



EFFECT OF SUSTAINABLE FOOD PRODUCTION PRACTICES ON HOUSEHOLD FOOD SECURITY IN IGABI LOCAL GOVERNMENT AREA OF KADUNA

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Abstract

This study examined the effect of sustainable food production practices on household food security in Igabi Local Government Area of Kaduna State, Nigeria. The study specifically assessed the influence of soil conservation, water conservation and post-harvest loss reduction on household food security. A survey research design was adopted, and data were collected from selected farming households using structured questionnaires. The data were analyzed using descriptive statistics and multiple regression analysis. The findings revealed that soil conservation and water conservation showed positive and statistically significant effects on household food security, while post-harvest loss reduction had a positive but insignificant influence. The study concludes that the adoption of sustainable food production practices plays a crucial role in improving household food security in the study area. It therefore recommends that government and relevant stakeholders should promote and support the adoption of these practices through farmer education, access to inputs, and extension services to enhance food security outcomes in Igabi Local Government Area and similar settings.

Keywords: *Household food security, soil conservation, water conservation and postharvest loss reduction.*

1 Introduction

1.1 Background to the Study

Sustainable food production practices have become increasingly important in addressing the persistent challenge of household food insecurity, particularly in developing countries such as Nigeria. Household food security is not only determined by the availability of food but also by the ability of households to access, utilize and sustain adequate food supplies over time. According to the Food and Agriculture Organization (FAO, 2008), food security exists when individuals have consistent access to sufficient, safe and nutritious food necessary for an active and healthy life. This highlights the need for agricultural practices that ensure long-term productivity while conserving natural resources.

In Kaduna State, agriculture remains a major livelihood activity, with a significant proportion of the population depending on crop production for income and food supply. However, agricultural production in the state is largely characterized by traditional practices, environmental degradation and inefficient resource use, which limit productivity and threaten food security (Amaza et al., 2006; National Bureau of Statistics (NBS, 2020). Sustainable food production practices particularly soil conservation, water conservation, and reduction of post-harvest losses are therefore essential for improving agricultural outcomes and ensuring food security at the household level.

Soil conservation plays a critical role in maintaining land productivity and preventing degradation. It involves practices aimed at reducing soil erosion, nutrient depletion, and chemical pollution, thereby

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ensuring the long-term fertility of agricultural land (Lal, 2015). Effective soil conservation techniques, such as terracing, agroforestry, and proper land management, help farmers maintain stable crop yields and reduce the risk of land degradation, which is essential for continuous food production. As noted in the literature, sustainable land management practices not only enhance soil quality but also contribute to increased agricultural productivity and improved livelihoods (Pretty et al., 2011).

Water conservation is another vital component of sustainable agriculture, especially in regions like Kaduna State where farming is predominantly rain-fed and subject to climate variability. Efficient water use practices, including irrigation, water harvesting, and improved water management systems, enhance water use efficiency and increase crop productivity (Rockström et al., 2010). High water use efficiency enables farmers to produce more output with limited water resources, thereby strengthening resilience against drought and erratic rainfall patterns. This is particularly important in ensuring stable food production and reducing vulnerability to food shortages.

In addition, the reduction of post-harvest losses is crucial in improving food availability and household food security. FAO (2011) pointed that post-harvest losses refer to the deterioration in both the quantity and quality of agricultural produce between harvest and consumption. Studies indicate that a significant proportion of food produced is lost due to poor handling, inadequate storage, inefficient transportation, and pest infestation. In Nigeria, it is estimated that a considerable percentage of food is lost along the supply chain, which reduces the effective food supply and negatively impacts farmers' income (World Bank, 2011). Minimizing these losses through improved storage facilities, better handling practices, and efficient processing techniques can significantly enhance food availability and household welfare.

The integration of soil conservation, water conservation and post-harvest loss reduction forms a comprehensive approach to sustainable food production. These practices are interconnected and collectively contribute to improving agricultural productivity, enhancing food availability, and increasing household income. By adopting these strategies, farming households can achieve more stable food systems and improve their resilience to environmental and economic shocks.

Despite the recognized importance of sustainable food production practices, their adoption in Kaduna State according to Ajayi et al. (2018) remains limited due to factors such as lack of awareness, inadequate access to technology, and insufficient institutional support. This situation continues to hinder efforts to achieve food security at the household level, thereby necessitating further investigation into the effects of these practices on food security outcomes.

This study seeks to explore the extent to which sustainable agricultural practices influence household food availability, access, utilization, and stability in the state.

1.2 Statement of the Problem

Household food insecurity remains a significant challenge in Kaduna State despite the region's strong agricultural potential. Many farming households continue to experience inadequate food availability, limited access to nutritious food and unstable food supply throughout the year. This situation persists even as agriculture remains the primary source of livelihood for the majority of rural households, indicating inefficiencies within the food production system (NBS, 2020).

One of the major contributors to this problem is the low adoption of sustainable food production practices. As stated by Lal (2015), poor soil management has led to soil degradation, reduced fertility and declining crop yields, thereby limiting the quantity of food available to households. Similarly,

Rockström et al. (2010) emphasized that inefficient water use and dependence on rainfall expose farmers to the risks of climate variability, resulting in inconsistent agricultural output and seasonal food shortages.

Furthermore, high levels of post-harvest losses continue to undermine food security in Kaduna State. A significant portion of agricultural produce is lost between harvest and consumption due to inadequate storage facilities, poor transportation systems, pest infestations and improper handling. These losses not only reduce food availability but also diminish farmers' income, thereby limiting their ability to access food and improve their standard of living (World Bank, 2011).

Although various studies have emphasized the importance of soil conservation, water conservation and post-harvest loss reduction in enhancing agricultural productivity and food security, there is limited empirical evidence on how these practices specifically affect household food security in Kaduna State (Ajayi et al., 2018). This gap in knowledge makes it difficult for stakeholders to design targeted interventions that address the root causes of food insecurity in the region.

Therefore, this study seeks to examine the effect of sustainable food production practices on household food security in Igabi local government area of Kaduna State.

1.3 Research Questions

- i. To what extent does soil conservation affect households' food security in Igabi local government area of Kaduna state?
- ii. To what extent does water conservation affect households' food security in Igabi local government area of Kaduna state?
- iii. To what extent does post-harvest loss reduction affect households' food security in Igabi local government area of Kaduna state?

1.4 Objectives of the Study

To provide answers to the above questions, the study is guided by the general objective which is to examine the effect of sustainable food production practices on households' food security in Kaduna state. To achieve this major objective, the study has the following specific objectives:

- i. To examine how soil conservation affect households' food security in Igabi local government area of Kaduna state.
- ii. To examine how water use efficiency affect households' food security in Igabi local government area of Kaduna state.
- iii. To examine the extent to which reduction in post-harvest loss affect households' food security in Igabi local government area of Kaduna state.

1.5 Hypotheses of the Study

- H₀1 Soil conservation has no significant effect on household food security in Igabi local government area of Kaduna state.
- H₀2 Water conservation has no significant effect on household food security in Igabi local government area of Kaduna state.
- H₀3 Postharvest loss reduction has no significant effect on household food security in Igabi local government area of Kaduna state.

2 Literature Review

2.1 Concept of Household Food Security

Food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs for an active and healthy life (FAO, 2008; FAO, 2021). It is a fundamental human right and a key component of human welfare, national stability, and sustainable development. Food security goes beyond the availability of food; it also includes the ability to access, utilize, and sustain food supplies over time. Food security is commonly discussed using four key dimensions: **food availability** – the presence of sufficient food in a region through local production, imports or reserves; **food accessibility** – the ability of individuals and households to obtain food through income, markets or social support; and **food utilization** – the proper biological use of food, ensuring adequate nutrition through quality diets, clean water and healthcare.

According to Olayemi and Musa (2022), food availability does not only depend on the existence of food at a national level but also on its distribution to local communities and households where it is needed. Without adequate food production or supply, meaningful discussions about food security cannot occur. Therefore, food availability remains a critical component of household welfare and national stability. At the household level, food availability depends on a family's access to farmland, labour, agricultural inputs and seasonal cropping patterns (Okoh & Edeh, 2023).

The World Food Programme (2023) explains that food accessibility is determined by economic access, physical access and social access. Economic access to food is determined by a household's purchasing power. Income levels, employment, savings, and access to livelihood opportunities all influence the ability of families to purchase food from the market (Adedeji & Adeoye, 2022). Household food accessibility is also affected by food prices, which are often unstable due to market fluctuations, fuel prices, and insecurity affecting food transportation.

Food utilization refers to the proper biological use of food by the body, which involves the intake of adequate, safe and nutritious food that meets dietary needs, combined with an environment of proper health care, sanitation and food preparation practices. It emphasizes the nutritional quality of food rather than just the quantity consumed. According to UNICEF (2022), food utilization is essential for maintaining good health, physical growth and cognitive development, especially among children and women of reproductive age. The World Health Organization (WHO, 2023) further explains that even if food is available and accessible, food insecurity can still occur if the nutritional value of the food consumed is poor or if diseases prevent the body from properly absorbing nutrients. The nature of food utilization is multidimensional and closely linked to nutrition, health, food safety and hygiene. Diet diversity, meal frequency, and the inclusion of key nutrients such as proteins, carbohydrates, vitamins, and minerals determine the quality of food utilization (FAO, 2021). In addition, access to safe drinking water, sanitation facilities, and health services plays a vital role in ensuring that the body can utilize food effectively. Households that lack clean water or rely on contaminated sources are more prone to food-borne diseases, which can lead to malnutrition even when food is adequate. Food utilization is influenced by several factors, including household knowledge of nutrition, childcare practices, cooking methods and access to healthcare.

Post-harvest loss according to Food and Agriculture Organization (FAO, 2011) is the term used to describe the deterioration of agricultural food production, both in terms of quantity and quality that takes place between the period of harvest and consumption. The analysis shows that one-third of the food produced for human consumption is lost or wasted (FAO, 2011). Research conducted by the United Nations Environmental Programme (UNEP, 2021) estimated that the percentage of food wasted at the retail and consumer level was about 17%. This shows a great concern considering the ever-

increasing population in Nigeria. Deterioration of plant crops can take place at different stages after harvest which may include during handling, drying, threshing, storage, transportation, packaging and marketing (Ovharhe et al., 2021). Otitoju and Olawoye (2025) pointed that numerous chemical, economic, biological and cultural factors can influence losses after crop harvest, including locations which can also affect the extent and intensity of this damage in the food supply chains. Post-harvest loss reduction must be given priority to bridge the gap of food supply in different parts of the state and country at large and ensure food harvests are preserved and utilized which will increase effective means of improving the standard of living and income of smallholder farmers, who produce most of our food. If farmers can embrace a better and more efficient technology, a bulk of food harvested will be preserved from post-harvest losses.

2.2 Soil Conservation

Soil conservation is a set of farming methods and practices that keep the land from degradation, erosion and depletion. Soil conservation is of utmost importance to farmers since sustainable management of land is essential to their livelihood. Good soil conservation practice minimize soil fertility loss from erosion or chemical pollution. Soil conservation target longterm use toward the future. Soil conservation strategies rely on three strategies as obtaining proper knowledge of the land's resource use; monitoring fields and detecting critical zones; and controlling and estimating the efficiency of applied soil conservation techniques **Tesfaye (2011)**.

According to Ahaneku (2010), there are various processes and practices resulting from agricultural and non-agricultural practices cause soil degradation, among which are soil erosion, soil toxicity, soil pollution and depletion of soil nutrients. Sarvade etal (2019) identified two types of practices for soil and water conservation namely, mechanical (engineering, otherwise known as structural) measures and biological measures. According to them, mechanical measures are permanent and semi-permanent structures which include terracing, bunding, loose/stone boulders, check dams, crib wall, etc. Terraces are earth embankments built across a slope to intercept runoff water, reduce soil erosion, and increase in situ water infiltration. Charles etal (2019) maintain that level terraces can reduce runoff by 92% and soil loss by 87–95%, while graded terraces can reduce runoff by 77–92% and soil loss by 98%. Terraces can be designed to channel excess water into waterways or stable outlet. Terraces are stabilized with the non-weedy grass species. On sloping lands, terracing is necessary for reducing overland flow rates, thereby contributing to water and nutrient conservation (Ahuchaogu, 2022).

Loose Boulder/Stone/Masonry Check Dams are effective for preventing runoff rate and severe erosion in steep and broad gullies, and most suitable for high elevation areas of the catchment. These structures are cheap, having a long life, and fewer maintenance requirements. The depth of gully bed is kept about 0.3 m and flat stones of 20–30 cm size are used for the construction of dams. A spillway is provided in the middle of the dam to allow the safe discharge of runoff water (Sarvade etal, 2019; Shinde etal 2019). Similarly, gabion check dams are also used for drainage line treatment in sharp slanted gullied areas to check sedimentation, erosion, and to conserve soil moisture.

On the other hand, biological (agronomic otherwise known as agricultural and agroforestry) measures are the vegetative measures which include forestry, agroforestry, horticulture and agricultural/agronomic practices.

2.3 Water Conservation

Water conservation practice has recently become a priority to be part of a solution for the resilience of the agricultural sector in response to erosion (Fontes, 2020). Water conservation can be defined as the judicious use of water resources and the use of appropriate cropping patterns to increase thereby

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improving the livelihoods of local communities (Gordon et al., 2010). Water conservation is a measure of how effectively a plant or agricultural system converts water into biomass or yield. It can be defined as the ratio of plant biomass to water lost through transpiration, or more simply in agriculture, as the amount of biomass produced per unit of water consumed. A system with high WUE produces more with less water by minimizing losses like evaporation and runoff.

Ahuchaogu et al (2022) stated that water conservation is concerned with all the strategies, policies and activities aimed at maintaining the natural resource of fresh water. These are all the actions conducted to protect the hydrosphere and to meet human demand for water. It includes programs of improving water use efficiency, environmental protection and improving the efficiency of industry, housing, utilities and agriculture. Water consumption methods include any reduction of water losses, water use or pollution as well as the preservation of the quality of water resources; the reduction of water usage by introducing water conservation measures or increasing water use efficiency; implementing water management systems that reduce or favour the reduction of excess water consumption.

The first big program related to water resources management appeared in Nigeria in 1976, was the Nigeria River Basin Development Authorities (RBDAs), today, water conservation efforts in the country seem to be quite struggling (Ezeabasili et al, 2014). Such conservation programs as Water Aid, UNICEF, USAID operate in Nigeria, but in most cases they have to work with water sanitation issues.

Some researchers believe that the efforts to protect water resources and treat them with care should be, first of all, related to farmers since 70% of the World's water is used for agriculture. The world over, agriculture consumes more than two-thirds of the water withdrawn from the earth's rivers, lakes and aquifers but, in low-income countries like Nigeria, agricultural water use is some 90% of the whole. Agriculture is not only the world's largest water user in terms of volume, it is also a relatively low-value, low-efficient and highly subsidized water user (Ahuchaogu et al, 2022).

Water harvesting also involves the construction of dams particularly in drought prone regions as well as the collection of water from rooftops and storage in tanks. Various dams' designs using different construction materials abound in the country. Use of local materials at chosen dam sites effectively saves cost whilst achieving the desired result (Ahuchaogu et al, 2022).

Traditions of water harvesting and irrigation are to be found in many parts of Africa that are centuries and even millennia old and evidence survives in landforms, structures and practices; yet sub-Saharan Africa has the lowest proportion of irrigated land in the world. FAO estimates that the proportion of irrigated to total arable land in Asia is 37%, in North Africa 24% and in Latin America 15%, but in sub-Saharan Africa, it is only 4%. Moreover, 75% of all irrigated land in Africa is accounted for by just six countries: Egypt, Madagascar, Morocco, Nigeria, South Africa and Sudan (Ahuchaogu et al, 2022).

Nigerian agriculture is basically rain fed, characterized by low production and subjected to the vagaries of weather. Water is therefore a limiting factor to agricultural production in most parts of the country. The physical potential of the nation's irrigation is in the order of 3.14 million hectares, which is about ten times more than the land currently under irrigation (Musa, 2001). Irrigable area within the River Niger alone constitutes more than 50% of the potential areas. About 855,000ha of this area is under sprinkler irrigation system, while about 90,847ha are under surface system. Nigeria also has large potential for small valley bottom irrigation system development. Over one million hectares of *Fadama* is estimated to be available for irrigation. The irrigation system is constructed to divert water from the valley bottom streams and low flood plains with high water table for agricultural production most especially rice. The technologies needed include water lifting from streams/rivers and shallow tube

wells using small pumps

The seasonality of rainfall in the country results in situations where water is available and often in excess at certain times (especially in the humid tropical rainforest zone), whereas the arid and semi-arid regions are characterized with low rainfall, high evapotranspiration rates and erratic temporal and spatial rainfall distribution. The use of surface flooding in conjunction with groundwater resources has augmented the production of dry season farming considerably.

It is worthy of note that conservation of water is not limited to its quantity alone. Quantity and quality of water are two vectors in water resource management; the former is sometimes used in the context of resources and the later in the context of environment. The quality of water depends on its intended use. The most important characteristics of irrigation water are the total concentration of soluble salts, proportion of sodium to other cations, concentration of potentially toxic elements and bicarbonate concentration as related to the concentration of calcium plus magnesium (Schwab et al, 2002).

2.4 Postharvest Loss Reduction

Post-harvest according to Mutungi et al (2020) refers to time farm produce leaves the field, after maturity, to the time of culinary preparation for consumption. Usually harvesting operation is considered part of the post-harvest period because the decisions taken at harvesting have impact on successive operations. Post-harvest system encompasses the delivery of the produce from the time and place of harvest to the time and place of consumption. The term "system" denotes a dynamic set of logically interconnected functions laid out in succession. The celebrated scholars went ahead to explain the main elements of the post-harvest system to include pre-harvest drying, harvesting, transport, drying, threshing, storage, processing and marketing.

In explaining the main elements of the post-harvest system, Mutungi et al (2020) pointed that extended pre-harvest field drying ensures good preservation but also increases the risk of loss due to attack by birds, rodents, insects and molds. However, harvesting before maturity entails the risk of loss through molds and rotting. They also maintained that the time of harvesting is determined by the degree of maturity. The stage of harvesting affects successive operations, such as preliminary processing, storage and secondary processing. Moreover, care is needed in transporting the harvested produce to prevent detached grain from falling on the road before reaching the storage or threshing place. Collection and initial transport of the harvest thus depend on the place and conditions where it is to be stored, especially with a view to threshing. They further explained that the length of time needed for full drying of ears and grains depends on weather, atmospheric conditions and drying structures. If grain is not dry enough, it becomes vulnerable to mold and can rot during storage. If grain is too dry it becomes brittle and will crack during threshing. Broken grain is more susceptible to attack by insects and molds. In addition, too dry grain means unnecessary weight loss, hence a loss of money at the time of sale. You only address structures for lengthy drying. In structures for lengthy drying such as cribs, or even unroofed threshing floors, the harvest is exposed to predations by birds, rodents or small ruminants. The droppings left behind by these pests result in quality losses. In structures for quick drying, more energy, labor and attention will be required to ensure effective drying is achieved.

To them, if the harvest is threshed before it is dry enough, this operation will most probably be incomplete, and more energy will be required. An appropriate threshing method should not inflict grain damage. Facilities, hygiene, and monitoring must all be adequate for effective, long-term storage. In closed structures e.g. granaries, warehouses and air-tight containers, the control of cleanliness, temperature and humidity is particularly important. Apart from attacking the stored grain, pests such as insects, rodents and termites can damage storage structures. Excessive hulling can result in losses. The

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de-huller and grain parameters such as seed coat, size, shape and hardness and density influence - hulling efficiency and therefore the amount of losses. Marketing is the last element in the post-harvest system, although it can occur at various points in the chain. The step also involves transportation or distribution and market storage which should be monitored to avoid losses e.g. through spillage, and deterioration.

Post-harvest loss is the term used to describe the deterioration of agricultural food production, both in terms of quantity and quality that takes place between the period of harvest and consumption (PHL) Food and Agriculture Organization (2011). A research by the United Nations Environmental Programme (UNEP) estimated that the percentage of food wasted at the retail and consumer level was about 17% (UNEP, 2021). Deterioration of plant crops can take place at different stages after harvest which may include during handling, drying, threshing, storage, transportation, packaging and marketing (Ovharhe et al., 2021). However, numerous chemical, economic, biological and cultural factors can influence losses after crop harvest, including Locations; which can also affect the extent and intensity of this damage in the food supply chains. After-harvest losses typically result in a waste of resources that were used to produce food crops but weren't eaten or used for other purposes (Abbas et al., 2018).

This directly falls back to the farmers' standard of living and affects their means of income. Additionally, it negatively impacts well-being by causing a shortfall of availability (food stocks), a balance in food supply for a long period and an increase in marketable produce which should significantly contribute to the farming household financial commitments. Stathers et al (2024) pointed that tackling postharvest food loss offers an entry point to improve food security, reduce emissions from food systems and improve livelihoods/incomes for vulnerable smallholder producers in low- and middle-income countries.

Post-harvest losses in developing economies are deeply influenced by physical, biological, and environmental variables that directly affect crop preservation and shelf life. Michael and Ogunsola (2018) emphasise that poor handling practices during harvesting, packaging, and transportation expose agricultural produce to bruising, mechanical damage, and microbial infestation. These damages, though often overlooked, accelerate biochemical deterioration, leading to rapid spoilage, weight loss, and reduced market value. Durowade, Adetokunbo, and Ibironge (2016) emphasize that inadequate environmental control during post-harvest stages facilitates fungal growth and aflatoxin contamination, particularly in humid tropical regions. Moreover, temperature fluctuations, high humidity, and lack of cold-chain infrastructure create conditions favorable for enzymatic decay and pest proliferation (Menson et al., 2018). The absence of temperature-controlled logistics systems is particularly detrimental to perishable goods such as fruits, vegetables, and dairy products, where the physiological and microbial interactions are accelerated by heat exposure (Olamoyegun et al., 2015).

3 Methodology

The purpose of this study is to investigate the effect of sustainable food production practices on household food security in Kaduna State, Nigeria. To achieve this objective, a quantitative research approach is employed, using questionnaire as the primary data collection instruments. The use of questionnaire allows for an in-depth exploration of farmers' perspectives, practices, and challenges, facilitating a richer understanding of the factors influencing both sustainable food production and household food security.

The target population for this study consists of farming households in Igabi LGA which stood at 127280 according to 2022 estimate. The sample size of 127280 according to Crecy and Morgan (1970) is 384. A

purposive sampling technique is employed to select participants who have substantial experience in farming and can provide valuable insights into the effect of sustainable food production practices on household food security. The sample includes a diverse range of households in terms of farm size, farming practice, and socio-economic status.

Questionnaire is used as the primary data collection instrument. This approach allows flexibility in exploring specific topics in depth while ensuring that all relevant themes are addressed. Questionnaire is developed based on the study's objectives. The data collected are analyzed using multiple regression analysis with the help of SPSS.

4 Results and Discussion

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.497 ^a	.247	.238	.52524	1.673

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	23.287	3	7.762	28.137	.000 ^b
	Residual	70.901	257	.276		
	Total	94.188	260			

Regression Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.580	.226		6.979	.000
	Soil Conservation	.138	.064	.148	2.171	.031
	Water Conservation	.346	.064	.344	5.410	.000
	Postharvest Loss Reduction	.076	.050	.103	1.524	.129
Dependent Variable: Household Food Security						

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Discussion

The results of this study provide empirical evidence on the effect of sustainable food production practices (soil conservation, water conservation, and post-harvest loss reduction) on household food security in Kaduna State.

The model summary indicates that the combined effect of soil conservation, water conservation, and post-harvest loss reduction explains approximately 24.7% of the variation in household food security ($R^2 = 0.247$). This suggests that while these variables are important determinants of food security, other factors not included in the model also play a significant role. The adjusted R^2 value of 0.238 further confirms that the model has a moderate explanatory power. Additionally, the Durbin-Watson statistic of 1.673 indicates the absence of serious autocorrelation problems in the model, suggesting that the regression results are reliable.

The ANOVA results reveal that the regression model is statistically significant ($F = 28.137$, $p < 0.05$). This implies that the independent variables, when considered together, significantly predict household food security.

Examining the individual contributions of the independent variables, soil conservation was found to have a positive and statistically significant effect on household food security ($\beta = 0.148$, $t = 2.171$, $p = 0.031$). This result leads to the rejection of the first null hypothesis. The implication is that improved soil conservation practices such as erosion control, use of organic manure and crop rotation enhance soil fertility, leading to increased crop yields and improved food availability at the household level. This finding aligns with existing literature that emphasizes the role of sustainable land management practices in improving agricultural productivity and food security.

Water conservation also showed a strong positive and statistically significant effect on household food security ($\beta = 0.344$, $t = 5.410$, $p = 0.000$). Thus, the second null hypothesis is rejected. The relatively higher beta coefficient suggests that water conservation has the greatest influence among the variables studied. This indicates that efficient water management practices, such as rainwater harvesting, irrigation systems and water storage techniques, significantly improve crop productivity and ensure stable food supply, particularly in regions prone to rainfall variability. This finding is consistent with studies that highlight the critical importance of water availability in agricultural production and food security.

In contrast, post-harvest loss reduction was found to have a positive but statistically insignificant effect on household food security ($\beta = 0.103$, $t = 1.524$, $p = 0.129$). Therefore, the study fail to reject the third null hypothesis. Although reducing post-harvest losses is expected to improve food availability and reduce waste, the insignificance of this variable in the study area may be due to limited adoption of modern storage technologies, inadequate infrastructure or the relatively lower emphasis placed on post-harvest management by farmers compared to production activities. It may also suggest that production-related factors (soil and water management) have a more immediate and pronounced impact on food security than post-harvest practices in the study area.

5 Conclusion and Recommendations

This study examined the effect of sustainable food production practices (soil conservation, water conservation, and post-harvest loss reduction) on household food security in Kaduna State. The findings reveal that soil conservation and water conservation have positive and statistically significant effects on household food security. This emphasizes the critical role of maintaining soil fertility and ensuring efficient water management in improving crop productivity and food availability. On the other hand, post-harvest loss reduction, although positively related to household food security, did not show a

statistically significant effect. This suggests that in the study area, greater emphasis is currently placed on production-related practices rather than post-production management. It also reflects possible constraints such as inadequate storage facilities, limited access to modern preservation technologies and low awareness of post-harvest handling techniques. The study concludes that enhancing soil and water conservation practices is essential for improving household food security in Kaduna State, while increased attention to post-harvest management is needed to fully optimize agricultural output and reduce food losses.

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

1. Government and relevant agricultural agencies should intensify efforts to promote soil conservation practices among farmers through training, extension services and awareness campaigns. Practices such as crop rotation, use of organic manure and erosion control techniques should be widely encouraged.
2. There is a need to prioritize water conservation strategies by investing in irrigation infrastructure, rainwater harvesting systems and efficient water management technologies. This will help farmers maintain stable production levels, especially during periods of irregular rainfall.
3. Although post-harvest loss reduction was not statistically significant, efforts should still be made to improve storage facilities, transportation systems and access to modern preservation technologies. This will help minimize food waste and enhance food availability over time.

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APPENDIX: Research Questionnaire
Soil Conservation (SC)

ID	Statement	Level of Agreement				
		SD	D	U	A	SA
SC1	I practice soil conservation methods on my farm					
SC2	Soil conservation practices help to reduce soil erosion on my farmland					
SC3	The use of terraces improves soil fertility					
SC4	I have adequate knowledge of soil conservation techniques					
SC5	Soil conservation practices contribute to increased crop yield					

Water Conservation (WC)

ID	Statement	Level of Agreement				
		SD	D	U	A	SA
WC1	I practice efficient use of water in my farming activities					
WC2	Water conservation practices help to improve crop productivity in my farm					
WC3	I have access to water conservation technologies					
WC4	Proper water management reduces the impact of drought on my farm					
WC5	Water conservation practices improve my household agricultural output					

Post-Harvest Loss Reduction (PLR)

ID	Statement	Level of Agreement				
		SD	D	U	A	SA
PLR1	I use proper storage facilities to reduce losses after harvesting my crops					
PLR2	Proper handling of crops reduces spoilage					
PLR3	I adopt improved techniques to preserve crops					
PLR4	Post-harvest loss significantly reduces the quantity of food available in my household					
PLR5	Reducing post-harvest losses increases my household food availability					

Household Food Security (HFS)

ID	Statement	Level of Agreement				
		SD	D	U	A	SA
HFS1	My household has enough food to meet our daily needs throughout the year					
HFS2	We can afford to buy sufficient nutritious food when needed					

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