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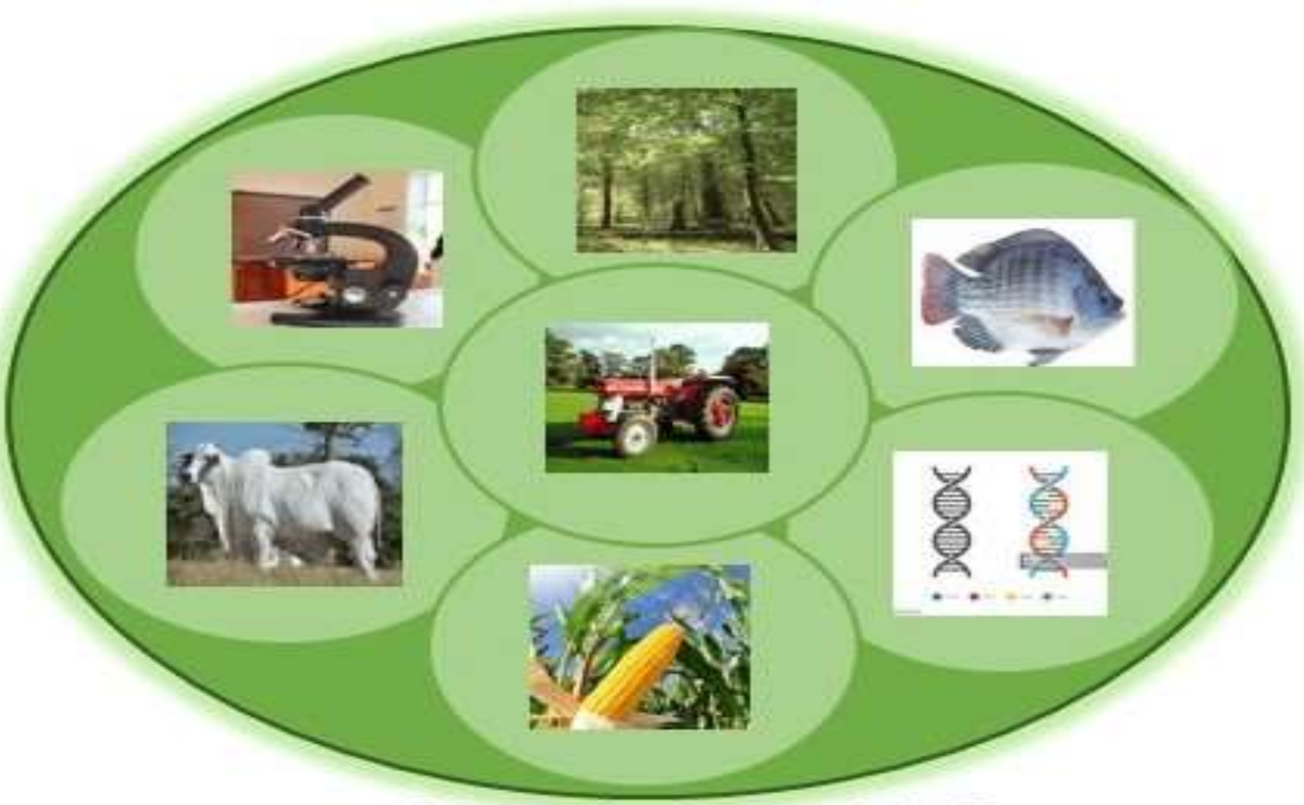

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EFFECTS OF CLIMATE SMART AGRICULTURAL PRACTICES ON FOOD SECURITY AMONG SMALL SCALE FARMERS IN OYO STATE, NIGERIA

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ABSTRACT

Small-scale agriculture plays a crucial role in sustaining rural livelihoods and food supply in Nigeria, yet its productivity and resilience are increasingly destabilized by climate change. Climate-Smart Agricultural Practices (CSAP) have been promoted as pathways to enhance productivity, build resilience, and strengthen food security. This study examines the adoption of CSAPs and their effects on household food security among small-scale farmers in Oyo State, Nigeria Using Primary data that were collected from 350 farming households through a multistage sampling design and analyzed using descriptive statistics, Poisson regression, and multiple regression models. Results show that farmers adopted an average of 3.6 CSAPs, with 43% classified as medium adopters and 32% as high adopters. Education, gender, and farm size significantly influenced the extent of adoption, ($\beta = 0.0215$; $p < 0.001$), ($\beta = 0.1294$; $p < 0.05$), ($\beta = 0.0199$; $p < 0.10$) while age and income had no significant effects. Regression results reveal that higher adoption levels significantly improved both Household Dietary Diversity Score ($\beta = 1.599$; $p < 0.01$) and Food Consumption Score ($\beta = 13.167$; $p < 0.01$), indicating positive impacts on food access and dietary quality. However, household size negatively affected food security, while income and farming experience contributed positively ($p < 0.05$). These findings highlight that education ($p < 0.05$) and access to resources are stronger drivers of CSAP adoption than demographic characteristics. Policies should prioritize farmer training, gender equity in resource access, and targeted support for smallholders to encourage sustained adoption of CSAP bundles, thereby enhancing agricultural resilience and food security in the face of climate change.

Keywords: CSAP, Small Scale, Food Security, Household, Farmers

Introduction

Agriculture is central to the source of livelihood of majority of rural households in Nigeria generally and particularly in states like Oyo where small-scale farming dominates food production (Nwaogwugwu and Njoku 2017). However, despite its importance to the livelihood of the state dwellers, the sector is

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increasingly threatened by the adverse impacts of climate change, which includes erratic rainfall patterns, prolonged droughts, and soil degradation (Nhemachena, 2020). According to Wijerathna-Yapa and Pathirana (2022) these challenges destabilizes farm productivity, food availability, and the overall resilience of farming systems which in essence leads to food insecurity. In response to these threats, Climate-Smart Agricultural Practices (CSAP) have emerged as a promising solution to enhance agricultural sustainability while improving food security and climate resilience (Hussein, 2024)

CSAP involves farm practices that is sustainable which can increase productivity, enhance adaptation and help build resilience to climate change, and also aid reduction of greenhouse gas emissions where possible (FAO, 2023). CSAP include conservation agriculture, agroforestry, crop rotation, use of drought-resistant varieties, efficient water management, mulching and so on (Abhilash - 2021). Mpala, and Simatele Autio (2021) submitted that these practices are particularly relevant for small-scale farmers, because they are often faced with resource constraints and are highly vulnerable to climate variability because they often practice rain-fed Agriculture. Despite the fact that CSAP is perceived to be relevant for climate resilience and the growing promotion in Nigeria, there are still limited empirical evidences on their effectiveness at the local level, particularly in terms of their contribution to household food security (Ojoko, 2021). Oyo State, having diverse agro-ecological zones and large population of smallholder farmers, provides a relevant environment to assess the relationship between CSAP adoption and its consequences on food security. This study therefore aims to investigate the effect of Climate-Smart Agricultural Practices adoption on the food security of small-scale farmers in Oyo State. It specifically seeks to identify the level of climate smart adoption amidst small scale farmer in Oyo State, compare the socioeconomic factors influencing adoption the CSAP level, and effect of CSAP adoption on food security among small scale farmers in Oyo State. Findings from this study will inform policy and develop ent programs aimed at promoting sustainable agriculture and improving food security in the face of climate change.

Material and Methods

Study Area

The study was conducted in Oyo State, southwest region of Nigeria. Oyo state has a mix of forest and savannah vegetation, with farming being a major occupation. Oyo state have many villages and are known for agrarian activities.

Types of Data and Methods of Data Collection

Primary data was employed for this study and a well-structured questionnaires with the aid of kobotool kits was used to collect data from the selected farming households. Data on Socioeconomic characteristics, household food consumptions, food availability, farm practices, types of CSAP adopted and so on were collected for the study.

Sampling Technique and Sample Size

A multistage sampling technique was used to select 350 farming households in Oyo State. The state was stratified by Local Government Areas (LGAs) to reflect ecological and socio-economic diversity. In the second stage, 35 villages (primary sampling units were randomly selected across five LGAs, using probability proportional to size (PPS) based on the number of farming households. Specifically, seven villages were selected in each of the LGAs: In the third stage, a complete listing of farming households was conducted in each selected village. From these lists, 10 small holders farming households per village were chosen using systematic random sampling, resulting in a total of 350 farming households. This design ensured proportional representation across LGAs, minimized sampling bias, and provided equal probability of selection for all households.

Theoretical framework

The adoption of CSAP and their potential impacts on food security can be explained within the broader context of agricultural household decision-making, risk management, and sustainable livelihood frameworks.

First, the fundamental framework is provided by the Agricultural Household Model (Singh, Squire, & Strauss, 1986). According to this model, farm households simultaneously decide how much to produce and how much to consume while dealing with market and resource constraints. Crop diversification, soil fertility management, conservation agriculture, and agroforestry are examples of CSAP that can change production outcomes by increasing resource efficiency, stabilising output under climate stress, and increasing yields. Food security is impacted by these changes since they have a direct impact on dietary outcomes and household consumption potential.

Second, the household's adoption of CSAP is supported by the Utility Maximization Theory. It is believed that farmers will implement strategies that optimize expected utility, which is influenced by risk preferences, long-term sustainability concerns, and farm revenue. Adoption of CSAP influences household welfare and food security by lowering exposure to income volatility and climatic hazards. Third, the approach is based on the Sustainable Livelihoods Approach (Chambers & Conway, 1992; DFID, 1999), this approach highlights how livelihood outcomes are shaped by natural, human, social, physical, and financial capital. Enhancing soil fertility (natural capital), expanding knowledge and skills (human capital), and making networks and inputs more accessible (social and physical capital) are all ways that CSAP helps to grow these capitals. Increasing these resources helps to increase food security and household resilience.

Lastly the four interrelated dimensions of food security as emphasized by FAO 2008 are availability, access, utilization, and stability. The adoption of CSAP is affects these dimensions by increasing food availability through higher productivity, enhancing access (via increased income), improving utilization through dietary diversity, and ensuring stability by shielding against climate shocks. This methodology is inline with the integration of FCS and HDDS as outcome indicators which captures both dietary quality and food access.

Data Analysis

The composite score analysis

The composite score was used in capturing CSAP among farming households. A binary scale was used to represent the use of CSAP by the farming households. Ten CSAP were identified in the study area. A practice was scored 1 if used by a respondent and 0 if not used by the respondent. A respondent based on the total number of CSAP identified can only have a maximum score of 10 and a minimum of 0. The score generated is used as a proxy to represent CSAP adapted by the farming households in the area of study.

The CSAP adoption index was constructed using scores assigned to different CSAPs adopted by farmers. Based on these scores, households was be categorized into three levels

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Poisson regression

To identify the socio-economic and farm-level factors influencing the adoption of CSAPs, we employ a count-data model consistent with the Poisson specification. The dependent variable in this study is the **number of CSAPs adopted** by each household, which is a **non-negative count variable**. Such outcomes violate the assumptions of Ordinary Least Squares (OLS), since OLS assumes a continuous dependent variable with normally distributed errors. Applying OLS to count data often leads to inefficient estimates, biased standard errors, and potentially misleading inference.

A binary logistic model would be restrictive because it treats adoption as a **yes/no decision,** thereby ignoring the intensity of adoption. However, in practice, households may adopt **multiple CSAPs simultaneously**, and understanding the determinants of the **extent (count)** of adoption provides richer insights for policy design.

Multiple regression

Food Consumption Score (FCS) and **Household Dietary Diversity Score (HDDS)** were the two complementary indicators employed to assess household food security outcomes for the selected farming households, both were used as a proxy for food security. The two jointly capture dietary quality, frequency, and access to diverse food groups, thereby offering a multidimensional understanding of food security. This was earlier used by Wekesa (2017) and Abegunde et al. (2019),

Variable definition

Food Consumption Score (FCS)

The FCS, developed by the World Food Programme (WFP), integrates dietary diversity, food frequency, and the relative nutritional importance of food groups. Household data were collected using a **7-day food frequency recall**, in which respondents reported the number of days various food groups were consumed. Eight standard food groups were considered: staples (cereals and tubers), pulses, vegetables, fruits, meat/fish, dairy products, sugar, and oils/fats. Each food group was assigned a weight reflecting its nutritional value: staples (2), pulses (3), vegetables (1), fruits (1), meat/fish (4), dairy (4), sugar (0.5), and oils/fats (0.5).

Household Dietary Diversity Score (HDDS)

The HDDS was calculated using the guidelines of the Food and Agriculture Organization (FAO). It captures the number of distinct food groups consumed by the household in the last 24 hours. Twelve food groups were considered: cereals, roots and tubers, vegetables, fruits, meat/poultry/offal, eggs, fish/seafood, pulses/legumes/nuts, milk and dairy products, oils/fats, sugar/honey, and condiments/beverages. Each food group consumed was assigned a score of "1," while not consumed was scored as "0." The HDDS was then calculated as the simple sum across all food groups

Using both FCS and HDDS provides a better perspective on food security. While the FCS reflects **medium-term food access and dietary adequacy** based on consumption over the past seven days, the HDDS provides insights into **short-term dietary diversity and food availability** within a 24-hour period. The combined use of these two strengthens the reliability of the analysis by capturing both habitual consumption patterns and immediate dietary access.

Results and Discussion

Descriptive Statistics of Respondents

Table 1 presents the summary statistics of the sampled farming households. The average age of respondents was 46 years, with a minimum of 25 years and a maximum of 69 years, which

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shows that most farmers were middle-aged and should therefore be active. Majority of the respondent are male, with approximately 62% of the respondents. Farmers had an average of nine years of formal education, although some had no schooling, while some others have up to 17 years. The average farm size is 5.6 acres, ranging from less than one acre (0.50 acres) to just above ten acres, while the mean annual income was approximately ₦286,040, and varies across households. The mean Household size is about five members, which is often common for rural household structures in Nigeria. The respondents adopted an average of 3.6 CSA practices out of a possible five, which shows a moderate uptake of CSAPs. Farmers also have 20 years' experience on the average, with values ranging from one to thirty nine years.

The Food security proxies revealed remarkable heterogeneity. The mean HDDS was 5.3, which shows consumption of about five food groups on average, but with wide variation across households. The FCS averaged 35.0, which falls within the borderline food security threshold, ranging from 4.4 (severe food insecurity) to 101.6 (food secure).These descriptive results reveals that despite the level of education and farm experience farmers in the study area the food security outcomes varied substantially across households, which support the importance of climate-smart agricultural adoption for enhancing food access and resilience.

Table 1. Summary of Socio-economic Characteristics of Small Scale Farmers in Oyo State

Variable	Mean	Std. Dev.	Minimum	Maximum
Age (years)	46.35	12.83	25	69
Gender (1 = male, 0 = female)	0.62	0.49	0	1
Education (years)	9.05	4.96	0	17
Farm size (acres)	5.59	2.74	0.50	10.05
Annual income (₦)	286,040.1	126,802.7	51,969	499,662
Household size	5.44	2.26	2	9
Number of CSAPs adopted	3.55	1.35	1	5
Farm experience (years)	20.20	11.15	1	39
Household Dietary Diversity Score (HDDS)	5.29	2.48	0.57	12.13
Food Consumption Score (FCS)	35.02	20.31	4.44	101.58

Source: Authors' Computation from Field Survey 2025

Level of Adoption Climate Smart Agricultural Practices among Small Scale Farmers in Oyo State

Figure 1 presents the distribution of CSAP adoption levels among small-scale farmers in Oyo State. Households were categorized into three levels of adoption based on the number of CSAPs adopted. The adoption score was computed by summing the number of practices each household adopted. Households that adopts less than three CSAP were classified as *low adopters*, those adopting between three and four practices were categorized as *medium adopters*, while those households adopting around five or more practices were classified as *high adopters*. The study revealed that majority (43.43%) of the small scale farming households in Oyo State were **medium adopters** of CSAP, equivalent to 152 farmers. This is followed by **high adopters**, who

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accounted for 32% (112 farmers), while **low adopters** represented the smallest group at 24.57% (86 farmers).

Though considerable proportion of farmers are moderately engaged with CSAP, there is still a significant number who have either adopted few practices or have not fully integrated them into their farming systems. The relatively lower proportion of low adopters indicates that there is a growing awareness and gradual circulation of CSAP among small-scale farmers in Oyo State. However, the fact that less than one-third of respondents are high adopters shows that there should be more campaign on CSAP benefits among small scale farmers so as to facilitate adoption of CSAP.

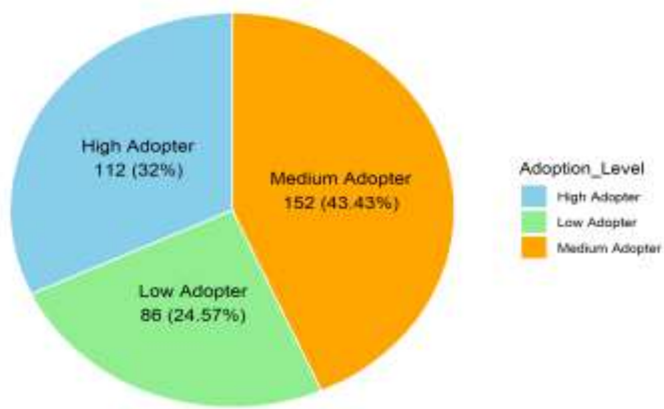

Figure 1. CSAP Adoption Levels among Oyo State Small Scale Farmers (N = 350)

Source: Authors' Computation from Field Survey 2025

Assessing Differences in Socio-Economic Characteristics across CSAP Adoption Categories.

The variation of socioeconomic characteristic of small scale farmers across various CSAP categories is presented in Table 2. The average age of respondents ranged from 45.1 to 47.1 years, this suggests that CSAP adoption is not strongly age-dependent. Similarly, gender distribution was uniform across the category, with males constituting 60%–63% of respondents. Educational attainment, however, differed significantly across adoption groups Farmers in the medium adoption category have a higher median of 10 years of schooling compared to 8 and 9 years for low and high adoption groups, respectively. Farm size was slightly larger among medium adopters (5.8 acres) compared to low (5.2 acres) and high adopters (5.7 acres), Household size and farming experience also showed no significant variation across categories This indicates that family labor availability and accumulated farming knowledge may not independently have a say on CSAP in the study area. Household income varied significantly across adoption categories. Contrary to expectation, medium adopters have the highest median annual income (₦305,532), while high adopters had comparatively lower incomes (₦264,012). This pattern may reflect the short-term financial burden associated with intensive adoption of CSAPs, as higher upfront costs and learning adjustments could reduce immediate income despite expected long-term gains (Mishra et al., 2024).

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Table 2. **Differences in Socio-economic Characteristics by CSAP Adoption Categories**

Variables	**Low Adoption (n=86)**	**Medium Adoption (n=152)**	**High Adoption (n=112)**
Age (mean ± SD)	45.1 ± 12.5	47.1 ± 13.2	46.3 ± 12.0
Gender (% male)	60%	63%	62%
Education (yrs, median)	8	10	9
Farm size (acres)	5.2	5.8	5.7
Income (₦ median)	278,084	305,532	264,012
Household size	6	5	6
Farm experience (yrs, mean)	18	20	19

Source: Authors' Computation from Field Survey 2025

Determinant of CSAP Adoption in Oyo State

The Poisson regression model was employed to analyze the determinants of CSAP adopted by smallholder farmers in Oyo State. The results as presented in Table 3 reveals that **education years has a** positive and highly significant effect on CSAP adoption. This implies that farmers with higher educational attainment are more likely to adopt a greater number of CSAPs. This may be due to the fact that higher education increases the awareness and openness to innovation, thereby facilitating uptake of CSAPs, This finding aligns with previous studies by Waaswa et.al (2021), *Alemayehu et al., (2024)*, which emphasize the role of education in enhancing farmers' capacity to understand and implement new technologies. Education is believed to improve awareness, access to information, and decision-making, thereby facilitating adoption. This finding also stresses the role of education in enhancing farmers' ability to acquire, process, and apply information on climate-smart practices (Asfaw & Maggio, 2018).

Gender also a statistically significant determinant of CSAP adoption in the area of study, the result indicates that male farmers are more likely to adopt CSAPs than female farmers. This may be due to the fact that male gender can easily access agricultural resources such as land, credit, and extension services and so on. This result corroborates earlier research highlighting gender gaps in technology adoption in Sub-Saharan Africa. This aligns with findings that while gender dynamics often affect access to resources, actual adoption decisions may be more strongly shaped by household and economic factors (Mutengwa et al., 2023). The findings from this study shows that age does not determine CSAP adoption, this is consistent with earlier findings by May et al., (2019); Ntshangase et. al, (2018) who submitted that both younger and older farmers are equally likely to adopt the practices when there are perceived benefit. Farm size was positively associated with CSAP adoption, although marginally significant. Larger farms may provide farmers with more flexibility and resources to experiment with and implement multiple practices. This result is consistent with findings by Musafiri et. al (2022), they submitted that resource endowment enhances adoption capacity; but contrary to Ojoko, et. al 2017 who state that farm size and CSAP adoption are negatively related, Income does not significantly influence CSAP adoption in the study area, the lack of significance for income may imply that adoption decisions are influenced by non-monetary factors such as institutional support and access to extension services rather than cash availability. This supports the submission by Abegunde et al., (2019b), Kassa and Abdi (2022) and contrary to findings by Negera et al., (2022).The model fit statistics show a reduction in deviance from the null deviance (206.01; df = 349) to the residual deviance (181.77; df = 342), indicating that the explanatory variables improved the model fit. The Akaike Information Criterion (AIC = 1269.3) further confirms the adequacy of the model.

Table 3: Determinants of CSAP Adoption in Oyo State

Variables	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	7.900e-01	1.818e-01	4.346	1.39e-05 ***
Age	1.221e-03	2.230e-03	0.548	0.58400
Gender	1.294e-01	5.986e-02	2.161	0.03067 *
Education Years	2.152e-02	5.861e-03	3.672	0.00024 ***
Household Size	5.026e-03	1.277e-02	0.394	0.69393
Farm Size Acres	1.993e-02	1.054e-02	1.891	0.05861 *
Farm Experience (Years)	1.120e-03	2.583e-03	0.434	0.66460 ***
Annual Income (Naira)	-8.568e-08	2.245e-07	-0.382	0.70272

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Null deviance: 206.01 on 349 degrees of freedom
Residual deviance: 181.77 on 342 degrees of freedom
AIC: 1269.3
Number of Fisher Scoring iterations: 4

Source: Authors’ Computation from Field Survey 2025

Effect of Climate smart Agriculture Practices on Food Security

Table 4 presents the regression estimates of the effect of CSAP on two indicators of household food security: Household Dietary Diversity Score (HDDS) and Food Consumption Score (FCS). The results show that adoption of CSAP significantly improves household food security. Households with medium adoption does not have any statistical significant effect on food security. Higher levels of adoption have stronger positive effects on dietary diversity and food consumption, suggesting that CSAP adoption enhances household food access and nutrition this supports the findings by Wekesa et. al (2018) and Nazifi et al., 2024). Age has no significant effect on either HDDS or FCS. Gender (male=1**)** was positive in both models but not statistically significant, implying that food security outcomes do not significantly differ between male- and female-headed households. Years of education had a significant negative effect on both HDDS ($p<0.05$) and FCS ($p<0.05$) this is in line with the findings by (Dembedza et.al, 2023) but contrary to expectations, suggesting that more educated household heads may diversify income sources away from farming, potentially reducing household reliance on self-produced food. Farm size had no significant effect on HDDS or FCS, while household income significantly improved both

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food security indicators ($p<0.05$), this shows the role of financial capacity on the enhancement of food security. Household size is negatively associated with both HDDS ($p<0.05$) and FCS ($p<0.01$), signifying that larger households face greater food security challenges. Farm experience had a positive and significant effect on HDDS ($p<0.01$) but a negative effect on FCS ($p<0.01$), this means that while experienced farmers diversify diets, they may face challenges in achieving consistently higher food consumption scores. The models explain a moderate proportion of the variation in household food security, with R^2 values of 0.280 for HDDS and 0.369 for FCS, showing that CSAP adoption and socioeconomic characteristics together significantly influence food security outcomes.

Table 4: Effect of CSAP Adoption on Food Security

	Household Dietary Diversity Score	Food Consumption Score
Medium Adoption	0.399	7.817***
	(0.335)	(2.758)
High Adoption	1.599***	13.167***
	(0.362)	(2.985)
Gender (Male=1)	0.253	1.156
	(0.270)	(2.225)
Years of Education	-0.059**	-0.506**
	(0.027)	(0.224)
Farm Size (Acres)	0.008	-0.245
	(0.048)	(0.399)
Annual Income (Naira)	0.073**	0.601**
	(0.034)	(0.311)
Household Size	-0.053**	-0.528***
	(0.059)	(0.482)
Farm Experience (Years)	0.039***	-0.089***
	(0.012)	(0.097)
Constant	4.584***	25.289***
	(0.810)	(6.678)

Note:*p<0.1; **p<0.05; ***p<0.01
Source: Authors' Computation 2025

Conclusion

Finding from this study maintained that the more small-scale farming households adopt CSAP practices, the more chances of being food secure they have. Also, CSAP has the potential to improve the alleviation of food insecurity among small-scale farming households. Small-scale farmers should be encouraged to adopt climate-smart practices This suggests that CSAP adoption is more strongly driven by knowledge and resource access than by demographic characteristics or household income. These findings underscore the importance of **investing in farmer education, promoting gender equity in**

resource access, and supporting smallholder farmers with adequate land and extension services to enhance the adoption of climate-smart practices and ensure long-term agricultural sustainability

Recommendations

Programs should emphasize moving farmers beyond basic awareness to full and sustained uptake of CSAP bundles, because high adoption yields the largest food security gains. CSAP should align within Nigeria's agricultural development frameworks

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