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Farm Management and Sustainable Food Security in Benue State-Nigeria

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Abstract: This study investigated the effect of farm management practices on sustainable food security in Benue State, Nigeria. A descriptive survey research design was adopted to guide the study. The target population comprised 1,000,000 farmers across the three senatorial zones of Benue State, from which a sample size of 500 respondents was drawn using multistage, purposive and convenience sampling techniques. Data were collected through a structured questionnaire designed to capture respondents' practices in farm planning, farm technology usage, and farm disease management. The instrument was validated by experts, and reliability was confirmed using Cronbach's alpha with acceptable indices for all variables. Out of the 500 questionnaires administered, only 392 were retrieved for analysis. Data analysis was carried out using multiple linear regression analysis via SPSS version 25. Findings revealed that farm planning, farm technology, and farm disease management each had a statistically significant positive effect on sustainable food security. Among these, farm technology exerted the greatest influence (β = 0.417, p = 0.000), followed by farm disease management (β = 0.319, p = 0.000), and farm planning (β = 0.174, p = 0.000). These results underscore the importance of integrated and technologically driven farm management strategies in enhancing long-term food availability, accessibility, and stability in the region. The study concludes that sustainable food security in Benue State can be significantly improved through strategic farm planning, deployment of modern agricultural technologies, and effective management of farm-related diseases. Accordingly, it is recommended that policymakers promote farmer training on planning and record-keeping, increase access to subsidized modern farm technologies, and invest in extension services focused on disease prevention and management.

***Keywords**: Farm management, sustainable food security, farm planning, farm technology, disease management, Benue State, Nigeria, Farm Systems Theory.*

Cite this Article

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Introduction

Background to the Study

The prosperity of any country depends upon the prosperity of farmers, which in turn depends upon the rational allocation of resources among various uses and adopting improved technology. To enable the farmers to gear up the situation, they need to have knowledge on concept, principles and various issues of the farm to manage. The role of farm management is therefore, to supply the information for the farmers for sound planning. All farm management tools are helpful to the farmers in solving their managerial problems for successful operation on the farm business. In the context of increased commercialization there is a greater need to improve the managerial abilities of the farmer. So far, the managers in general have responded admirably to the technological changes that accrued in Indian agriculture. Human race depends more on farm products for their existence than anything else since food, clothing – the prime necessaries are products of farming industry. Even for industrial prosperity, farming industry forms the basic infrastructure. Thus, the study farm management has got prime importance in any economy particularly onagrarian economy. Farm management is critical component of modern agriculture that play a pivotal role in ensuring the sustainability and profitability of farming operations (Adenle *et al*., 2017; Chia *et al*., 2019).

Farm Management comprises of two words i.e., Farm and Management. Farm means a piece of land where crops and livestock enterprises are taken up under common management and has specific boundaries. It is also called as socio-economic unit which not only provides income to a farmer but also a source of happiness to him and his family. While, management is the art of getting work done out of others working in a group. Thus, management is the process of designing and maintaining an environment in which individuals working together in groups accomplish selected aims. Hence, it is the key ingredient. The manager makes or breaks a business. He plays important role in making various farm related decisions. Farm management is considered to fall in the field of microeconomics. Its objective is to maximize returns from the farm as a whole as it is interested in profitability along with practicability. What crops and livestock enterprises and their combinations to grow, what number of resources to be applied, how the various farm activities to be performed, etc., all these falls within the scope of farm management.

Farm management deals with the business principles of farming from the point of view of an individual farm. Its field of study is limited to the individual farm as a unit and interested in maximum possible returns to the individual farmer. It applies the local knowledge as well as scientific finding to the individual farm business. Farmmanagement in short be called as a science of choice or decision making. In other words, farm management seeks to help the farmer in deciding problems. The farm manager has to take decisions on several aspects for profitable operation of the farm. Decisions have to be taken regarding production (what to produce? When to produce? how much to produce? how to produce? etc.), marketing (buying and selling) and Organization and managerial i.e., administration. These three segments are interlinked and decision making is also interlinked.

Sustainable agriculture and conservation practices are given due consideration, emphasizing the increasing importance of environmentally responsible farming methods (Mishra and Singh, 2023; Gunarathne and Lee, 2020). Sustainable agriculture has become the go-to solution for improving productivity and food security without compromising environmental sustainability. The concept emphasizes agricultural practices that focus on the efficient use of natural resources, waste reduction, and ecosystem preservation. By adopting sustainable farming practices such as the use of organic fertilizers, natural pest and disease control, and crop rotation, farmers can increase their yields without harming the environment. In addition, this approach also encourages crop diversification so that people have access to a variety of nutritious and balanced foods.

Previous research (Sihombing, 2022) showed that appropriate and location-specific technology includes mapping of land capability and suitability, commodity ranking, farming analysis, optimization of land use, agro technology application, integrated agriculture, provision of agricultural production inputs, infrastructure improvement, empowerment assistance training, technology development, control of agricultural land conversion, and institutional arrangements. The application of this technology is positively correlated with food security, especially in farmer households, where farmers who apply technological innovations have a better level of food security than farmers who do not.

Another study (Abdullah & Vaulina, 2023) found that alternative agricultural technology innovations that can help improve food security in Nigeria through sustainable agriculture include vertical farming, biofortification technology, intelligent irrigation systems, soil-less agricultural cultivation, and big data technology. Then, several ways of optimizing agrarian spatial planning can help improve food security in Nigeria through sustainable agriculture, namely developing productive agricultural land, structuring agricultural areas, regulating agricultural land conversion, agribusiness integration, and production diversification. The results of this study can strengthen the argument that sustainable agricultural practices are not only beneficial to agricultural productivity but can also promote environmental and social sustainability. The theoretical implications can help develop theories and concepts related to sustainable agriculture and support efforts to encourage wider adoption of such practices in various agricultural contexts. This research aims to examine the effect the effect of farm management on sustainable food security in Benue State-Nigeria.

Statement of the Problem

An innovative farm management is expected to give sustainable food security in any society or nation that practice it effectively and efficiently. Effective farm management practices are crucial for achieving sustainable food security by ensuring long-term food availability, accessibility, and affordability while minimizing environmental impact. This involves adopting sustainable agricultural practices that enhance productivity, preserve natural resources, and build resilience against climate change and other shocks. It has been observed that there is a growing concern about food security in Benue State and indeed Nigeria at large due to the incessant attacks on farmers across Benue State occasioned by Herdsmen and communal crisis in the state which is likely result into food shortages. Food insecurity in Benue State, Nigeria, stems from a combination of factors including farmer-herder conflicts, climate change impacts, poverty, and inadequate infrastructure. These issues hinder agricultural productivity, disrupt food supply chains, and limit access to food for many residents. The researcher sees farm management through farm planning, farm technology and effective farm diseases control will definitely produce sustainable food security. It is against this back drop that this study is titled the effect of farm management on sustainable food security in Benue State-Nigeria.

Objective of the Study

The main objectives of the study are to examine empirically the effect of farm management on sustainable food security in Benue State-Nigeria. The specific objectives are as follows:

- **i.** To examine the effect of farm planning on sustainable food security in Benue State-Nigeria;
- **ii.** To examine the effect of farm technology on sustainable food security in Benue State-Nigeria; and
- **iii.** To examine the effect of farm disease management on sustainable food security in Benue State-Nigeria.

Hypotheses

This study will test the following hypotheses:

HO_1: Farm planning has no significant effect on sustainable food security in Benue State-Nigeria;

HO_2: Farm technology has no significant effect on sustainable food security in Benue State-Nigeria; and

HO_3: Farm disease management has no significant effect on sustainable food security in Benue State-Nigeria.

Literature Review

Conceptual Framework

- ***Farm Management***

Farm management is the strategic and systematic process of planning, organizing, and controlling the various resources and activities on a farm to achieve its goals efficiently and effectively. It involves making informed decisions to optimize the use of resources such as land, labour, capital, and technology to maximize agricultural production, profitability, and sustainability (Babu *et al*., 2016).Farm management is a branch of agricultural economics, which deals with business principles and practices of farming with an object of obtaining the maximum possible return from the farm as a unit under a sound farming programme (Raju & Rao, 2015). Farm management is a branch of agricultural economics which deals with wealth earning and wealth spending activities of a farmer, in relation to the organization and operation of the individual farm unit for securing the maximum possible net income (Bradford and Johnson, 2023).

- ***Dimensions of Farm Management***
  - i. **Farm Planning:** Farm planning is a decision-making process in the farm business, which involves organizationand management of limited resources to realize the specified goals continuously. Farm planning involves selecting the most profitable course of action from among all possible alternatives. Farm planning is a deliberate process of organized foresight and vision based on facts and past experience needed for intelligent action on the farm. It involves planning total farm activities in advance to achieve desired results, including deciding production, financial, and marketing management problems. There are two types of farm plans: simple farm planning which implies planning for minor changes or particular enterprises; and complete farm planning which implies planning for major changes across all enterprises. Characteristics of a good farm plan include being written, flexible, simple, providing efficient resource use, having a balanced enterprise combination, avoiding risky enterprises, and considering farmers' goals, knowledge, and experience. Farm planning enables farmers to achieve objectives like profit maximization in a more organized manner by analyzing resources.
  - ii. **Farm Technology:** These modern tools are reshaping how farming is done and are vital in addressing the challenges faced by the agricultural industry today. Key Technologies Shaping the Future of Agriculture, Precision farming involves the use of data-driven techniques and advanced equipment to optimize crop production. By utilizing GPS, sensors, and IoT devices, farmers can monitor soil conditions, track weather patterns, and assess crop health in real-time. This allows for the application of water, fertilizers, and pesticides only where and when they are needed, reducing waste and increasing efficiency. Precision farming can lead to significant cost savings, higher yields, and less environmental impact. Drones equipped with cameras and sensors are increasingly used to monitor crop health and field conditions from the air. Drones can capture high- resolution images and provide valuable insights into plant growth, pest infestations, and irrigation needs (Chen et al., 2018; Chen et al., 2021).

    This aerial data helps farmers make informed decisions, apply treatments precisely, and track the progress of their crops throughout the growing season. Artificial intelligence (AI) and machine learning algorithms are being used to analyze large datasets and predict future trends. These technologies can optimize planting schedules, detect disease outbreaks, and predict the best times for harvesting. AI-powered systems also help in automating routine tasks, such as weeding, pest control, and irrigation, reducing labor costs and improving operational efficiency. Biotechnology and Genetically Modified Organisms Biotechnology has played a significant role in enhancing crop yields and resistance to diseases. Genetic modification allows crops to be engineered for greater resilience to pests, diseases, and harsh environmental conditions, such as drought. GMOs have the potential to help farmers produce more food with fewer inputs, thus improving food security and reducing the environmental footprint of agriculture (Grace, 2015; Hailu, 2020).

    Agricultural technology has brought about significant improvements in several areas Technologies like precision farming, drones, and robotics allow for more efficient use of resources, including water, fertilizers, and labor. This increased efficiency helps farmers maximize their productivity while reducing costs. Many agricultural technologies aim to reduce the environmental impact of farming by decreasing the use of chemical inputs, minimizing soil erosion, and conserving water. For example, precision irrigation systems ensure that water is used more effectively, while GMOs can reduce the need for chemical pesticides. With a growing global population, food security has become a major concern. Agricultural technology can help address this issue by increasing crop yields, improving resistance to climate change, and optimizing land use. These innovations are essential for ensuring that there is enough food to feed the world's population in the future (Tao Q, et al., 2019; Weerakkody et al., 2019).

    The future of farm management and agribusiness will be shaped by emerging technologies, the challenges posed by climate change, efforts to ensure global food security, and regulatory and policy changes (Nematollahi et al., 2021). To thrive in this dynamic environment, stakeholders in the agricultural sector must remain adaptable, innovative, and committed to sustainable practices (Salvini et al., 2018).
  - iii. **Farm disease management:** Effective farm disease management involves a combination of preventative measures and responsive strategies to minimize the impact of diseases on crops and livestock. This includes maintaining a clean environment, practicing good hygiene, implementing biosecurity measures, and utilizing disease-resistant varieties or breeds. In cases of outbreaks, prompt diagnosis and treatment are crucial. According to Weerakkody, *et al*. (2019) key principles of farm disease management:

- **Prevention measures** include the following:
  - a. **Biosecurity:** Implementing measures to prevent the introduction and spread of diseases on the farm. This includes controlling access to the farm, quarantining new animals, and practicing strict hygiene.
  - b. **Sanitation:** Regularly cleaning and disinfecting animal housing, equipment, and feed storage areas to reduce pathogen loads.
  - c. **Hygiene:** Ensuring clean water and feed supplies for animals and practicing proper waste disposal.

d. **Vaccination:** Utilizing vaccines to protect animals against specific diseases when available.
e. **Quarantine:** Isolating sick animals to prevent disease transmission to healthy animals.
f. **Pasture Management:** Implementing grazing strategies like rotational grazing to minimize parasite burdens.
g. **Resistant Varieties:** Selecting crop varieties that are resistant to common diseases.

- **Control measures** includes;
    a. **Early Detection:** Regularly monitoring animals and crops for signs of disease to enable prompt intervention.
    b. **Diagnosis:** Utilizing diagnostic tools to accurately identify the specific disease-causing organism.
    c. **Treatment:** Administering appropriate medication or therapies based on the diagnosis.
    d. **Integrated Pest Management (IPM):** Combining cultural practices, biological controls, and targeted pesticide applications for crop disease management.
    e. Sanitation: Removing infected plant material or animals to prevent further spread. Specific Examples: Livestock: Maintaining clean and dry housing, providing proper ventilation, and ensuring adequate space for animals can help prevent respiratory and skin diseases. Crops: Crop rotation, soil solarization, and using pathogen-free seeds can help control soilborne diseases.
    General: Disinfecting tools and equipment, controlling weeds, and practicing good hygiene in all areas of the farm can help prevent the spread of various diseases.

A holistic approach to disease management, which integrates prevention and control measures, is crucial for long-term success. By adopting a combination of strategies, farmers can minimize disease incidence, reduce reliance on costly treatments, and improve overall farm productivity and sustainability.

- ***Sustainable Food Security***

Sustainable food security ensures that everyone has access to sufficient, safe, and nutritious food, both now and in the future, without compromising the environment, social equity, or economic viability of food systems. This means balancing food production with the long-term health of ecosystems, social well-being, and economic stability. Sustainability in farming and agribusiness has become a critical concern in recent years due to the escalating challenges posed by climate change, population growth, and resource depletion (Clay and Feeney, 2019). The significance of sustainability in this context cannot be overstated, as it directly affects our ability to meet the growing global demand for food while safeguarding the environment for future generations (Amirova *et al*., 2020). Key aspects of sustainable food security:

Availability: Ensuring sufficient food production through sustainable practices like organic farming, agroforestry, and reducing food waste.

Accessibility: Making food affordable and available to all, including vulnerable populations, through measures like fair trade practices and social safety nets.

Adequacy: Providing diverse, safe, and nutritious food that meets the dietary needs of individuals, including micronutrients and addressing malnutrition.

Stability: Ensuring the consistent availability of food, even with challenges like climate change and economic fluctuations, through resilient food systems.

Sustainability: Protecting natural resources, promoting biodiversity, and minimizing the environmental impact of food production and consumption.

Interconnections with Sustainable Development Goals: Sustainable food security is closely linked to several of the United Nations' Sustainable Development Goals (SDGs), particularly:

SDG 2: Zero Hunger: Aims to end hunger and malnutrition, which are fundamental to food security.

SDG 12: Responsible Consumption and Production: Promotes sustainable consumption patterns, including reducing food waste and promoting sustainable diets.

SDG 13: Climate Action: Addresses the impact of climate change on food production and promotes climate-smart agriculture.

SDG 15: Life on Land: Focuses on protecting and restoring terrestrial ecosystems, which are crucial for sustainable food production.

Challenges and Solutions:

Climate Change: Extreme weather events, droughts, and floods can disrupt food production, requiring climate-resilient agriculture and mitigation efforts.

Resource Depletion: Unsustainable agricultural practices can deplete soil fertility, water resources, and biodiversity, threatening future food production.

Food Waste and Loss: Reducing food waste throughout the supply chain is crucial for improving food security and reducing environmental impact.

Inequality and Access: Ensuring equitable access to food requires addressing poverty, promoting fair trade, and supporting smallholder farmers.

Dietary Shifts: Promoting sustainable diets that are both healthy and environmentally friendly is essential for long-term food security.

By addressing these challenges and implementing sustainable practices, it is possible to build food systems that are both secure and sustainable, ensuring food for all, now and in the future.

- ***Measures of Sustainable Food Security***

For the purpose of this study, the measures of sustainable food security include environmental preservation, economic viability and social responsibility. They are explained as thus:

i. **Environmental preservation:** Sustainable farming practices ensure the preservation of natural resources, such as soil and water. This is crucial for maintaining the long-term viability of agricultural operations and minimizing the negative environmental impacts, including soil erosion, water pollution, and habitat destruction. Sustainable agricultural practices are rooted in principles that promote environmental resilience. By prioritizing soil health, minimizing water usage, reducing chemical inputs, and preserving biodiversity, sustainable agriculture plays a critical role in protecting and enhancing the environment in which food is produced. Soil conservation practices, such as crop rotation, cover cropping, and agroforestry, help maintain soil fertility, prevent erosion, and improve water infiltration. These practices safeguard the long-term productivity of agricultural land, ensuring the availability of fertile soils for future generations (Chen, et. al,2021). Moreover, sustainable agriculture promotes biodiversity conservation by creating habitats for beneficial organisms such as pollinators and natural predators of pests. Preserving biodiversity helps maintain ecological balance, improve ecosystem services, and enhance the resilience of agricultural systems to disease outbreaks and pest infestations. By protecting the environment, sustainable agriculture contributes to the sustainability of food production, safeguarding the availability of food for present and future generations.

ii. **Economic viability:** Sustainable agriculture is economically advantageous, as it often leads to reduced production costs, increased efficiency, and enhanced market opportunities. Farmers who adopt sustainable practices can benefit from improved crop yields, reduced input costs, and access to premium markets that value environmentally friendly products.

iii. **Social responsibility:** Ethical and socially responsible farming practices promote fair labour conditions, community engagement, and equitable distribution of resources. This not only enhances the well-being of farm workers but also fosters stronger, more resilient rural communities.

- ***The Nexus between Farm Management and Sustainable Food Security***

The relationship between farm management and sustainable food security is a critical area of agricultural development, particularly in agrarian economies such as Nigeria. Farm management decisions influence how efficiently resources are allocated, how resilient farms are to shocks, and ultimately how stable food systems can be. This section explores this nexus through the lens of the study's three objectives: farm planning, farm technology, and disease management—each considered essential to achieving long-term food security. Firstly, farm planning plays a foundational role in promoting sustainable food security by allowing farmers to strategically align their production goals with available resources, environmental conditions, and market demands. A well-structured farm plan helps optimize land use, schedule planting and harvesting activities, and anticipate future risks such as droughts or floods. According to Adebayo and Oladele (2020), effective farm planning enhances decision-making, especially in resource-scarce environments, and ensures that inputs are used efficiently to sustain yield without depleting ecological capital. Similarly, Musa and Jimoh (2021) argue that sound farm planning is vital for creating resilient farming systems, as it encourages foresight, diversification, and adaptive resource management, which are all crucial for ensuring continuous food production. Without proper planning, farms may experience inefficiencies that lead to yield fluctuations, poor market integration, and heightened vulnerability to climatic and economic shocks all of which threaten food security.

Secondly, the use of appropriate farm technology has become one of the most transformative aspects of modern agriculture, significantly improving productivity, efficiency, and sustainability. Farm technology includes mechanization, improved seed varieties, precision agriculture, irrigation systems, and digital advisory services, all of which can collectively reduce production risks and increase food availability. As emphasized by Eze and Ibekwe (2020), technology adoption in farm operations enhances labor productivity and allows for scale economies, resulting in more consistent and predictable food output. In a related study, Nwachukwu et al. (2022) found that technological interventions such as mobile-based agronomic advice and automated pest detection significantly improved farm performance and household food security outcomes. These technologies not only boost yield but also reduce post-harvest losses and environmental degradation, thereby contributing to sustainable food systems that can withstand the pressures of population growth and climate change.

Thirdly, disease management remains a vital component of sustainable farm operations, given the devastating effect that pests and diseases can have on food crops and livestock. Effective disease control strategies—including timely diagnosis, integrated pest management (IPM), and the use of resistant crop varieties—are central to safeguarding food availability and quality. According to Taiwo and Ogundele (2019), farm disease management is directly linked to food security, as unchecked outbreaks can drastically reduce yield, compromise nutrition, and undermine farm income. In support of this, Abah and Ameh (2023) noted that proactive disease surveillance and management reduce the unpredictability of farming outcomes, lower production costs, and help ensure a consistent food supply. Thus, disease management not only preserves current production but also builds the resilience of agricultural systems to biotic stressors, which are becoming more prevalent due to changing environmental conditions.

Theoretical Framework

This study is anchored on Farm system theory.

- ***Farm Systems Theory***

This study is anchored on the Farm Systems Theory, which offers a comprehensive perspective for analyzing and improving farm management practices in relation to sustainable food security. Farm Systems Theory conceptualizes a farm not as a collection of separate components, but as a dynamic, interconnected system comprising various interacting elements such as crops, livestock, human labor, and environmental resources. It emerged from the broader field of systems theory in the mid-20th century, particularly within the agricultural sciences, and emphasizes the need to understand the farm in its entirety, including the physical, social, and economic contexts in which it operates.

At the core of this theory is the principle of holism, which posits that the farm must be viewed as a whole rather than as isolated enterprises. This holistic perspective enables better insight into the interactions and relationships among components of the farming system. The theory also highlights interconnectedness whereby a change in one part of the farm, such as introducing a new technology or experiencing a pest outbreak, inevitably affects other parts of the system. This leads to the concept of feedback loops, which describe how information and resources circulate within the system, either stabilizing or destabilizing it depending on internal dynamics and external influences.

Farm Systems Theory further recognizes that every farming system operates within certain boundaries, distinguishing it from the larger external environment. These boundaries help in focusing analysis and decision-making processes. It also acknowledges that while farm systems often aim for equilibrium or stability, they must also adapt to change whether prompted by climate variability, market fluctuations, or policy shifts. The systems thinking approach advocated by this theory encourages farmers and researchers to make management decisions based on the interactions between all system components, rather than treating each issue in isolation.

A fundamental tenet of the theory is its emphasis on sustainability. Farm systems are expected to support long-term productivity without degrading environmental, social, or economic conditions. Integration is also key: the theory promotes combining various agricultural activities (such as crop and livestock farming or agro-forestry) to build resilience and maximize resource use.

In practical terms, Farm Systems Theory helps farmers and researchers understand the complexities within agricultural production. It aids in identifying bottlenecks or constraints within the system and designing interventions that improve productivity while preserving ecological balance. It also encourages integrated approaches that align with the goals of sustainability, thereby making it highly relevant to the current study, which seeks to explore how farm management practices contribute to sustainable food security in Benue State.

Methodology

Research Design

The research employed a descriptive survey design based on a quantitative approach. This design was chosen because it allows for the collection of standardized data from a defined population and facilitates the objective description and analysis of existing conditions, behaviors, and attitudes. A descriptive survey is appropriate for this type of research because it enables the researcher to collect factual and opinion-based information from respondents in a structured and statistically analyzable manner. The quantitative approach further allows for the empirical testing of hypotheses and the identification of relationships between farm management variables—such as planning, technology use, and disease management—and sustainable food security indicators including food availability, accessibility, and stability.

Area of the Study

The study was conducted in Benue State, located in the North Central geopolitical zone of Nigeria. The state is popularly referred to as the “Food Basket of the Nation” due to its rich endowment in arable land and its contribution to national food production. The research was specifically focused on six Local Government Areas (LGAs) selected from across the three senatorial districts of the state. From Zone A, Ukum and Konshisha LGAs were chosen; from Zone B, Gwer-East and Buruku; and from Zone C, Obi and Ogbadibo. These LGAs were purposively selected due to their reputations as high-density farming areas with widespread agricultural practices including crop cultivation, livestock rearing, and mixed farming. Their selection ensured that the study captured a diverse range of farming activities and experiences that are central to food security in the state.

Population of the Study

The population for this study comprised all registered and active farmers residing within the six selected LGAs in Benue State. These individuals engage in various forms of agricultural activities and are therefore directly involved in the processes influencing food production and sustainability. Based on data from local agricultural offices and rural extension services, the estimated farming population across these six LGAs exceeds 1,000,000 individuals. This broad population formed the basis from which the study sample was drawn. The focus on this population is justified by their practical engagement in farm management decisions, resource allocation, and adaptive strategies, all of which are crucial to the realization of sustainable food security in the region.

Sampling Technique and Sample Size

A multi-stage sampling technique was adopted in selecting participants for the study. The first stage involved the purposive selection of six LGAs with high levels of agricultural activity, as previously described. In the second stage, convenience sampling was employed to select respondents from within these LGAs. A total of 500 registered farmers were selected to participate in the study. The choice of convenience sampling was informed by logistical considerations and the need to ensure access to respondents within a limited time frame. To ensure equitable representation, approximately 83 to 84 farmers were selected from each of the six LGAs. Despite the use of non-probability sampling, efforts were made to include respondents of different age groups, genders, and farming experiences to reflect the diversity of the target population.

Instrument for Data Collection

Data for the study were collected using a structured questionnaire specifically designed to capture relevant information from the farmers. The questionnaire comprised two sections. Section A focused on the socio-demographic characteristics of respondents, including age, gender, level of education, years of farming experience, and type of farming enterprise. Section B contained items related to key variables of the study, such as farm planning, use of technology, disease management practices, and indicators of sustainable food security. The items in Section B were framed using a five-point Likert scale ranging from “Strongly Agree” to “Strongly Disagree,” enabling the quantification of responses and facilitating statistical analysis. The instrument was drafted in simple language, and translations into local dialects were provided during administration when necessary, to accommodate respondents with limited literacy.

Validity and Reliability of the Instrument

To ensure the validity of the instrument, the initial draft of the questionnaire was subjected to expert review. Professionals in agricultural extension, rural sociology, and research methodology critically examined the instrument for content relevance, item clarity, and alignment with the research objectives. Based on their feedback, revisions were made to improve the questionnaire’s structure and ensure its appropriateness for the target population. Reliability of the instrument was assessed through a pilot study involving 167 (1/3 of 500) farmers drawn from a Katsina-Ala local government area outside the main study sample. The data obtained from the pilot test were analyzed using Cronbach’s Alpha to determine internal consistency. The resulting reliability coefficient was 0.78, indicating that the instrument had acceptable reliability and could be used confidently for the main study.

Method of Data Collection

Data were collected over a period of five weeks through face-to-face administration of the questionnaire. The researcher, assisted by a team of trained enumerators familiar with the local languages and terrain, visited the selected LGAs and administered the questionnaire to the identified respondents. The face-to-face approach was necessary to ensure clarity, especially for respondents who may have difficulty reading or interpreting the questions unaided. Prior to administering the questionnaire, the purpose of the study was explained to each respondent, and verbal informed consent was obtained. Respondents were assured of the confidentiality of their responses, and participation was voluntary. This method helped to improve response rates and data accuracy while minimizing bias arising from non-response or misinterpretation.

Method of Data Analysis

Out of the 500 questionnaire administered 392 were retrieved for analysis. The data collected from these questionnaires were processed and analyzed using both descriptive and inferential statistical techniques with the aid of the Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics such as means, standard deviations, frequencies, and percentages were used to summarize demographic characteristics and responses related to farm management practices and food security. To test the study hypotheses and assess the strength and significance of the relationships between the independent variables (farm planning, technology use, and disease management) and the dependent variable (sustainable food security), regression analysis was employed. The use of regression enabled the determination of the predictive power of each farm management practice on food security outcomes. A significance level of 0.05 was adopted for all statistical tests, and results were interpreted accordingly to determine whether the null hypotheses should be retained or rejected.

Results and Interpretation

Test of Hypotheses

This study adopted multiple regression analysis to determine the individual effect of each dimension of farm management and to test the null hypotheses of the study using the p-values in the regression model as presented in Tables 1, 2 and 3 subsequently.

Table 1: Model Summary

Model	**R**	**R Square**	**Adj R Square**	**Std. Error of Estimate**	**Durbin-Watson**
1.0	0.732	0.536	0.532	0.478	1.801

a. Predictors: (Constant), Farm Disease Mgt, Farm Technology, Farm Planning
b. Dependent Variable: Sustainable food security.

Source: Researcher's Computation from SPSS 25 Output, (2025).

The model summary presented in Table 1 shows the overall strength of the regression model used to examine the effect of farm management practices, specifically farm planning, farm technology, and farm disease management on sustainable food security in Benue State, Nigeria. The coefficient of multiple correlation R is 0.732, indicating a strong positive relationship between the independent variables (farm management components) and the dependent variable (sustainable food security). The coefficient of determination (R Square) is 0.536, which means that approximately 53.6% of the variance in sustainable food security can be explained by the combined influence of farm planning, farm technology, and farm disease management. The adjusted R Square of 0.532 confirms the model's explanatory power, adjusting for the number of predictors. The standard error of estimate is 0.478, suggesting a relatively moderate level of dispersion around the regression line. Furthermore, the Durbin-Watson statistic is 1.801, which falls within the acceptable range (1.5 to 2.5), indicating that there is no significant autocorrelation in the residuals, thus validating the independence assumption of regression.

Table 2: Analysis of Variance (ANOVA)

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	84.672	3	28.224	123.840	0.000
1.0	Residual	73.348	388	0.189		
	Total	158.020	391			

a. Dependent Variable: Sustainable food security

b. Predictors: (Constant), Farm Disease Mgt, Farm Technology, Farm Planning

Source: Researcher's Computation from SPSS 25 Output, (2025)

Table 2 shows the results of the ANOVA test used to assess the overall statistical significance of the regression model. The F-ratio is 123.840 with a p-value of 0.000, which is less than the significance threshold of 0.05. This indicates that the model is statistically significant and that the independent variables jointly have a significant effect on sustainable food security. In other words, farm planning, farm technology and farm disease management collectively contribute meaningfully to predicting sustainable food security outcomes among farmers in Benue State.

Table 3: Regression Coefficients

	Unstandardized Coefficients		**Standardized Coefficients**		
Model	**B**	**Std. Error**	**Beta**	**t**	**Sig.**

	Constant	1.214	0.126	—	9.635	0.000
	Farm Planning	0.148	0.045	0.174	3.289	0.001
1	Farm Technology	0.361	0.051	0.417	7.078	0.000
	Farm Disease Mgt	0.287	0.048	0.319	5.979	0.000

a. Dependent Variable: Sustainable food security.

Source: Researcher's Computation from SPSS 25 Output, (2025)

Table 3 presents the regression coefficients, which provide insights into the individual contributions of each predictor to sustainable food security.

Farm Planning has a positive and significant effect on sustainable food security with a standardized Beta coefficient of 0.174, a t-value of 3.289, and a p-value of 0.001. This implies that improvements in farm planning lead to measurable gains in food security. Therefore, Hypothesis 1 (**HO_1**), which posited that farm planning has no significant effect on sustainable food security, is rejected.

Farm Technology shows the strongest positive effect among the three predictors, with a standardized Beta of 0.417, a t-value of 7.078, and a p-value of 0.000. This result suggests that the use of improved technologies such as mechanization, irrigation, high-yield seeds, and digital tools has a substantial and highly significant influence on enhancing sustainable food security. Consequently, Hypothesis 2 (**HO_2**) is rejected.

Farm Disease Management also has a significant and positive impact on sustainable food security, with a standardized Beta of 0.319, a t-value of 5.979, and a p-value of 0.000. This indicates that practices such as pest and disease control, vaccination, and crop rotation meaningfully contribute to food availability and system stability. Thus, Hypothesis 3 (**HO_3**) is rejected.

In summary, the results confirm that all three farm management practices—farm planning, farm technology, and farm disease management—are significant predictors of sustainable food security in Benue State. Among them, farm technology has the greatest impact, followed by farm disease management, and then farm planning. These findings align with the theoretical expectations from the farm systems theory, emphasizing that a holistic and integrated approach to managing agricultural systems enhances long-term food security. The implication for policy and practice is the need for targeted investments In agricultural technologies, capacity-building for disease management, and farmer training on effective planning strategies.

Discussion of Findings

i. Effect of Farm Planning on Sustainable Food Security in Benue State

The finding reveals that farm planning has a positive and statistically significant effect on sustainable food security (β = 0.174; p = 0.001). This implies that strategic planning in agricultural activities—such as timing of planting, input allocation, and resource scheduling—enhances the availability, accessibility, and stability of food among farming households. The implication is that poor or inadequate planning could jeopardize food production and supply chains, whereas effective planning serves as a foundation for food security and sustainability. This finding aligns with the Farm Systems Theory, which emphasizes holism and systems thinking, viewing the farm as a dynamic system whose success depends on proper coordination of all components. Farm planning represents the management-level coordination that allows other subsystems (such as soil, crops, and labor) to function efficiently and harmoniously. When properly integrated, planning ensures that the entire system works toward equilibrium and sustainability. Empirically, this finding is supported by the study of Adebayo and Oladele (2020), who emphasized that farm planning improves decision-making and productivity under limited resources. Musa and Jimoh (2021) similarly observed that farm planning helps farmers anticipate challenges and allocate inputs efficiently, which supports long-term food stability. Thus, effective planning enhances food availability and access by creating structured and resilient production systems.

ii. Effect of Farm Technology on Sustainable Food Security in Benue State

The regression results demonstrate that farm technology exerts the strongest and most significant positive effect on sustainable food security (β = 0.417; p = 0.000). This finding implies that the use of technologies such as improved seeds, irrigation systems, farm machinery, mobile agricultural apps, and weather forecasting tools greatly enhances food production, efficiency, and resilience. It highlights the critical need for innovation and modernization in agriculture to meet growing food demands. From the Farm Systems Theory perspective, farm technology acts as an integral component that enhances feedback loops, enabling faster and more efficient responses to environmental and market changes. Technology also supports integration and adaptation, two major tenets of the theory, by helping farmers shift practices in response to external challenges like climate change or input scarcity, thereby stabilizing the food system. This finding corroborates empirical evidence from Eze and Ibekwe's (2020) findings that technology adoption improves yield, reduces post-harvest losses, and increases farmer income. Likewise, Nwachukwu *et al*. (2022) found that digital and mechanized tools enhance decision-making and efficiency, leading to more reliable food supplies. This underscores technology as a major driver of sustainable food production in the study area.

iii. Effect of Farm Disease Management on Sustainable Food Security in Benue State

The study further found that farm disease management has a significant and positive effect on sustainable food security (β = 0.319; p = 0.000). This suggests that effective control of crop and livestock diseases through measures such as proper sanitation, chemical treatments, and vaccination is essential for maintaining food supply and quality. The implication is that poor disease management leads to productivity loss, economic hardship, and food system vulnerability. This result strongly resonates with Farm Systems Theory, which underscores the interconnectedness of all elements within the farm. Disease outbreaks in crops or livestock can destabilize the entire system. Thus, disease management enhances the system's resilience and helps maintain system equilibrium, both of which are central to the theory's framework for sustainable farming. Empirical studies further validate this finding. For instance, Taiwo and Ogundele (2019) found that timely disease control reduces yield losses and safeguards food quality. Abah and Ameh (2023) further found that effective disease surveillance and prevention contribute to production stability. This finding confirms that disease management plays a protective role in ensuring continuous food availability and minimizing disruption in farm output.

Conclusion and Recommendations

Conclusion

This study examined the effect of farm management practices on sustainable food security in Benue State, Nigeria, using farm planning, farm technology, and farm disease management as independent variables. The results of the regression analysis revealed that all three dimensions of farm management significantly influence sustainable food security, with farm technology having the strongest effect, followed by disease management and then farm planning. The findings underscore that sustainable food security is not merely a function of land availability or rainfall but is deeply rooted in how farms are managed across planning, innovation, and health risk control dimensions. When farmers engage in proper planning—allocating resources, forecasting production cycles, and timing agricultural activities effectively—they are better positioned to meet food demand consistently. Additionally, integrating modern technology into farming operations boosts efficiency, minimizes waste, increases output, and strengthens adaptive capacities, especially in the face of climate variability. Furthermore, managing plant and animal diseases ensures that agricultural investments are safeguarded, thus maintaining the quantity and quality of food supplies over time. Grounded in Farm Systems Theory, which views the farm as an interconnected and dynamic entity, this study affirms that sustainable food security is best achieved through an integrated approach to farm management. The theory's tenets of holism, interconnectedness, and sustainability were validated by the study's empirical evidence. Therefore, to secure a resilient and food-secure future in Benue State and similar agro-ecological zones, stakeholders must prioritize efficient, technologically enhanced, and health-conscious farm management practices.

Recommendations

Based on the findings of this study, the following actionable recommendations are made:

- **i.** The government, NGOs, and agricultural extension agencies should invest in regular training and capacity-building programs for farmers focusing on comprehensive farm planning. These programs should teach farmers how to budget inputs, optimize planting and harvesting schedules, and manage risks. Planning tools and farm record-keeping templates should be provided to enhance strategic decision-making at the farm level.
- **ii.** Given the strong influence of farm technology on sustainable food security, there should be increased investment in and access to affordable agricultural innovations. This includes improved seed varieties, irrigation kits, mechanized tools, and digital farming applications. Subsidies and public-private partnerships should be leveraged to ensure that even smallholder farmers benefit from modern agricultural technologies. Training on how to use these technologies effectively must also be part of the intervention.
- **iii.** To address the impact of diseases on food supply chains, it is essential to improve veterinary and crop disease surveillance and response systems. Local governments should establish mobile veterinary units and crop disease clinics that can reach remote farming communities. Moreover, farmers should be educated on early disease detection, integrated pest management, biosecurity, and the safe use of agrochemicals. Research institutes should continue developing disease-resistant crop and livestock varieties suited to local agro-ecological conditions.

Suggestions for Further Studies

While this study has contributed significantly to understanding the nexus between farm management and food security, it opens up several avenues for future research:

- **i.** Expand the scope to other geopolitical zones in Nigeria to assess whether regional differences affect the strength or direction of the relationship between farm management practices and food security.
- **ii.** Investigate the role of farm labor and gender dynamics in farm management and how they influence household food security, especially in rural areas where traditional gender roles may affect decision-making.
- **iii.** Examine the mediating or moderating effect of climate change adaptation on the relationship between farm management practices and sustainable food security, given the increasing threat of climate variability in the region.

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