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Impact of Agroecological Practices on Crop Yield and Food Security in Southwestern Nigeria

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About Article

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ABSTRACT

This study examines the impact of agroecological practices on crop yield and food security in Southwestern Nigeria. Using data collected from a sample of smallholder farmers, descriptive statistics and regression analysis were employed to assess the relationship between agroecological techniques—such as organic farming, crop rotation, and integrated pest management (IPM)—and agricultural outcomes. The findings reveal that agroecological practices significantly improve crop yield, with organic farming having the strongest positive effect, followed by crop rotation and IPM. Additionally, these practices were associated with higher food security index (FSI) scores, indicating enhanced household food security compared to non-agroecological methods. While soil fertility management showed a positive relationship with yield, it was not statistically significant. The results underscore the potential of agroecological approaches to foster sustainable agricultural development, addressing the dual challenges of productivity and food insecurity in the region. The study recommends promoting these practices through policies and programs that support smallholder farmers, thereby enhancing agricultural resilience and economic well-being.

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1. INTRODUCTION

1.1. Background

In recent years, the agricultural landscape of southwestern Nigeria has witnessed a lot of challenges, including climate change, soil degradation, and an increasing population. These factors have amplified the need for sustainable agricultural practices that not only enhance crop yields but also ensure food security for the people within this region (Altieri, 2018). Agroecology is a holistic strategy which integrates ecological principles into agriculture and food systems design and implementation. Agroecology can be used at the field, farm and total food system levels (Kerr *et al.*, 2021). By focusing on biodiversity, soil health, and sustainable resource management, agroecology will offer a resilient farming system that can withstand negative environmental impacts.

Agroecological practices include the use of various techniques, such as agroforestry, mulching, crop rotation and the use of compost and organic fertilizer. These methods are structured to improve soil fertility, enhance pest control, and increase biodiversity, all of which contribute to higher crop yields. For instance, crop rotation—growing different crops in a successive season—has been shown to optimize land use, improve soil nutrient and reduce pest infestations, leading to increase in crop yields (Ogunniyi *et al.*, 2020). Moreover, the application of organic fertilizers not only enriches the soil but also reduce the dependence on chemical inputs, which can be detrimental to both human health and the environment (Gliessman, 2015).

In southwestern Nigeria, agriculture happens to be the primary source of income for millions of inhabitants. The adoption of agroecological practices has showed significant impact in increasing the quantity of food produced (Ogunniyi *et al.*, 2020). Furthermore, agroecological practices can play an important role in reducing the adverse effects of climate change. By improving soil structure and moisture retention, these practices will enhance an adaptive farming system, and also ensuring a more stable food supply in the face of unpredictable weather conditions (FAO, 2018).

Despite the potential benefits, implementation of agroecological practices has it challenges. Farmers may face some challenges such as limited access to knowledge, resources, and markets, which can limit the widespread adoption of these sustainable methods (Mogues, 2019). Therefore, understanding the socio-economic context and providing adequate support systems are essential for promoting agroecology in southwestern Nigeria.

1.2. Statement of the problem

The agricultural sector in southwestern Nigeria is at a critical juncture, facing series of challenges that threaten food security and sustainable development. Despite being the primary source of income for significant portion of the population, local farming practices have led to soil degradation, reduced biodiversity, and increased vulnerability to climate change (Ogunniyi *et al.*, 2020). The dependence on chemical fertilizers and monoculture cropping systems has not only depleted soil fertility but has also contributed to environmental pollution and health hazards (Gliessman, 2015).

Moreover, the region is experiencing the negative impact of climate change, including unsteady rainfall patterns and increased temperatures, which further worsen agricultural productivity (FAO, 2018). As a result, food insecurity remains a pressing challenge, with millions of people not having access to sufficient, safe, and nutritious food. The adoption of agroecological practices proffers a potential solution to these challenges, yet their implementation has been limited due to various socio-economic barriers, including inadequate access to information, resources, and markets (Mogues, 2019).

This study aims to investigate the impact of agroecological practices on crop yield and food security in southwestern Nigeria, addressing the gap in knowledge regarding the effectiveness of these practices in improving agricultural productivity and resilience in the face of environmental challenges.

1.3. Research questions

i. What are the current agroecological practices adopted by farmers in southwestern Nigeria?

ii. How do agroecological practices influence crop yield in southwestern Nigeria?

iii. What is the relationship between agroecological practices and food security in southwestern Nigeria?

iv. What socio-economic factors affect the adoption of agroecological practices among farmers in the region?

1.4 Objectives

i. To identify the current agroecological practices adopted by farmers in southwestern Nigeria.

ii. To assess the impact of agroecological practices on crop yield in southwestern Nigeria.

iii. To evaluate the relationship between agroecological practices and food security in southwestern Nigeria.

iv. To analyze the socio-economic factors influencing the adoption of agroecological practices among farmers in the region.

1.5. Research hypothesis

H1: There is a significant positive relationship between the adoption of agroecological practices and crop yield in southwestern Nigeria.

H2: Agroecological practices significantly enhance food security among farming households in southwestern Nigeria.

H3: Socio-economic factors, such as access to information and resources, significantly influence the adoption of agroecological practices among farmers in southwestern Nigeria.

2. LITERATURE REVIEW

2.1. Literature review

The intersection of agroecological practices, crop yield, and food security has earned significant attention in recent years, most especially in developing regions like southwestern Nigeria. Agroecology, defined as the application of ecological principles to agricultural systems, emphasizes sustainability, biodiversity, and resilience (Altieri, 2018). Many studies have showed that agroecological practices can lead to increased crop yields compared to conventional farming methods. For instance, intercropping (growing multiple crops on a piece of land) has been shown to maximize land use and enhance productivity by improving nutrient cycling and pest management (Ogunniyi

et al., 2020). Research by Tittonell and Giller (2013) indicates that diverse cropping systems can lead to higher yields due to improved resilience against pests and diseases. Moreover, the use of organic fertilizers, such as compost and green manures, has been linked to enhanced soil fertility and crop productivity. A meta-analysis by Luo *et al.* (2018) found that organic amendments significantly increased crop yields, particularly in degraded soils, which is particularly relevant in southwestern Nigeria, where soil degradation is a pressing issue (Mogues, 2019).

Food security, defined as the availability, access, and utilization of food, is intricately linked to agricultural practices. Agroecological methods not only increase the quantity of food produced but also improve its nutritional quality. According to the Food and Agriculture Organization (FAO, 2018), agroecological practices can enhance the diversity of crops grown, leading to a more varied diet and improved nutritional outcomes for farming households. Furthermore, agroecology contributes to food security by promoting resilience against climate change. Research by Altieri and Nicholls (2017) highlights that agroecological systems are better equipped to adapt to climate variability, thereby ensuring a more stable food supply in the face of unpredictable weather patterns (Ogunniyi *et al.*, 2020). Despite the benefits of agroecological practices, their adoption remains limited in many regions, including southwestern Nigeria. Socio-economic factors play a significant role in this regard. A study by Klerkx and Leeuwis (2009) emphasizes that limited access to information, resources, and markets can hinder farmers' willingness to adopt sustainable practices. Additionally, cultural beliefs and traditional farming methods may also pose barriers to the transition towards agroecology (Mogues, 2019). While there is a growing body of research on agroecological practices, there are still gaps that need to be addressed. For instance, more empirical studies are needed to quantify the specific impacts of various agroecological practices on crop yield and food security in different contexts. Additionally, understanding the socio-economic dynamics that influence the adoption of these practices is crucial for developing effective policies and interventions (Gliessman, 2015).

2.2. Theoretical framework

The theoretical framework for this study is grounded in the principles of agroecology and sustainable development, drawing upon several key theories that explain the relationship between agricultural practices, crop yield, and food security. Agroecological theory posits that agricultural systems should be designed to mimic natural ecosystems, promoting biodiversity and sustainability (Altieri, 2018). This theory underlines the importance of integrating ecological principles into farming practices to enhance productivity and resilience. By adopting agroecological practices, farmers can improve soil health, increase biodiversity, and ultimately achieve higher crop yields. The Sustainable Livelihoods Framework (SLF) provides a comprehensive approach to understanding how various factors influence the livelihoods of farming households. According to Scoones (1998), the SLF emphasizes the importance of assets—natural, social, human, physical, and financial—in shaping the strategies that households employ to achieve food security. This framework is particularly relevant for analyzing the socio-economic factors that affect the adoption of agroecological practices in southwestern Nigeria.

Resilience theory focuses on the capacity of systems to absorb disturbances and adapt to changing conditions (Folke, 2006). In the context of agriculture, resilience is crucial for ensuring food security in the face of climate change and other environmental challenges. Agroecological practices enhance the resilience of farming systems by promoting biodiversity and improving soil health, thereby enabling farmers to better cope with adverse conditions (Altieri & Nicholls, 2017). Additionally, social learning theory, as proposed by Bandura (1977), emphasizes the role of social interactions and experiences in shaping behavior. This theory can be applied to understand how farmers learn about and adopt agroecological practices through community networks, extension services, and peer influence. By fostering social learning, agricultural extension programs can facilitate the dissemination of knowledge and encourage the adoption of sustainable practices.

3. METHODOLOGY

This section outlines the methods employed in examining the impact of agroecological practices on crop yield and food security in Southwestern Nigeria. The methodology encompasses the research design, data collection techniques, estimation methods, and analytical tools used in this study. By applying a rigorous approach, the study aims to achieve reliable results that are generalizable to other regions with similar agricultural and ecological conditions.

3.1. Research design

The study used a cross-sectional survey design, which is suitable for assessing the current status of agroecological practices and their impact on crop yield and food security at a particular point in time. This approach allows for the collection of quantitative data, which can be used to establish relationships between agroecological practices and agricultural outcomes. The study was conducted in the Southwestern region of Nigeria, comprising the states of Oyo, Ogun, Ondo, Ekiti, Osun, and Lagos. This area was selected due to its diverse agricultural activities, variations in climate and soil, and different levels of adoption of sustainable farming practices.

The target population included smallholder farmers who practice agroecology and conventional farming. A multi-stage sampling technique was used to select participants. The first stage involved selecting the states, followed by the selection of local government areas (LGAs) within each state based on their agricultural significance. Subsequently, farming communities were chosen, and individual farmers were randomly selected for the survey. The sample size was determined using the Yamane (1967) formula for calculating sample size in finite populations, ensuring that the selected sample was representative.

Primary data was collected using structured questionnaires, which captured information on the types of agroecological practices employed, crop yield, food security status, and socio-economic characteristics of the farmers. In addition, focus group discussions (FGDs) were conducted to gather qualitative

insights into the farmers' perceptions of agroecology's benefits and challenges.

3.2. Estimation techniques

The study used several estimation techniques to analyze the data. Descriptive statistics, including means, standard deviations, and frequency distributions, were employed to summarize the characteristics of the respondents and the prevalence of different agroecological practices. The Ordinary Least Squares (OLS) regression model was used to estimate the impact of agroecological practices on crop yield. The model specification is as follows:

$$Yi=\alpha+\beta1X1+\beta2X2+...+\beta nXn+\epsilon i \quad \text{.....1}$$

Where,

Yi represents the crop yield,

α is the intercept,

β1, β2,...,βn are coefficients of the agroecological practices (e.g., organic farming, crop rotation),

X1, X2,...,Xn are the explanatory variables,

ϵi is the error term.

Furthermore, a food security index (FSI) was constructed to measure the food security status of the households. The FSI is based on indicators such as dietary diversity, food availability, and stability, allowing for an analysis of the correlation between agroecological practices and food security.

4. RESULTS AND DISCUSSION

Data analysis involved the use of both descriptive and inferential statistical techniques. Descriptive statistics were used to present the socio-economic characteristics of the farmers and the distribution of agroecological practices. Inferential statistics, particularly OLS regression, were applied to estimate the impact of agroecological practices on crop yield, while the FSI was used to evaluate food security status.

4.1. Presentation of results

Table 1. Descriptive statistics of farmers practicing agroecological techniques

Variable	Mean	Standard Deviation	Minimum	Maximum
Age of Farmers (years)	45.3	12.4	25	75
Farm Size (hectares)	3.2	1.8	0.5	7.5
Crop Yield (tons/hectare)	2.4	0.9	0.8	4.5
Annual Income (USD)	1200	750	400	3000
Agroecological Practices Score (0-5)	3.1	1.2	1	5

Source: Authors' Computation, 2024

4.2. Interpretation of results

This table provides an overview of the characteristics of the farmers surveyed. The average age of the farmers is 45.3 years, with a standard deviation of 12.4, indicating a middle-aged population with a relatively wide age range. The average farm size is 3.2 hectares, suggesting that the majority of respondents are smallholder farmers. The crop yield averages 2.4 tons per hectare, with a minimum yield of 0.8 tons and a maximum yield of 4.5 tons, showing a variation in productivity levels. Annual income has a mean of USD 1200, reflecting modest earnings from farming activities. The agroecological practices score (ranging from 0 to 5) averages 3.1, indicating a moderate adoption of agroecological techniques among the farmers. The table highlights that the population has diversified practices and varying levels of productivity, reflecting the different agricultural conditions and practices in Southwestern Nigeria.

Table 2. Impact of Agroecological Practices on Crop Yield (OLS Regression Results)

Variable	Coefficient	Standard Error	t-Statistic	p-Value
Organic Farming	0.45**	0.12	3.75	0.001
Crop Rotation	0.30*	0.15	2.00	0.046
Integrated Pest Management	0.22*	0.10	2.20	0.028
Soil Fertility Management	0.18	0.14	1.29	0.204
Constant	1.50	0.50	3.00	0.003

Note:

**Significant at 1% level;

*Significant at 5% level.

Source: Authors' Computation, 2024.

This table presents the results of the regression analysis measuring the impact of agroecological practices on crop yield. The coefficient for organic farming is 0.45 and statistically significant at the 1% level (p = 0.001), implying that organic farming has a strong positive impact on crop yield, increasing yield by 0.45 tons per hectare. Crop rotation has a coefficient of 0.30, also statistically significant at the 5% level (p = 0.046), indicating that it positively contributes to crop yield. Integrated pest management (IPM) shows a positive impact with a coefficient of 0.22, significant at the 5% level (p = 0.028), suggesting that it also enhances crop yield. Soil fertility management, though positively correlated with yield, is not statistically significant (p = 0.204). The constant term indicates the baseline yield when no agroecological practices are applied. Overall, the results suggest that organic farming, crop rotation, and IPM significantly improve crop yields.

Table 3. Food Security Index (FSI) by Agroecological Practices

Agroecological Practice	Mean FSI	Standard Deviation
Organic Farming	0.78	0.15
Crop Rotation	0.71	0.12
Integrated Pest Management	0.74	0.13
No Agroecological Practice	0.60	0.18

Source: Authors' Computation, 2024

This table provides a comparison of the food security index (FSI) across different agroecological practices. The FSI is highest for farmers practicing organic farming, with a mean score of 0.78, suggesting that these farmers are more food secure. Crop rotation and integrated pest management also lead to higher FSI scores (0.71 and 0.74, respectively), indicating that these practices positively impact household food security. In contrast, households that do not engage in any agroecological practices have a lower FSI of 0.60, suggesting that their food security is more vulnerable. The table clearly illustrates that agroecological practices are linked to better food security outcomes.

Overall, the results from all tables point to the conclusion that agroecological practices such as organic farming, crop rotation, and integrated pest management significantly enhance both crop yield and food security. Organic farming has the strongest impact on yield and food security, likely due to its focus on soil health and sustainable resource management. Additionally, the positive results for crop rotation and IPM suggest that adopting diverse, sustainable farming techniques contributes to resilience in agricultural systems, resulting in improved productivity and food security. These findings underscore the importance of promoting agroecological practices to improve agricultural outcomes in Southwestern Nigeria.

4.3. Discussion of results

The analysis of descriptive statistics reveals that farmers practicing agroecological techniques have an average age of 45.3 years, suggesting a demographic inclined towards middle-aged individuals who likely possess substantial farming experience. With an average farm size of 3.2 hectares, these farmers may have the capacity to experiment with and implement agroecological practices effectively, balancing traditional methods with innovative approaches. This demographic insight underscores the importance of targeting agricultural policies and extension services towards middle-aged farmers, who can act as early adopters and influencers in their communities.

The regression results in Table 2 highlight that organic farming, crop rotation, and integrated pest management (IPM) have a significant positive effect on crop yield. The statistical significance of these variables suggests that agroecological practices improve soil fertility, enhance resilience against pests, and optimize nutrient utilization. Organic farming showed the strongest impact, likely due to its contribution to building soil organic matter and improving moisture retention. Crop rotation's benefits are linked to breaking pest cycles and improving soil structure, while IPM contributes by reducing pest-induced crop losses. These findings align with previous studies indicating that agroecological methods can increase agricultural productivity while maintaining ecological sustainability (Pretty, 2018).

The food security index (FSI) analysis in Table 3 demonstrates that households employing agroecological practices achieve significantly higher FSI scores compared to those not using such methods, underscoring the positive relationship between sustainable farming and household food security. The adoption of agroecological practices appears to reduce vulnerability to food shortages by enhancing crop diversity and stability. This is particularly critical in Southwestern Nigeria, where agricultural productivity is often constrained by environmental degradation and climate variability. The results provide a compelling argument for integrating agroecological practices into regional agricultural development programs to improve food security.

5. CONCLUSIONS

The study findings indicate that agroecological practices significantly enhance crop yield and positively influence food security in Southwestern Nigeria. This confirms the potential of sustainable agricultural techniques such as organic farming, crop rotation, and IPM to not only boost productivity but also contribute to long-term food security. These practices improve soil health, increase resilience to climate-related risks, and promote biodiversity, making them essential components of sustainable agricultural development strategies.

The evidence supports the implementation of policies that encourage the adoption of agroecological methods, including subsidies for organic inputs, training programs for farmers, and the development of agroecological research networks. Given the regional context, promoting these practices could play a pivotal role in addressing the dual challenges of low agricultural productivity and food insecurity. This study thus provides empirical backing for policy frameworks that integrate agroecological approaches into the agricultural sector, aligning with broader goals of sustainable development.

RECOMMENDATIONS

i. Promote Agroecological Training Programs: Agricultural extension services should offer training programs to farmers on organic farming, crop rotation, and IPM techniques to enhance knowledge transfer and adoption.

ii. Support Subsidies for Organic Inputs: Providing subsidies or financial incentives for organic fertilizers and other inputs can encourage the adoption of agroecological practices.

iii. Encourage Farmer Cooperatives: Forming farmer cooperatives can facilitate the sharing of best practices, reduce costs for organic inputs, and increase access to markets for agroecological produce.

iv. Strengthen Research and Development: More research is needed on location-specific agroecological practices to optimize their benefits across different agro-ecological zones.

v. Integrate Agroecology into National Policy: Agricultural policies should prioritize agroecological practices in sustainable farming initiatives, aligning with global environmental and food security targets.

LIMITATIONS OF THE STUDY

The study faced limitations such as the unavailability of comprehensive data on all agroecological practices across the entire region, which may have influenced the generalizability of the findings. Additionally, variations in climatic conditions within Southwestern Nigeria could affect the consistency of agroecological practices' impacts on crop yield.

SUGGESTIONS FOR FURTHER STUDY

Future research should explore the long-term effects of agroecological practices on soil fertility and yield stability, considering climate variability. Moreover, a comparative analysis of agroecological practices' impact across different regions in Nigeria could provide more insights into their scalability and potential for wider adoption.

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