smart farming could provide food sufficiency and zero hunger. Cross-sectional research design was used and multi-stage sampling method adopted. Five hundred and eight-four smart tech-agricultural farmers were purposively selected. Primary data were collected through a structured validated questionnaire administered to agribusiness farmers in South-West Nigeria. Inferential statistics were employed as data analytical techniques. Findings revealed that smart agri-preneurship variables (greenhouse farming, hydroponics, geo-mapping, drone agriculture, nutrient cycling and soil analysis) significant effected farm yield in South-West Nigeria. The conclusion focused on agri-preneurship adopting smart technology address food security in Nigeria. It was recommended that entrepreneurs and government through the Ministry of Agriculture encourage adoption of techno-preneurship in farming practices and value addition to address food security issues in Nigeria.

Keywords— Smart agri-preneurship, Food security, Farm yield, technologies

1 INTRODUCTION

Achieving food security is the desire of every progressive and security conscious nation. Food security output around the world continues to account for not-ending insecurity, wars, insufficiency, poverty and hunger, and the best-fit model to alleviate starvation seems elusive to farmers especially in Nigeria. This challenge has technically devalued household living standard, created a mecca of have-and-have-not, and majority of Nigerians are deprived or lack access and affordable meal per day. The drivers of food insecurity are both anthropos-centric growth in population, and traditional farming methods which produce low food output yet employed most Nigerians. The technological methods of dealing with the challenges remain vague among policy-makers and citizens in Nigeria. This seems to exacerbate food-insecure environment, amplifies hunger, and deprivation with low entrepreneurial investment in agribusiness, erratic economic indicators and poverty.

The global demand to end starvation, deprivation and insecurity are rhetorical in content and construct without visible reduction in food insecurity. [33] and [41] accounts on smart agri-preneurship and food security is that of pro-economics, [42] farming practices, and [31] food sufficiency which are possible enablers of food security. [30] discussion of agricultural productivity was smart farming, which [51] saw as ingredient for the attainment of food security in Nigeria. According to [45], [34], food production should globally increase in 2050 by 60% due to continuous population growth. Similarly, greenhouse farming [48], hydroponics, geo-mapping, drone agriculture, soil analysis [55] and nutrient cycling are productive larger-scale smart agri-preneurship dimensions that add value and food security, according to [54].

The need to grow food and suppress hunger is pressing, and smart agri-preneurship is imperative in addressing food insecurity [2]. The tenets of smart farming are anchored on hybridization and utilization of scientific knowledge and technological advancements as farmers' tools to increase yield [8]. This enables infusion of sciences into farming and to gain efficiency; a paradigm shifts that increases yield and enhances the nutritional content. [7] philosophy on smart agriculture involves technology as embedded input to reduce reliance on foreign food importation and stimulate home-grown production. [17] and [8] painted agribusinesses in developing nations as deliberate trivialization of food security as a result of unjustifiable benefits, income and burdens among smallholders, which killed the interest of potential entrants. [45] approach is beyond profitability and gaining competitive advantage to value creation/addition, which are preconditions for a rising population to addressing hunger.

Evidence revealed by International Institute of Tropical Agriculture [IITA] synthesis report (2017) revealed that the per capita food supply per day dropped steadily from 2,720 kcal (2007), 2706 kcal (2011) and further down to 2690 kcal (2015), which exposed that Nigeria is experiencing food insecurity. [6] position on Nigeria is that smart technologies (such as greenhouse farming, hydroponics, geo-mapping, drone agriculture, soil analysis) increases farm yield. Several studies [25,26,42] have investigated the interactions between smart agri-preneurship and food security with divergent perspectives. The distinction between context and practices debates among the aforementioned scholars is crucial from the viewpoint of paradigm shift and prospect for solutions. It is this sense of paradigm incompatibility and context differentials that gaps in knowledge were discovered as to how smart agri-preneurship dimensions (hydroponics, geo-mapping, greenhouse farming, drone agriculture, nutrient cycling and soil analysis) affect farm yield in South-West Nigeria.

2. LITERATURE REVIEW

Smart agri-preneurship embodies three concepts: smart agribusiness, smart technology and entrepreneurship. Smart agribusiness recognizes the utilization of technology for farming

activities as post-positivist perspective. Smart technology uses advanced technological devices for agricultural purpose without compromising sustainability. Smart technology is technology driven concepts, systems and gadgets that aid information tracking and sharing, efficiency improvement in farming through environmentally friendly ways [35]. Entrepreneurship entails the *mesa´* instituted to identify unique opportunities, create modalities, and develop resources and actions towards profitable agribusiness [16]. Hence, smart agripreneurship is health-friendly technological procedures employed and deployed in sustaining innovative community-oriented and proactive agriculture and allied businesses [8]. Smart agripreneurship was further defined by [10] as profitable union of agriculture, climate awareness, technology and entrepreneurship turning farms into successful agribusinesses. In addition, [45] approached it as advanced sensing technologies that proffer solutions to agricultural problems by gathering information on soil, status of crops, and environmental conditions to ensure increased farm yield.

Smart agri-preneurship has interdisciplinary content and constructs which [55] discussed from greenhouse farming position as enhancement of plants performance within a favourable environmental condition. Greenhouse environment is fundamental framed or inflated structures, transparent, and translucent materials to cover grow crops within a partial or fully controlled environment [6,55]. The greenhouse accommodates and protects plants from adverse climatic conditions such as storm, dry weather conditions, rainfall, heat, insects and diseases. In addition, [4] revealed that greenhouse farming has positive effect on farm yield with a 10-12 times higher output than that of outdoor crop growing. Drone agriculture is an aerial technological machine that keeps artificial eyes on crops to detect diseases, irrigates, observe soil variation and fungal infiltrations [3] According to [2], drone significance hinges on its ability to provide farmers with precision in decision making. This perspective was sustained by [29] that it enhances prediction and optimizes production chain downstream.

Hydroponic farming according to [13] is soilless approach that needs liquid nutrient solution with artificial or natural supporting medium. [12] defined it as soilless culture whose origin emanated from studying plant mineral nutrition for sustainable cropping systems under greenhouse conditions. Hydroponics is a viable method of producing vegetables as well as ornamental crops in a climate friendly way [14]. According to [44], soil analysis delivers an examination of soil texture, pH, and organic substance on three major plant nutrients (potassium, phosphorus and magnesium) for varied purposes. Soil analysis is also a verification and authentication of soil status nutrients relative to a target area over an estimated period to enhance productivity [48]. In addition, is the alignment and properties of soil in a specific geographical location from the mechanical, chemical, mineralogical, and microbiological content using professional scrutinization [13,44]. Nutrient cycle entails the movement and exchange of organic and inorganic matter back into the production of living matter [2]. This position makes nutrient cycling approach to farming scientific and robust to discuss farm yield in the Nigeria context

The concept of geo-mapping is geographical documentation of metadata and codes or an act of data analysis from several coordinates within a given geographic region, to capture and utilize the cultural features of residents with specifics according to [39]. [24] referred to geo-mapping as geographic mapping or precise geographic intelligence gathering 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 are harnessed through geospatial technologies; global positioning system (GPS), geographic information system (GIS) and remote sensing (RS) [39].

2.1 Farm yield

[15] defined farm yield as the quantity and quality of what is produced/harvested from specific farm location. [28] asserted that farm yield is the ratio of the quantity of farm produces presented in kilograms (kg) or in metric tonnes (t) in terms of produce per hectare (ha). Farm yield is conventionally affected by social-economic factors; 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 [49]. Despite soil and water contributing to increase in farm yield, certain factors that hindered farm yield has been identified by [7]. According to [7] and [15] non-use of high-yielding crop varieties, pests and diseases, global warming, and high use of pesticides are resulting to low farm yield.

2.2 Smart Agri-preneurship dimensions and Farm yield

The inter-connection between smart agri-preneurship and farm yields in different economies has been academically scrutinized along diverse measurements and constructs in relation to hunger, poverty, and performance with stark contrast in positions. The findings are multidirectional and lack convergence both in context, content, and construct; but constructs such as hydroponics, drone agriculture, and soil analysis had exhibited positive and significant effect on agribusiness output/food security [5,2]. In addition, [38] associated smart agripreneurship with fastest growing agribusiness and possessing the capacity to dominate food production and significantly increase farm yield to strengthen food security. Similarly, [36], [38] and [43] revealed that positive and significant relationship exist between smart agri-preneurs' income and farm yield. The views of [5], [6], [43] are constitutive of social, economic and context realities and actions which somehow amplified paradigmatic differences.

Furthermore, [5], [12] [37], and [36] showed the empirical positivism and significant effect of smart agripreneurship measures on farmers' output, while [42] revealed that soil analysis data and GIS are important tools and had positive and significant effect on farm yield. The aforementioned views depicted the convergence of perspectives so that interactions between smart agri-preneurship constructs and farm yield constitute a mixed dose for addressing food insecu-

rity. However, [42] account on geo-spatial approach and geo mapping techniques indicated profound significant increase in farm yield. [1] and [25] also revealed that smart agri-preneurship positively contributed to livelihoods and food security of people affecting the diet and special health needs of people. On the other hand, [6] revealed that fertilizers applied without soil analysis reduced farm output. Moreover, [9], [48], and [55] investigated how smart agri-preneurship measures sustained agricultural output, environmental analysis and agricultural business growth with findings sustaining a positive nexus. Similarly, [54] affirmed the view that smart agri-preneurship affect farm yield. In light of the positions, resource based view (RBV) was adopted since it asserted that organizational inherent resources and capabilities are imperative for outcomes according to [50]. This provided a theoretical rationale for human and firm application of technological resources for farm yield.

3 METHODOLOGY

The study adopted a cross-section survey research design pillared on the ontological issues [11] and its quantitative ability to profile respondents' perception [52]. Registered agribusiness firms within South-West Nigeria geo-political zone (Lagos, Ogun, Oyo, Osun, Ondo and Ekiti) were selected being the second most populous in Nigeria (World Population Prospect - WPP, 2019). The total population was 2557; Lagos State 438, Ogun State 578, Oyo State 212, Osun State 321, Ondo State 621, and Ekiti State 387 respectively. Multi-stage sampling technique was used to capture 584 agri-preneurs (owner/manager).

Structured questionnaire was used and the question items for smart agri-preneurship were adapted. The question items were ranked on 6 point Likert-type scale from very high, high, moderately high, moderately low, low and very low. The questionnaire was subjected to content and construct validity using Kasier Meyer Olkin (KMO) and Cronbach's alpha coefficient reliability test as presented in Table 1. The tests were to ascertain the internal consistency of the data and to determine if the instrument measures what it is intended to measure in regard to creditability, reliability and confidence on the data collected.

Table 1: Validity and Reliability test results

Variable	No of Items	KMO	Cronbach alpha
Greenhouse Farming	6	0.559	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 results from Kaiser-Meyer-Oklin's (KMO) test revealed that the variables on aggregate and individual passed the validity test and measured the intended. Also, the Cronbach's coefficient alpha (a) values were greater than 0.70 which [47] considered as the minimum threshold. Copies of the validated questionnaire were administered to 584 respondents in South-West Nigeria and 558 were retrieved, but 551 were judged usable after data screening.

Model Specification

An econometric model was formulated to cushion for the variables under investigation. The core assumption of the work was to determine if smart agri-preneurship reduces food insecurity through farm yield. The fundamental response model was X instrumental role to change Y. Where Xi $(x\ldots x)^n$ is the behavior of a construct relative to others in the discussion of Y. The linear combination of parameters X is the simple difference between the constructs as they affect Y. The generalized form of the estimation is given as: $Y= \propto + \beta X\tau + \beta X\tau \cdots + \mu\tau$ ….(1)

where:

Y is the dependent variable (Farm yield);
a is a constant, also known as intercept;
X is the explanatory variable;
β is the regression coefficient of the explanatory variables;
Subscript i is primary data denotes
μ is the error term

From the generalized estimation, the functional equation was arrived:

$$Y = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \mu \quad \ldots\ldots\ldots(2).$$

The acronyms for the proxies of the independent variable were introduced into multiple regression with its form as:

$$FY = a + \beta_1 GF_i + \beta_2 HD_i + \beta_3 GM_i + \beta_4 NC_i + \beta_5 SA_i + \beta_6 DA_i + \mu \quad \ldots\ldots\ldots(3).$$

Where:
GF = green farming;
HD = hydroponic;
GM = geo-mapping;
NC = nutrient cycle;
SA = soil analysis;
DA = drone agriculture

The *a priori* expectation as the first premise was that farmers or agribusiness that utilizes smart technologies (smart agri-preneurship) will observe high farm yield which enables food security in South-West Nigeria. Expressed in a functional way: $\beta_i \neq 0$, $p \leq 0.05$ the assumption is sustained.

4 DATA ANALYSIS AND FINDINGS

Smart agri-preneurship dimensions have no significantly relationship/effect on farm yield in South-West, Nigeria was the hypothesis. This assumption constituted the thrust of inquiry and to address this, Pearson Product-Moment coefficient was adopted and employed to describe the pattern of relationship among measured constructs. In addition, multiple linear regression was utilized to determine the effect of smart agri-preneurship variables on farm yield. From Table 2, the direc-

tion and strength of the relationship is indicated by the sign correlation coefficient *r* and *p*-value.

Table 2: Smart Agri-preneurship and Farm Yield Correlation Matrix

Constructs	*r*-Statistics	*P*-Values	Results
Greenhouse Farming and Farm yield	0.731**	0.00	Significant
Hydroponics and Farm yield	0.766**	0.00	Significant
Geo-mapping and Farm yield	0.701**	0.00	Significant
Nutrient Cycling and Farm yield	0.763**	0.00	Significant
Soil Analysis and Farm yield	0.779**	0.00	Significant
Drone Agriculture and Farm yield	0.202**	0.00	Significant

*Significant at 1% ** or 5% **

4.1 Interpretation

Table 2 presented the findings of the correlation between smart agri-preneurship constructs and farm yield with each exhibiting different statistical strength and direction. A significant positive moderate relationship was observed between greenhouse farming (r = 0.731**, p < 0.01), hydroponics (r = 0.776**, p < 0.01), geo-mapping (r = 0.701**, p < 0.01), nutrient cycling (r = 0.763**, p < 0.0) and soil analysis (r = 0.779**, p < 0.01) and farm yield. Drone agriculture exhibited weak positive significant relationship with farm yield (r = 0.202**, p < 0.01). From the results, it becomes evident that smart agri-preneurship proxies influenced farm yield among the surveyed in South-West Nigeria. However, the strength of each construct differs as soil analysis had the highest relative influence on farm yield and drone agriculture had a profound weak correlation among the constructs. The introduction or adoption of smart agri-preneurship (technology) is conventionally associated with the creation of a sustainable process and practice, leading to food security which implies the sustainability of farm yield. In the context of these findings, smart farming is a new development through which farmers' expand their farm yield and gain control over their environment, hunger and deprivation. Essentially, technology adoption and utilization in farming endeavor bring about higher yield which inevitably cushion for shortage and sustain food security.

The inherent weaknesses in Pearson Product-Moment fueled the necessity of employing another technique for the organization of concrete position so as to determine the predictors of farm yield through the eyes of smart agri-preneurship. Smart agri-preneurship proxies are key drivers of farm yield, as such farm yield can follow the logic of linear technology utilization but also the logic of nonlinear smart agri-preneurship. The model developed assumed the sequential "first-then" relationship, where in first and then diffuse gradually into the society and economy. It is expected that a predictor or predictors will linearly increase the production curve of farmers and encourage creative farming and expand knowledge in smart agri-preneurship. The second phase of the analysis used multiple regression to unearth the effect of smart agri-preneurship on farm yield. The result of the analysis indicated that smart agri-preneurship affected farm yield.

Table 3: Smart Agri-preneurship Dimensions and Farm 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
Nutrient Cycling	0.200	0.040	5.011	0.000
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 < 0.05)

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 coefficient of multiple determination, adjusted R^2 was 0.619 revealed that smart agri-preneurship explained 61.9% of the changes in farm yield in South-West, Nigeria. The implication was that the 38% is a progenitor of other variables that were not considered in this work. The *F*-statistics (df = 6, 551) = 151.798, p < 0.05) means that the model was fit for use. 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), nutrient cycling (β = 0.200, t = 5.011, p<0.05) and soil analysis (β = 0.248, t = 6.118, p < 0.05) had positive and significant effect on farm yield. Also, drone agriculture (β = 0.033, t = 1.762, p > 0.05) had positive but insignificant effect on farm yield. The findings indicated that agri-preneurs should focus on green-house farming, hydroponics, geo-mapping, nutrient cycling and soil analysis to improve farm yield in South-West, Nigeria.

Thus, practices of smart agri-preneurship enhances the growth in farm yield, creates a resilient economy and food security in Nigeria. It is evident that smart agri-preneurship enabled farm yield which is a precondition for food security. The results from correlation and regression sustained and intensified the assumption that smart agri-preneurship influences productivity of farmers as well as the farm produce. It should be noted that green-house farming, hydroponics, geo-mapping, and soil analysis are fundamental agri-preneurship dimensions that improve farm yield. The results indicated that when smart agri-preneurship is practiced across the geo-

political zones, the abundance of farm produce is ensured, and the tendency for hunger rate reduction in Nigeria is possible. This is because food security is guaranteed, which implies that there will be adequate food for the people.

4.2 Discussion of findings

The study was initiated and designed to deepen insight on food security through smart agri-preneurship. It tested one proposition utilizing different statistical approaches to better address farm yield through the practices of smart agri-preneurship. Using the proxies of smart agri-preneurship, the empirical analysis supported the premise that food security is possible. In particular, the results showed that within South-West Nigeria, smart agri-preneurship had a relationship with farm yield. In addition, smart agri-preneurship affected farm yield vis-à-vis traditional approach. The findings have implication for both the farmers and government. In terms of research in agri-preneurship, the findings shed new light on how smart farming improves and contributed to farm yield. Past studies have also confirmed that smart agri-preneurship dimensions aid agribusiness to achieve agricultural purposes [43.21,50,49,35] and established that smart agri-preneurship dimensions enhance food security. However, the findings of the study disagree with the results of [54], [27], and [32] who established a negative relationship between smart agri-preneurship and food security.

The result of these studies [48,37] agree and added value to the existing findings that smart agri-preneurship measures like hydroponics, nutrient cycling and soil analysis have positive and significant effect on farm yield, agribusiness output, and guaranteed food security output. Furthermore, it correlates with the findings of researchers like [5,24,38] which revealed that smart agri-preneurship indicators are the fastest growing practices, and could dominate food production in the future because of their abilities to strive in dry climate conditions and significantly increase farm yield. Similarly, [37,38] and [43] findings revealed that there is a positive and significant relationship between the smart agri-preneurship income and farm yield. This shows that sufficient investments in the smart technology agribusiness sector would give better yields.

Similarly, looking at smart agri-preneurship measures such as geo-mapping, soil analysis, and nutrient cycling, studies of [44,49,3] corroborated the findings of this study, as these measures were seen as positive and significant enhancers of farm yield. Also, [45] examined geo-spatial approach for temporal monitoring of loss of agricultural land to pests or disease and found that geo-mapping and drone agriculture techniques significantly increase farm yield. This result provides support for smart agri-preneurship and farm yield relationship from the point of geo-mapping, but diverged from the context of drone agriculture, as the outcome of this study revealed that drone agriculture is irrelevant in farm yield from the South-West Nigeria perspective. However, [12] showed that smart agri-preneurship dimensions do not significantly determine growth and stability of farm production in all cases.

5 CONCLUSION AND RECOMMENDATION

This paper's objective was to investigate smart agri-preneurship and farm yield towards achieving food security in Nigeria. It was established from the literature that the possibility exists and the empirical results further substantiated the position. On this premise, the paper concluded that investment in smart technologies (agri-preneurship) affected farm yield. This implies that food insecurity can be addressed in Nigeria through progressive encouragement and investment in modern farming toward engendering food sufficiency. Based on the finding, this study suggests that smart agri-preneurship dimensions engender farm yield. This is because the aggregation of the respective constructs of smart agri-preneurship jointly enabled improvements in quantity of farm produces which invariably exhibited ripple-effect on food security. Also, on an individual basis, the insignificance of drone agriculture could be attributed to poor adoption and introduction of drone into farming. The study recommended that agri-businesses seeking to engineer growth should engage and adopt technology to improve food security output. In addition, the government should formulate policies that encourage the agri-preneurs to practice smart farming in Nigeria.

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