



IMPACT OF SMART AGRICULTURE TECHNICAL AND VOCATIONAL EDUCATION TRAINING ON SUSTAINABILITY OF FARMING PRACTICES IN OGUN STATE

By

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Abstract

This study examines the impact of smart agriculture-focused Technical and Vocational Education and Training (TVET) on sustainable farming practices among rural farmers in selected communities in Ogun State, Nigeria. A survey research design was adopted, and data were collected from 400 randomly selected farmers using a structured questionnaire. The study employed multiple regression analysis to evaluate the relationship between exposure to TVET and key dimensions of sustainable agriculture, namely land use efficiency, adoption of eco-friendly technologies, and climate resilience.

The findings reveal that exposure to smart agriculture-focused TVET has a statistically significant positive effect on sustainable farming practices ($R^2 = 0.479$, $p < 0.01$), indicating that nearly half of the variation in sustainability outcomes is explained by training exposure. Other results show that TVET significantly enhances land use efficiency ($R^2 = 0.420$), promotes the adoption of environmentally friendly technologies ($R^2 = 0.391$), and strengthens farmers' resilience to climate variability ($R^2 = 0.350$). These results suggest that practical, skill-based training plays a critical role in facilitating the transition toward climate-smart and resource-efficient agricultural systems. The study recommends strengthening digital infrastructure, scaling mobile learning platforms, and institutionalizing monitoring mechanisms to enhance the effectiveness of TVET interventions in the agricultural sector.

Keywords: Smart agriculture, TVET, sustainable farming, climate resilience, Rural development

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Introduction

Agriculture remains a critical sector in Nigeria, particularly in rural areas of the Southwest region, where a significant proportion of the population depends on it for livelihood and food security. However, the sector is increasingly confronted with challenges such as climate variability, land degradation, obsolete farming techniques, and limited access to technical knowledge. These constraints continue to hinder productivity and threaten long-term sustainability (Food and Agriculture Organization [FAO], 2023). Addressing these issues requires a transition toward a more resilient and sustainable agricultural system.

Agricultural transformation has been widely recognized as a key driver of sustainable rural development, especially in regions where farming constitutes a major source of income and employment. Despite its importance, agricultural productivity in Southwest Nigeria remains constrained by systemic issues including inefficient farming practices, inadequate access to modern inputs, and increasing environmental pressures (Adewuyi & Adefalu, 2021). With the rapid evolution of global agricultural systems through digitalization and precision technologies, the need for smart agriculture has become more pronounced. This shift necessitates the development of human capital capable of effectively utilizing emerging technologies (Aker et al., 2016).



Technical and Vocational Education and Training (TVET) play a crucial role in equipping farmers with practical and technical skills required to adopt modern agricultural practices. TVET enhances farmers' capacity to implement sustainable land use strategies, eco-friendly farming methods, and climate adaptation measures (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2015). In this context, smart agriculture—characterized by the integration of digital tools, precision farming, and climate-smart techniques—has emerged as a viable solution for improving productivity and environmental sustainability (World Bank, 2022).

Smart agriculture leverages advanced technologies such as the Internet of Things (IoT), Geographic Information Systems (GIS), drones, mobile applications, and big data analytics to optimize farming operations and resource use efficiency (Nnaji et al., 2023). Despite these advancements, the adoption of smart agricultural technologies among rural farmers in Nigeria remains relatively low. One of the major barriers is the knowledge gap, as many farmers lack the technical expertise required to utilize these innovations effectively (Akinola & Yusuf, 2022).

TVET provides a strategic platform for bridging this knowledge gap by delivering context-specific training that enhances farmers' technical competence and encourages behavioral change toward sustainable practices. Furthermore, while previous studies have examined agricultural innovation and climate-smart practices, there is limited empirical evidence on how smart agriculture-focused TVET contributes to measurable improvements in land use efficiency, adoption of eco-friendly technologies, and climate resilience, particularly within rural communities in Ogun State.

Although the Nigerian government has increased investment in agricultural innovation through initiatives such as the National Agricultural Technology and Innovation Policy (NATIP), adoption at the grassroots level remains slow. Existing studies suggest that this gap may be largely attributed to inadequate farmer-centered education and limited access to relevant skill development programs (Ibrahim et al., 2023). In addition, infrastructural deficiencies and weak policy implementation continue to constrain the diffusion of agricultural innovations (Ogunlade & Olaniyan, 2021).

Empirical studies in Southwest Nigeria have provided insights into aspects of climate-smart agriculture adoption. For instance, Olajide (2023) examined farmers' propensity to utilize media platforms for accessing climate-smart agricultural information, while Ojo et al. (2023) analyzed the adoption and financing of climate-smart agriculture among rice farmers in Osun State. However, these studies did not explicitly evaluate the role of structured TVET programs in enhancing sustainable farming practices.

Against this backdrop, this study seeks to examine the impact of smart agriculture-focused TVET on sustainable farming practices among rural farmers in selected communities in Ogun State, Nigeria. Specifically, the study aims to determine the extent to which TVET influences land use efficiency,

assess its effect on the adoption of eco-friendly farming technologies, and evaluate its contribution to climate resilience among rural farmers.

Materials and Methods

This research was conducted in four local government areas in Ogun State are: Yewa South (Ilaro, Oke-Odan, Owode), Ifo (Ojodu, Coker), Odeda (Alabata, Obantoko), and Obafemi Owode (Ajebo, Mowe). These places were deliberately chosen because of their importance in subsistence and semi-commercial farming operations. A descriptive survey approach was used to study rural farmers' access to smart agriculture-focused Technical and Vocational Education and Training (TVET) and its impact on sustainable agricultural practices. Given the lack of a precise sampling frame, the population was assumed infinite, and Cochran's method for infinite populations was used to calculate a statistically acceptable sample size of 400 farmers, chosen at random to assure representativeness.

Data were gathered using a validated structured questionnaire created with consultation from agricultural extension and TVET professionals. The test had Likert-scale items assessing farmers' exposure to smart agriculture TVET, adoption of sustainable agricultural techniques, and perceived climate resilience.

The data collected were analysis using SPSS version 26. The data was summarized using descriptive statistics (means and frequencies), and multiple regression analysis was performed to assess the connections between TVET exposure and the three characteristics of sustainable agriculture at a 5% level of significance.

The regression model was specified as:

$$Y = \beta_0 + \beta_1 X_1 + \epsilon$$

Where **Y** = Composite score for Sustainable Farming Practices,

X₁ = Exposure to Smart Agriculture TVET, **β₁** = Regression Coefficient, **ε** = Error term.

To examine the dimensions individually, the following sub-models were applied:

- **Land Use Efficiency:** $Y_1 = \beta_0 + \beta_1 X_1 + \epsilon$
- **Eco-Friendly Technology Adoption:** $Y_2 = \beta_0 + \beta_2 X_1 + \epsilon$
- **Climate Resilience:** $Y_3 = \beta_0 + \beta_3 X_1 + \epsilon$

Results

Table 1: Model Summary – Overall Sustainable Farming Practices

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.692	.479	.475	0.587

Source. Researchers' computation (2025).

Table 2: ANOVA – Overall Model

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	86.314	1	86.314	31.75	.000
Residual	93.686	368	0.255		
Total	180.000	369			

Source. Researchers’ computation (2025).

Table 3: Coefficients – Overall Sustainable Farming Practices

Model	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t	Sig.
(Constant)	1.152	0.132	—	8.727	.000
TVET Exposure	0.547	0.097	0.692	5.634	.000

Source. Researchers’ computation (2025).

Table 4: Regression – Land Use Efficiency (Sub-Model 1)

Model	R	R Square	F	B (TVET Exposure)	Beta	Sig.
1	.648	.420	28.23	0.42	.648	.000

Source. Researchers’ computation (2025).

Table 5: Regression – Eco-Friendly Technology Adoption (Sub-Model 2)

Model	R	R Square	F	B (TVET Exposure)	Beta	Sig.
1	.625	.391	26.89	0.39	.625	.000

Source. Researchers’ computation (2025).

Table 6: Regression – Climate Resilience (Sub-Model 3)

Source. Researchers’ computation (2025)

Discussion of Findings

The findings of this study provide strong empirical evidence that exposure to smart agriculture-focused Technical and Vocational Education and Training (TVET) significantly enhances sustainable farming practices among rural farmers in Ogun State. The overall regression model indicates that TVET accounts for approximately 47.9% of the variation in sustainable agricultural outcomes, suggesting that skill acquisition and knowledge transfer are central drivers of agricultural transformation at the grassroots level.

This result reinforces the argument that TVET is a critical enabler of agricultural modernization. Consistent with the position of UNESCO (2015), TVET serves as a strategic tool for equipping individuals with practical competencies required for sustainable production systems. Similarly, Aker et al. (2016) emphasized that the effectiveness of digital agricultural innovations is largely dependent on the capacity of users to understand and apply such technologies. The present study extends this argument by demonstrating that structured training not only facilitates technology adoption but also translates into measurable improvements in sustainability outcomes.

A sustainable agriculture reveals important insights. First, the strong relationship between TVET and land use efficiency ($R^2 = 0.420$) suggests that trained farmers are more likely to adopt improved land management practices such as crop rotation, soil conservation techniques, and precision farming. This aligns with previous findings that extension education and skill-based training significantly enhance resource-use efficiency among smallholder farmers (Ajayi & Salako, 2020). The implication is that knowledge dissemination through TVET can directly address the problem of land degradation, which remains a major constraint to agricultural productivity in Nigeria.

Second, the positive and significant influence of TVET on the adoption of eco-friendly technologies ($R^2 = 0.391$) highlights the role of training in promoting environmentally sustainable practices. Farmers exposed to TVET are more inclined to adopt innovations such as organic fertilizers, water-efficient irrigation systems, and integrated pest management techniques. This finding supports the broader literature that links vocational education to environmental stewardship and sustainable resource management. It also validates the World Bank’s (2022) assertion that digital and precision agriculture can enhance both productivity and environmental outcomes when supported by adequate training systems.

Third, although relatively lower, the impact of TVET on climate resilience ($R^2 = 0.350$) remains substantial and statistically significant. This indicates that training contributes to farmers’ ability to adapt to climate variability through the adoption of climate-smart practices such as drought-resistant crop varieties, early warning systems, and improved water management strategies. This finding is consistent with Musa et al. (2021), who reported that digital skill acquisition significantly improves the adoption of climate adaptation strategies among rural farmers. It further suggests that resilience-building is not solely dependent on access to technology but also on the capacity to utilize such technologies effectively.

Despite these positive outcomes, the findings also imply that more than half of the variation in sustainable farming practices is explained by factors outside TVET exposure. This suggests the presence of complementary constraints such as infrastructural deficiencies, limited access to finance, and policy implementation gaps, as noted by Ogunlade and Olaniyan (2021). Therefore, while TVET is a critical

intervention, its effectiveness may be enhanced when integrated with broader institutional and infrastructural support systems.

Overall, this study makes a significant contribution to the literature by providing localized empirical evidence on the role of smart agriculture-focused TVET in promoting sustainable farming practices in Southwest Nigeria. Unlike previous studies that focused primarily on technology adoption or climate-smart agriculture in isolation, this research adopts a more comprehensive approach by linking training directly to multiple dimensions of sustainability. The findings underscore the need to reposition TVET as a central component of agricultural policy, not only as a means of skill development but also as a catalyst for sustainable rural transformation.

Conclusion

This study provides robust empirical evidence on the role of smart agriculture-focused Technical and Vocational Education and Training (TVET) in enhancing sustainable farming practices among rural farmers in Ogun State, Nigeria. The findings reveal that exposure to TVET significantly improves overall sustainability outcomes, accounting for a substantial proportion of the variation in farming practices. Specifically, the study establishes that TVET positively influences land use efficiency, accelerates the adoption of eco-friendly technologies, and strengthens farmers' resilience to climate variability.

The results highlight that sustainable agricultural transformation is not solely dependent on the availability of advanced technologies but is fundamentally driven by the capacity of farmers to utilize such innovations effectively. In this regard, TVET emerges as a critical mechanism for bridging the knowledge and skills gap that constrains the adoption of smart agriculture in rural communities.

Furthermore, the study demonstrates that while TVET plays a central role, sustainable farming outcomes are also shaped by complementary factors such as infrastructure, access to finance, and institutional support. This suggests that a holistic approach is required—one that integrates training with broader agricultural development policies.

Importantly, this study contributes to the literature by offering context-specific, quantitative evidence from Southwest Nigeria, thereby addressing a notable gap in empirical research on the intersection of TVET, smart agriculture, and sustainability. It advances the argument that TVET should be repositioned from a peripheral intervention to a core component of agricultural transformation strategies. In conclusion, smart agriculture-focused TVET is not merely a tool for skill acquisition but a strategic driver of environmental sustainability, food security, and inclusive rural economic development in Nigeria.

Recommendations

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

- Institutionalize smart agriculture curricula within national and regional TVET programs to ensure sustainability and relevance.
- Expand mobile and digital learning platforms to reach remote and underserved farming populations.
- Improve digital infrastructure in rural areas to support smart agriculture technologies and training delivery.
- Establish monitoring and support systems within TVET programs to ensure program effectiveness, follow-up, and scalability.

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