

ADVANCING FARMER EDUCATION FOR GREEN TECHNOLOGY IN AGRICULTURE: IMPLICATION FOR SUSTAINABLE FOOD SECURITY IN NIGERIA

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Abstract

Escalating food demands placed on farmers in recent times has brought the need for alternative sustainable means of producing food at lower cost and at the same time meeting food demands without causing harm to the environment. This alternative means requires educating the farmers. The study therefore explored Farmer education as a tool to accelerate the attainment of food security through the use of green technology to increase food production in Nigeria. The content analysis methodology was adopted to examine the narrative content of various scholars and the inductive approach was used to x-ray further the emerging challenges facing food security, innovative green technologies that are needed by farmers, the importance of Farmer education and the implication it has on sustainable food security in Nigeria. Innovative green technologies such as precision agriculture, automated irrigation systems, genetically modified crops, animal tracking collars among others are technologies that farmers need to know more about because of the benefits it can offer. The study concludes that Farmer education is critical to green technology utilization and attainment of food security. Based on this narrative, the study recommended that farmers should make use of all available platforms to gather information about green technology suitable for their farming activities; reconsider innovative eco-friendly methods in their farming activities in increasing their productive capacity among others.

Keywords: Content Analysis, Digital Technology, Farmer Education, Green Technology in Agriculture, Precision Agriculture, Sustainable Food Security.

Introduction

The advancement of digital technology in agriculture is fast spreading in many countries of the world forcing world leaders to think of alternative means for tackling climate related changes and at the same time produce enough food for all (Li & Song, 2022; Agbidi *et al.*, 2022; Kinda, 2021; Defrance *et al.*, 2020; Lynch & Pierrehumbert, 2019; United Nation [UN], 2015). Green technology, clean agriculture, eco-friendly agriculture, and going green are terms referring to the use of innovative digital technologies in agriculture. These technologies are commonly used in precision agriculture, vertical farming, green house farming, and soilless farming among others.

Green technology as described by Boye and Arcard (2013) is the global collaborative compendium. Green technology implies the application of science with the use of digital data to model, manipulate, monitor, and conserve the farming environment and resources in a sustainable manner. Green technology makes use of small land space for crop production and other dedicated areas for livestock (Boye & Arcard, 2013). Li and Lin (2023) posited that increasing agricultural productivity with reduced undesirable waste input, yields a desirable output in resolving food security. This suggested that green technology can impact environmental regulations, firstly by increasing production efficiently (Tang *et al.*, 2022) and secondly by reducing the use of agrochemical on farmlands (Li & Lin, 2023). Moreover, green technology is eco-friendly but require adequate knowledge and skills in its usage. This necessitates the call for green technology education.

Some scholars recently have called for attention on improving agricultural productivity and efficiency through green technology (Li & Lin; 2023; Rahman *et al.*, 2021; Shah *et al.*, 2021). However, mankind inability to anticipate how and when food production could change and

increase in response to farming practices, and how the potential that breeds food crisis could likely create new innovations in technological approach and institutional changes in ensuring food security is now a concern (Asseng *et al.*, 2021). More than a few scholars have maintained that transiting from obsolete farming practices to green technology is critical to food security (Li & Lin; 2023; Agbidi *et al.*, 2021; Assen *et al.*, 2021; Kinda, 2021). This transition however, requires educating the farmer.

Despite several internet media platforms advancing digital technology usage in agriculture, this has not really trickled down to farmers in many developing countries like Nigeria as many farmers are under pressure to increase farm yield while relying on crude farming practices rather than innovative technology (Agbidi, 2023). This suggests bridging knowledge gap through education. Farmer education in green technology is the ability to stimulate interest in basic knowledge and skills about eco-friendly technology that can be useful in optimizing increase in yield and profitable farming. Paltasingh and Govari (2018) maintained that education has significant influence on the adoption of modern farming technologies. The National Institute of Food and Agriculture (NIFA) of United State Department of Agriculture (2023) upheld that up-to-date education is required by farmers to be aware and well informed of technological development in agriculture and the range of new innovations that influences farming operations.

Furthermore, Paltasingh and Govari (2018) attest to the fact that farmer education arises due to quantification of the education (how valuable it is), the education to be considered (information to be known), where it matters (intended purpose), and whom it is for (the benefactor). National Institute of Food and Agriculture (2023) aligned with Farmer education because it

increases the farmers' knowledge and skills in adoptable technological practices that are rewarding both in profit and sound environment.

Despite global awareness about green technology in agriculture, developing countries like Nigeria are yet to fully explore its benefit in ensuring food security. Food is vital, but educating the farmer is equally important in generating the right force to remain current on innovative technologies useful in engendering food security. This paper therefore explores farmer education as a tool in advancing green technology in agriculture for ensuring that food is safe, nutritious and enough for everyone.

Objective of the Study

The main objective of the study is to advance farmer education for green technology in agriculture as a tool for achieving food security in Nigeria. Specifically, the study aimed at:

1. ascertaining the emerging challenges facing food security in Nigeria;
2. assessing the pathway to food security in Nigeria through green technology innovation;
3. Determining the importance of Farmer education for green technology in Nigeria; and
4. Ascertaining the implications of green technology education for sustainable food security in Nigeria.

Methodology

The qualitative approach using the narrative content analysis methodology was employed in this paper to examine the narrative content of various scholars about advancing Farmer education in green technology in agriculture as a tool for attaining food security. The content analysis involves examining the content of a narrative in order to identify motives and patterns to a concern in a chronological order and sequencing it to create a better

experience (Creswell, 2007). The paper therefore analyzes the narrative of scholars and making deductive reasoning in confirming the opinion about Farmer education, green technology and food security attainment.

Food Security and Emerging Challenges in Nigeria

The recent Covid-19 epidemic and the emerging food crisis heightened by Naira change and cashless policy of the Central Bank of Nigeria, pump price of premium motor spirit subsidy removal and resultant transportation hike and high cost of food, and threats to farmers' lives and farmlands has been an intimidating issue confronting the democratic government of President Bola Ahmed Tinubu in Nigeria. These emerging issues has greatly slowed down the United Nations (UN) agenda for attaining food security through the inter-related Sustainable Development Goals (SDGs) platform for zero hunger in Nigeria (Agbidi & Imobighe, 2022; Agbidi *et al.*, 2021, UN, 2015). Consequently, leading to the declaration of a state of emergency on food security in Nigeria.

Food security is far beyond providing safe and nutritious food for mankind but extends to producing food that meet the demand of mankind in a sustainable manner. Food security is the availability, accessibility, affordability and utilization of food by all category of persons irrespective of their background (Agbidi *et al.*, 2021). Food availability and accessibility is relative to local production and purchasing power despite being a right to available food (Agbidi *et al.*, 2022; Food & Agricultural Organization [FAO], 2016). Besides, rain fed agriculture has remained predominant in Nigeria farming system often creating unfavourable conditions to food supply and high price of food in the market.

More so, the Food Security Information Network (FSIN) (2020) global report on food crisis acknowledged that half of the

world worst food problem is in Africa as the number of people affected increased considerably from 174.3 million to 234.7 million in 2005 to 2019. In spite of the population of people rising in the world, this rise is not commensurate with increasing food production as a lot of persons are entrenched in hunger and uncertain about the next meal (Aguirre-Unceta, 2023; Rivers, 2022; Asseng *et al.*, 2021; Samberg, 2018). This uncertainty is worsened by economic and health instability leading to widespread extreme hunger (Rivers, 2022; Asseng *et al.*, 2021).

The un-matched population rise without corresponding progressive food production increase has been blamed in recent times on poor power supply, armed conflict and insurgencies in farming communities, climate change with resultant flooding, drought, erosion among others, and bush burning (Li & Song, 2022; Agbidi & Imobighe, 2022; Rivers, 2022; Agbidi *et al.*, 2021; Samberg, 2018). Aguirre-Unceta (2023) implicated socio-economic demographics, natural disasters and human caused conditions for the challenges facing food security in Sub-Sahara countries not excluding Nigeria. Energy crisis has also endangered food security as many industries in Nigeria struggle for survival (Li & Lin, 2023). These challenges create a perception and attitude of inevitability of food crisis despite several attempt to end hunger and achieve food security (Aguirre-Unceta, 2023).

Notwithstanding, the hope of attaining food security by world leaders has relied on international investment in agriculture, infrastructure and political will to support food production (Agbidi & Imobighe, 2022; Rivers, 2022; Samberg, 2018). However, this reliance has not produced the desired result as 800 million people's world over are food insecure (FAO, 2016). More so, mustering political will for enabling policies is important, but implementers of these policies need to

reconsider, putting the farmer into perspective (Agbidi *et al.*, 2021). This implies supporting farmers in balancing food supply with the demand for food despite the challenges facing them. Nevertheless, a seemingly intangible solution to the present-day challenges facing the availability, accessibility and utilization of sustainable food for all is to adopt the use of eco-friendly agricultural technologies (Agbidi, 2023).

Green Technology Innovation: A Pathway to Food Security in Nigeria

Green technology concept is an emerging innovative technology that is gradually gaining ground in developing countries (Kinda, 2021). The technological advancement of any nation is essential to farmers as a pathway to attaining food security in the area of genetic improvement of crop plants, reduced food waste and loss, soil fertility improvement, and restoration of degraded land area (Rivers, 2022). Top most innovative green technology in agriculture today includes and not limited to the use of agricultural drones, automated modified crops, animal tracking collar, takeaway, hydroponic greenhouses, vertical farming, precision agriculture, biofuel technology, post-harvest processing technologies among others. These technologies are mostly automatedly controlled (Asseng *et al.*, 2021).

The reports of some scholars also identified genetic manipulation technologies in use today in green farming including gene technology, transgenic technology in crop plant and animal breeding programmes, gene sequencing, proteomics, molecular crop breeding technology, induced mutation breeding among others (Rivers, 2022; NIFA, 2023; National Intelligence Council Report [NICR], 2012). Some other technologies heavenly rely on Artificial Intelligence (AI) in farming such as the use of sensors to adjust application of soil nutrients, the use of Global Positioning System (GPS), drones, robotics, automated

farms among others. Asseng *et al.* (2021) added that AI is often attached to digital data and remote sensors but requires knowledge and skills to optimize limited resources and minimize external challenges.

Other green technologies that hold the promise of promoting sustainable food production include food safety using block chain technology. Some other green technologies also depend on satellite imaging, cloud computing, high speed internet networking in integrating agricultural ecosystems. These technologies allow the use of hyper-spectral satellites to decode images of farms and at the same time provide detail information in helping farmers to make decisive and predictable decisions. Although, these green technologies are advancing in food production in some developing nations, however, the NICR (2012) argued that some of these green technologies of today had long be in existence in the last two decades but are recently made popular owing to climate change and quest for food security.

Hegde (2023) argued further that the adoption of green technologies in agriculture by stakeholders holds the capacity to promote food security and economic sustainability in:

1. providing avenues for precision agriculture;
2. limiting the use of toxic agrochemicals to the environment;
3. conserving non-renewable resources of the environment; and
4. aiding farmers to prepare ahead of external shocks.

Thus, advancing agricultural productivity for food security calls for measures far beyond computer science, remote sensing, molecular biology, agronomy, animal science among others but putting into consideration the end user of the innovative technology through Agricultural education. Education in form of human capital in

terms of knowledge (information and awareness) acts as catalyst in engineering the application of these green technologies despite been highly commercialized (Agbidi & Imobighe, 2022, NCRI, 2012).

Advancing Farmer Education for Green Technology in Nigeria

Different programmes and initiatives of Nigeria government in the past has focused on farmers wellbeing to produce more food, yet the situation of food insecurity is worsening. Could it be that farmers lack the necessary education in making decisive decisions on their farming activities or lack the drive to apply innovative technologies in production? Could it also be that Nigeria leaders are not doing enough to muster political will for genuine agricultural investment in innovative green technologies adoptable to local farmers? Or is Farmer education the problem? Agbidi and Imobighe (2022) affirmed that perception and knowledge is key to attitude towards any innovation.

On this basis, Agbidi *et al.* (2021) outlined three main cardinal objectives of Zero hunger of the SDGs focusing on (a) achieving food security, (b) improving nutrition, and (c) promoting sustainable agriculture. These ambitious objectives are achievable when farmers are supported in education and the use of accessible and affordable innovative technologies. Furthermore, innovative green technologies suitable for sustainable food production can be incorporated through creation of awareness among farmers, stimulating interest among farmers, helping farmers in making decisive decisions, and identifying benefits (Ogana & Ukonze, 2021).

Farmer education encompasses the crucial element of information and awareness (Agbidi & Imobighe, 2022). More so, Farmer education in modern era is supposed to create an avenue where farmers acquire new knowledge, special skills and

competencies needed in improving production more effectively and efficiently at minimal cost. Asseng *et al.* (2021) affirm that technological advancement in food production relies to a large extent on knowledge and skills, innovative technology, behavioural change in consumers' preference, and affordability of adoptive new technology to the farmer work environment. In consonance, Agbidi and Imobighe (2022) established that knowledge is crucial towards a sustainable action. Furthermore, Rivers (2022) remarked that green technology has the capacity to improve global food security when harnessed and utilized productively. Moreover, harnessing and utilizing green technology is achievable only through education.

Notwithstanding, Farmer education in green technology usage and benefits is a function of the type of education received by farmers. Farmer education is supposed to create a knowledge-based farming community where food security is achievable. Rivers (2022) emphasized that Farmer education helps in patterning a better future for farmers as income increases from increased farm yields. Besides, investing on Farmer education compliments the investment on green technology as it is capable of creating the right information and awareness about the benefits of green technology in filling the gap exacerbated by limited farmland, low harvest, harvest loss, the use of crude implement, high cost of farm labour among others.

More so, information gathering and sharing recently has shifted ground owing to digital media platforms. Consequently, it is important that farmers are updated regularly on current trends in innovative agricultural technology both physically and digitally through all available media platforms. In line with the foregoing, Machuka (2023) highlighted the importance of Farmer education to include

improving productivity, maximizing the use of resources, ensuring higher incomes or better economic outcome, better equipped for health and safety, ensuring food security, much improved resilience, improved land use. Better position for market opportunities, access to useful information, improving food quality, and reduced poverty. This demonstrates that Farmer education in green technology offers nations the opportunity and the knowledge of technology reaching more farmers in speed, and reducing corresponding challenges (Asseng *et al.*, 2021).

Implications of Green Technology Education for Sustainable Food Security in Nigeria

Finding the means to increase agricultural productivity has remained a critical challenge to the world. Existing applications in green technologies like genetically modified crops, water and soil management, Integrated Pest Management, post-harvest processing among others has impacted agricultural productivity in most developed countries (NICR, 2012). Studies have showed that technological advancement in crop, fish and livestock production relies much on knowledge and skills, innovative technology, adoption of new technology, behavioural change in consumer preference and affordability of adaptive new technology to the environment (Asseng *et al.*, 2021).

Innovative green technology such as AI, digital data, robotics, vertical farming are capable of meeting food needs at a lower cost (Asseng *et al.*, 2021). More so, green technology is capable of disrupting the present food production functioning systems either negatively or positively (Asseng *et al.*, 2021). Several studies established that green technology is useful in limiting cost in farm resource usage; reducing expensive labour cost; solving the problems of farm size and land fragmentation; drastically reducing soil



degradation occasioned by heavy mechanization; increasing soil nutrient concentration on crops and improving crops and livestock productivity; reducing green house emission; reducing post harvest waste and loss; and improving food nutrition value and health of consumers (Agbidi *et al.*, 2022; Rivers, 2022; Asseng *et al.*, 2021; Asseng & Asche, 2019; Lynch & Pierrehumbert, 2019; Glass & Fanzo, 2017).

Furthermore, green technology provides the ultimate benefit of efficiently and effectively aiding the farmers to produce safe, nutritious and affordable food to the final consumer. This implies that green technology improves farmers' income (Agbidi *et al.*, 2022; Asseng *et al.*, 2021),

In spite of these benefits accrued by green technology utilization, widespread acceptance and adoption by farmers remained a concern to food security. This could be fingered on the neglect of Farmer education in Nigeria (Agbidi, 2023). Thus, the pursuit for food production has brought about extensive dependence on production output leading to land degradation, resource waste, greenhouse gas emission and other harmful effect on the environment (Li & Lin, 2023). Smith *et al.* (2017) added that the use of non-green technologies in agriculture deposits harmful effect on the local environment. This suggests that Farmer education on green technology holds the potential to reduce drastically the use of agrochemical, water wastage and reduce deforestation of the environment and thereby sustaining wildlife resources (Pinstrep & Andersen, 2018; NICR, 2012). This implies that green technology has the capacity to reduce dangers of farming activities on the environment (Azmi *et al.*, 2017).

Nevertheless, green technology in recent time has gathered significant amount of attraction as well as investors due to increasing awareness regarding climate

change alongside the depletion of natural resources. Advancing Farmer education in green technology is therefore needed to keep farmers abreast with innovative technologies suitable for agricultural production.

Conclusion

Apart from emerging issues of food security, Farmer education is equally a serious concern that is being neglected over the years. Escalating food demands placed on farmers recently has brought the need for alternative sustainable means of producing food with limited space, lower cost and little resources. Therefore, the pathway to food security is the utilization of green technology in farming activities. However, this pathway is achievable when farmers are educated about green technology and its benefit to mankind.

Recommendation

Having explored the narrative of various scholars about green technology, farmer education and food security, the following recommendation are put forward

- i. Farmers should utilize every available platform to gather information about green technology suitable for their farming activity;
- ii. Farmers should reconsider innovative eco-friendly methods in their farming activities in increasing their productive capacity to achieves food security;
- iii. Agricultural education institutions should introduce green farming technologies at early stages in school agriculture
- iv. Agricultural policies and legislation leading to sustainable food production should promote green culture and encourage eco-friendly technologies by ensuring easy access to innovative technologies by farmers at affordable cost;
- v. The government of Nigeria should invest in green technology education in vocational institutions so as to



- encourage early adoption of these technology by farmers;
- vi. The Nigerian government should also invest in green technology to pave way for more farmers to be interested in it; and
 - vii. Vigorous sensitization and awareness campaign should be carried out by the National Orientation Agency of Nigeria on the benefit and use of green technology on farms.

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