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PERCEIVED BENEFITS AND FACTORS INFLUENCING URBAN HOUSEHOLDS' CONSUMPTION OF CHARCOAL AS COOKING ENERGY SOURCE IN MAKURDI METROPOLIS, BENUE STATE, NIGERIA

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Abstract:

The study assessed perceived benefits and factors influencing urban households consumption of charcoal as a cooking energy source in Makurdi Metropolis, Benue State, Nigeria. The population of this study consisted of all consumers of Charcoal in Makurdi town. A cross-sectional survey design was employed, and data were collected from 400 respondents using a multistage sampling procedure. Primary data were obtained through structured questionnaire and interviews, and analyzed using descriptive and inferential Statistics. Findings from the study revealed that majority (70%) of the household heads were males, with a mean age of 45 years. Majority (67.5%) of the respondents were married, 70% were educated, and 35% had completed secondary or higher education. Households typically had six members, with 50% of the respondents engaged in farming. Charcoal use was widespread, with 70% of the respondents reporting regular use. Key perceived benefits of charcoal included affordability ($\bar{x}$= 4.00), ease of storage ($\bar{x}$= 4.45), suitability for long-duration cooking ($\bar{x}$= 4.05), and general availability. However,, drawbacks such as being time-consuming, producing dirt, and posing health risks due to indoor air pollution were also noted. Furthermore, the result revealed that majority (85%) of the respondents agreed that limited or unreliable electricity availability leads them to rely on charcoal, with a high mean score of 4.5. Affordability also emerged as a statistically significant factor ($p < .001$), with 60% of the respondents agreeing or strongly agreeing that charcoal is a cost-effective cooking option. It was found that majority (60%) of the respondents acknowledged that the nearness of charcoal vendors affected their usage patterns. A mean score of 3.7 suggests that accessibility and convenience play substantial roles in

consumers' decisions. The study concludes that charcoal use persists due to a combination of economic reality, cultural practices, and limited access to alternative energy sources. It recommends improving access to cleaner energy, advancing cookstove technologies, and implementing policy and behavioral interventions to facilitate a transition towards sustainable energy options.
Keywords: *Charcoal, Cooking energy, factors, Perceived benefits.*

1.0 Introduction

Charcoal remains an essential source of household energy worldwide, particularly in areas with limited access to modern alternatives. Over 2.4 billion people still depend on traditional biomass, such as charcoal and firewood, for cooking (FAO, 2017). In Sub-Saharan Africa (SSA), around 200 million people rely on charcoal, not only in rural communities, but also among urban middle-income families (Rose *et al.,* 2022; Castán Broto *et al.,* 2020). As Africa's urban population is expected to double by 2050 (UN, 2022), cities are under increasing pressure to meet rising energy demands, but many still face challenges like inadequate infrastructure and unreliable power supplies. For many, charcoal remains an accessible, affordable, and culturally integral option.

Despite policy initiatives to encourage clean energy as part of Sustainable Development Goal 7 (SDG 7), progress has been minimal; by 2021, only 16% of SSA households had access to clean cooking fuels (IEA *et al.,* 2021). The ongoing use of charcoal presents significant environmental hazards, including deforestation, soil degradation, and greenhouse gas emissions (Nnaji *et al.,* 2021). It also poses serious health risks, with pollutants from indoor burning contributing to respiratory and cardiovascular diseases, particularly among women and children (WHO, 2018). Nonetheless, charcoal plays a key economic role, providing jobs for millions through its informal production and supply chain (World Bank, 2011; UNEP, 2014).

In Nigeria, issues such as unreliable electricity, high LPG prices, and poverty impede the shift to cleaner fuels (Megbowon *et al.,* 2018; Sufiyan *et al.,* 2021). Even in urban areas like Makurdi, where alternatives are available, charcoal is often favored for its affordability, accessibility, and suitability for traditional cooking methods. However, its production leads to significant deforestation in Benue State, and its use in homes contributes to indoor air pollution. Previous studies in Nigeria typically focused on rural

settings or only consider fuelwood use, overlooking urban-specific factors influencing charcoal usage and the broader environmental and health context (Tsue *et al.,* 2016; Vihi *et al.,* 2022; Tee *et al.,* 2009).

Research often overlooks the perceived benefits that drive household fuel choices such as affordability, convenience, and cultural acceptability which are key to understanding user behavior. Moreover, few studies took a comprehensive approach that links socio-economic characteristics, environmental impacts, health risks, and policy dynamics. Consequently, gaps in local implementation and behavioral barriers to clean energy adoption remain insufficiently explored, particularly in urban centres like Makurdi.

2.0 Objectives of the Study

The broad objective of the study was to assess perceived benefits and factors influencing charcoal use among urban households in Makurdi metropolis.

The Specific objectives were to: (i) describ the socio-economic characteristics of Users of charcoal; (ii) identify perceived benefits associated with the use of charcoal as cooking fuel (iii) identify factors influencing the use of charcoal as a cooking energy source (iv) ascertain challenges associated with the use of charcoal as cooking fuel, and (v) determine the health implications of charcoal.

3.0 Methodology

The research was carried out in Makurdi Metropolis, the Capital city of Benue State, Nigeria. It was established in the early 20th century, it became a provincial headquarters in 1927 and was designated as the State capital with the creation of Benue State in 1976. As the largest urban centre in the State, Makurdi is situated between the latitudes 7°43' N and longitudes 8°32' E. The Makurdi Local Government Area (LGA) is surrounded by Guma to the North, Gwer East to the South, Gwer West to the West, and Doma LGA of Nasarawa State to the Northwest. According to the 2022 National Population Projection, Makurdi's population is estimated at 422,700 people.

The River Benue divides the city into two main areas: Makurdi North and Makurdi South. Located in the Guinea Savannah zone, a transitional ecological zone between the southern forests and northern grasslands, the area's vegetation is primarily composed of grasses, interspersed with scattered shrubs and small trees. Rapid urbanization, deforestation, and agricultural expansion have significantly changed the

natural landscape, with household energy demand, particularly for charcoal, increasingly driving wood extraction.

A multistage sampling technique was used to select 400 household respondents from Makurdi Metropolis. Initially, five council wards, namely: Agan, Fiidi, Wadata, Modern Market, and North Bank were randomly selected from the eleven existing wards using a simple random sampling method, giving each of the 11 wards an equal and unbiased chance of selection, thereby improving representativeness, reducing bias, and ensuring the feasibility of the multistage sampling process. This selection included a variety of Urban (Wadata, Modern Market, North Bank) and peri-urban/rural wards (Agan, Fiidi) to ensure demographic and spatial diversity. In the second stage, two rural communities were randomly selected from each of the five wards, yielding a total of ten rural communities.

In the third stage, to determine the number of households to be selected from each community, a proportionate sampling method was applied based on the estimated population size of each ward. This was to avoid assigning equal sample sizes to unequal populations, which could otherwise result in over-representation of smaller wards or under-representation of larger ones. Proportionate allocation ensured that larger wards contributed more households to the sample, reflecting their population size, while smaller wards contributed fewer.

Finally, within each selected community, households were chosen systematically using an interval derived from available household listings or street-based approximations. This systematic approach ensured randomization and reduced selection bias, resulting in a total sample size of 400 respondents

The study employed both primary and secondary data sources. Primary data were collected through structured questionnaire administered to household heads or informed adults within the selected households. The questionnaire included both open- and close-ended questions addressing socio-economic characteristics, energy usage patterns, perceived benefits, challenges, and health implications of charcoal use

The collected data were analyzed utilizing both descriptive and inferential statistics. Descriptive statistics, such as frequencies, percentages, and means, were used to summarize respondents' socio-economic characteristics and household energy profiles. Inferential statistics such as Chi-square (X^2) was also used for data analysis.

4.0 Results and Discussion

4.1 Socio-Economic Characteristics of Respondents in the Study Area

Table 1 shows that most (45%) of the respondents were aged 36–50 years, with a mean age of 45 years, indicating that energy decisions were largely made by mature, active household heads. Middle-aged individuals often bear financial responsibilities and manage cooking arrangements, influencing fuel choice.

Male respondents constituted 70%, highlighting gendered decision-making roles within households. While women were primarily responsible for cooking and may prefer cleaner energy, males had control over household income which likely determines the continued reliance on charcoal. This reflects the findings of Igbaukum *et al.,* (2024), who reported that although women used charcoal most, men influenced its purchase in patriarchal settings.

Majority (67.5%) of the respondents were married, which typically implies larger household sizes and greater energy demand. The household size averaged six people, with nearly equal distribution between 2–5 and 6–10 members. Larger households tend to favour bulk and affordable energy sources like charcoal, especially when incomes are modest.

Income levels further supported this trend, with 55% earning ₦20,001–₦50,000 monthly. This middle-income group remains price-sensitive, and thus more likely to rely on accessible fuels. Income constraints remain a central barrier to adopting cleaner energy options, a view reinforced by Igbaukum *et al.,* (2024).

Occupationally, 50% of respondents were farmers, suggesting an agrarian economic base. Farming households often opt for locally available, traditional fuels like charcoal due to cost and accessibility, as observed by Vihi *et al.* (2022). Educationally, 70% had at least secondary education, suggesting potential awareness of modern energy alternatives. However, the economic and infrastructural realities may hinder fuel switching despite awareness.

Finally, 70% reported regular charcoal use, affirming its dominance due to cost, availability, and cultural practices. This aligns with patterns in other urban centres across Sub-Saharan Africa where traditional fuels continue to prevail.

Table 1: Distribution of Respondents According to their Socio-Economic Characteristics (n = 400)

Variable	Category	Frequency	Percentage (%)	Mean
Age (Years)	23–35 years	110	27.5	45 yrs
	36–50 years	180	45.0	
	51–65 years	100	25.0	
	66–73 years	10	2.5	
Sex	Male	280	70.0	
	Female	120	30.0	
Marital Status	Single	90	22.5	
	Married	270	67.5	
	Divorced	20	5.0	
	Widowed	20	5.0	
Household Size	2–5 members	190	47.5	6
	6–10 members	190	47.5	
	11–15 members	20	5.0	
Monthly Income (₦)	1,500–5,000	50	12.5	₦31,447.50
	5,001–20,000	80	20.0	
	20,001–50,000	220	55.0	
	50,001–80,000	50	12.5	
Level of Education	Non formal edu.	60	15.0	
	Primary	60	15.0	
	Secondary	140	35.0	
	Tertiary	140	35.0	
Major Occupation				
	Farming	200	50.0	
	Civil Service	120	30.0	
	Business	40	10.0	
	Artisan	40	10.0	
Charcoal Usage				
	Yes	280	70.0	
	No	120	30.0	

Source: Field Survey 2025

4.2 Perceived Benefits of Using Charcoal as Cooking Fuel (n=400)

Table 2 revealed that charcoal was widely perceived as a cost-effective cooking fuel, with many respondents agreeing or strongly agreeing to this benefit. The mean score of 4.10 affirmed significant consensus on its affordability, aligning with Niambe *et al.* (2024), who noted charcoal's appeal among urban households due to its low cost and accessibility. Charcoal's solid form and non-perishable nature also contributed to its strong rating for ease of storage, with 85% of the respondents expressing agreement with a mean score of 4.45, one of the highest across measured variables.

While affordability and storability were strongly endorsed, the fuel's perceived availability showed mixed responses. A mean score of 3.4 indicated no significant agreement, suggesting regional or seasonal inconsistencies in supply. Additionally, the perception of cooking speed yielded less favorable feedback. A low score of 3.1 suggested that many users found charcoal inefficient in terms of quick meal preparation, despite its usefulness for long-duration cooking. This aligns with the high score (mean = 4.05) for time consumption, suggesting that charcoal is better suited for traditional dishes requiring prolonged heat. By and large, the respondents valued charcoal's economic and practical benefits, though concerns about speed and availability suggest trade-offs in daily use.

Table 2: Distribution of Respondents based on Perceived Benefits of Charcoal Us age (n=400)

Perceived Benefit	Response Distribution (%)	Mean	Std. Dev.	t-value	Sig. (2-tailed)
Cost Effectiveness	Undecided – 15.0%, Agree – 60.0%, Strongly Agree – 25.0%	4.10	0.63	19.191	0.000
Ready Availability	Disagree – 35.0%, Undecided – 5.0%, Agree – 45.0%, Strongly Agree – 15.0%	3.40	1.11	-1.794	0.074
Charcoal as a Fast Cooking Fuel	Strongly Disagree – 20.0%, Disagree – 10.0%, Undecided – 10.0%, Agree – 60.0%	3.10	1.22	-6.546	0.000
Ease of Storage	Undecided – 15.0%, Agree – 25.0%, Strongly Agree – 60.0%	4.45	0.74	25.646	0.000
Suitability for Long Cooking	Undecided – 35.0%, Agree – 25.0%, Strongly Agree – 40.0%	4.05	0.87	12.707	0.000

Source: Field survey (2025)

4.3 Factors Influencing Charcoal Consumption among Urban Households in Makurdi

Table 3 revealed that majority (85%) of respondents agreed that access to electricity influences their use of charcoal, with a mean score of 4.5, indicating a strong perception that unreliable or insufficient electricity supply encourages charcoal usage. This finding aligns with (Agada and Ogbodo (2020), who reported that electricity in Makurdi was often characterized by frequent outages, inconsistent supply, and limited reach, especially in densely populated or peri-urban communities.

The findings on the cost-effectiveness of charcoal as cooking fuel revealed that 60% of participants either agreed or strongly agreed that charcoal is affordable, with an average score of 4.00. This was found to be statistically significant ($p < .001$). These results support the Energy Ladder Model, which suggests that households generally prefer affordable energy sources when their income is limited. The proximity of charcoal vendors also significantly influences its usage, with 60% of the respondents acknowledging that nearby vendors affect their charcoal usage. An average score of 3.7 indicates that easy access to charcoal vendors strongly encourages its use. In summary, the main factors affecting charcoal usage in Makurdi were affordability, access to electricity, and availability of vendors, while cultural and traditional cooking practices had less influence.

Table 3: Perceived Factors Influencing Charcoal Us age in Makurdi town (n= 400)

Variable s	% Agreement¹	Mean	Std. Dev.	t (df=400)	Sig. (2 -tailed)	
Access to Electricity	85%	4.50	0.74	40.40.	.000	*
Affordability	60%	4.00	0.90	22.33	.000	*
Availability of Vendors	60%	3.70	0.64	21.84	.000	*
Preference for Traditional Cooking	—	3.00	0.00	—	—	
Cultural Practices	25%	2.85	0.96	-3.11	.002	

¹ % Agreement = Combined responses for "Agree" and "Strongly Agree"

Source: Field survey (2025).

4.4 Perceived challenges of charcoal use

Table 4 identified six primary challenges associated with charcoal usage in urban households in Makurdi. Interestingly, the cost of charcoal was not seen as a major concern. Only 35% of participants considered it pricey, while 45% were uncertain, and 20% disagreed. Although the average score (M = 3.10) was slightly above neutral, it was statistically significant, indicating that most users do not view charcoal as expensive. This finding contrasts with recent studies, such as Jinadu *et al.* (2019), which found cost to be a barrier in other Nigerian cities. This difference might be due to the relative affordability of charcoal in Makurdi compared to other fuel options.

Rainy weather was largely not seen as a hindrance, with 95% of those surveyed disagreeing or strongly disagreeing that rain affects charcoal usage. The low average score (Mean = 1.60) reflects a widespread dismissal of this issue, possibly because users employ strategies like cooking in covered areas or storing dry charcoal to address weather-related challenges.

A significant issue identified was the additional time required for using charcoal, with 85% of the respondents acknowledging it as time-consuming (Mean = 4.00). This supports findings by Mensah and Adu (2015), who noted time constraints as a major drawback of traditional fuels. Nevertheless, charcoal remains popular, likely due to its affordability and cooking efficiency.

The creation of dirty cooking environments was also recognized as an issue, with 65% agreeing that charcoal use leads to unclean conditions (Mean = 3.70). Participants noted

that ash and smoke from charcoal often compromise cleanliness, especially in poorly ventilated urban areas.

Lastly, lack of quality alternatives was identified as a considerable limitation, with 80% of the respondents agreeing (Mean = 3.60). This finding aligns with Guta (2014), who emphasized that limited access to cleaner and affordable fuels forces many households to continue relying on charcoal. This is consistent with the Energy Ladder Model, which suggests that energy choices are influenced by income levels and available infrastructure.

Table 4: Distribution of Respondents based on Perceived Challenges of Charcoal Us age (n=400)

Variables	Dominant Response(s)	Mean	Std. Dev.	t-value	p-value
High Price	Undecided (45%), Agree (30%)	3.10	0.996	- 8.030	0.000
Wet Weather	Disagree (50%), Strongly Disagree (45%)	1.60	0.584	- 65.088	0.000
Extra Time	Agree (70%), Strongly Agree (15%)	4.00	0.548	18.235	0.000
Dirty Cooking Area	Agree (60%), Undecided (35%)	3.70	0.557	7.175	0.000
Lack of Alternatives	Agree (80%)	3.60	0.801	2.497	0.013

Source: Field survey (2025)

4.5 Health implications of charcoal Usage

The perceived health and environmental issues connected to charcoal usage among urban households in Makurdi are presented in Table 5. Respiratory issues were recognized by 60% of the participants; however, the mean score (M = 3.50) and t-test result ($t \approx 0.042$, $p \approx 0.966$) indicated no statistically significant deviation from neutrality. This suggests that although the respondents were aware of potential respiratory concerns, their perception of risk was relatively mild. According to Amegah and Jaakkola (2016), such underreporting may stem from a lack of awareness or normalization of symptoms in households frequently exposed to biomass smoke.

Eye irritation, on the other hand, received moderate acknowledgment, with 60% agreement and a mean score of 3.2. The t-test outcome ($t = -5.564$, $p < .001$) showed a statistically significant deviation from the neutral value of 3.5, confirming that the respondents expressed notable concern regarding this issue.

There was the strongest agreement about the environmental impacts. A total of 100%

(with 85% agreeing and 15% strongly agreeing) believed that charcoal contributes to carbon emissions, showing the highest mean score (Mean = 4.15) and a highly significant t-value (t = 36.362; p < .001). Bailis *et al.,* (2015) and the International Energy Agency (IEA, 2022) confirmed charcoal's connection to deforestation and greenhouse gas emissions, which reflects an increasing awareness of climate change impacts in urban areas.

Concerns about child health were also significant, with 70% of the respondents agreeing that charcoal is harmful to children. The mean score (Mean = 3.65) and significant t-test result (t = 4.125, p < .001) emphasize this perception, perhaps due to children's vulnerability to indoor air pollutants.

Interestingly, while 80% were undecided about the notion that lack of alternatives maintains charcoal usage (Mean = 3.0), the t-test (t = -22.333, p < .001) suggests a broader dismissal of this assumption, indicating that affordability or habitual use may play more significant roles.

Table 5: Distribution of Respondents based on Perceived Health Implication of Charcoal(n=400)

Variable	Agree (%)	Undecided (%)	Disagree (%)	Mean	t-value	p-value
Breath Problems	60.0	30.0	10.0	3.50	0.000	1.00
Eye Irritation	60.0	10.0	30.0	3.20	-5.564	0.00
Carbon Emission	100.0	0.0	0.0	4.15	36.362	0.00
Child Health	70.0	20.0	10.0	3.65	4.125	0.00
Lack of Alternatives	10.0	80.0	10.0	3.00	-22.333	0.00

Source: Field Survey(2025)

Hypothesis Testing

The following null hypothesis was stated and tested.

H0: Socio-economic characteristics of respondents has no significant relationship with urban household consumption of charcoal.

The findings presented in Table 6 highlight the results of the Chi-square analysis, indicating a significant relationship between socio-economic factors and the use of charcoal. The Chi-square test for the variable of gender demonstrates a meaningful connection, as the calculated Chi-square value of 5.795 surpasses the critical threshold of 3.841 at the 0.05 significance level. This suggests that gender influences charcoal consumption, with a notably higher number of men (280) using charcoal compared to

women (70), even though the actual frequency for women is lower than anticipated (50 women not using charcoal).

In a similar vein, there is a noteworthy correlation between marital status and charcoal use. The Chi-square value of 15.37 is well above the critical value of 7.815, signifying that marital status impacts a household's choice to use charcoal. Single individuals (90) utilize charcoal far less than expected (61.54), whereas married individuals (270) exhibit higher-than-expected charcoal usage (180.77). This underscores the notion that marital status is linked to patterns of charcoal consumption.

Table 6: Chi-Square Test Summary for Socio-Economic Characteristics and Charcoal Usage (n=400)

Variable	Category	Observed (Yes)	Observed (No)	Expected (Yes)	Expected (No)	Chi-Square Value (Yes)	Chi-Square Value (No)	Total Chi-Square	df	Critical Value (α = 0.05)
Sex	Male	280	120	268.27	130.77	0.513	0.888	5.795	1	3.841
	Female	70	50	80.77	39.23	1.437	2.957			
Marital Status	Single	90	270	61.54	298.46	15.32	0.05	15.37	3	7.815
	Married	270	90	180.77	179.23	45.04	0.04			

Note *=Significant at 1% level Df =Degree of freedom: Ho is rejected at 0.05 levels.**
Source: Field survey (2025)

5.0 Conclusion and recommendations

5.1 Conclusion

This study assessed perceived benefits, and factors influencing usage of charcoal among urban households in Makurdi Metropolis, Benue State, Nigeria. The main findings revealed that charcoal remains the primary cooking fuel for approximately 70% of the respondents, driven by its affordability, availability, and cultural relevance. Most users were males, married, and between the ages of 36 and 50 years, indicating that energy choices in households are influenced by economically active, middle-aged individuals. Farming and civil service were the prevalent occupations, with over half of the respondents earning moderate monthly incomes ranging from ₦20,001 to ₦50,000, highlighting the preference for budget-friendly energy options. Charcoal's ease of storage and effectiveness for prolonged cooking durations significantly influenced user preference. Despite its advantages, the study found growing awareness of health and environmental hazards associated with charcoal usage.

5.2 Recommendations

Based on the findings of the study the following recommendations were made

i. Promote public awareness campaigns on the environmental and health impacts of

charcoal; Governmental and non-governmental organizations should initiate targeted educational programs that inform households of the risks associated with prolonged charcoal use, particularly regarding respiratory health and environmental degradation.

ii. Provide incentives for clean energy adoption: Policymakers should offer subsidies, microloans, or tax incentives to facilitate the transition to cleaner fuels such as LPG, biogas, or electricity, particularly for low-income households.

iii. Enhance access to sustainable alternatives: Investment in energy infrastructure and market reforms is essential to improve the affordability, reliability, and reach of alternative cooking fuels in Makurdi and similar urban areas.

iv. Integrate energy planning into urban development: Urban housing policies should require or support access to clean energy solutions in residential design and zoning rules. and

v. Support innovation in cooking technologies: Encouragement should be given to the local production of fuel-efficient, culturally suitable cookstoves to reduce charcoal use without disrupting traditional cooking methods

REFERENCES

Agada, F. A., and Ogbodo, C. M. (2020). Energy poverty and infrastructural limitations in North-Central Nigeria: A case study of Makurdi Metropolis. Energy Research and Social Science, 68, 101537.

Castán Broto, V., Baptista, I., Kirshner, J., Smith, S. and Alves, S. (2020). Energy poverty and access to infrastructure in the global South: Governance, politics, and policy. Routledge.

Energy Commission of Nigeria. (2020). National energy policy (Revised Edition). Abuja: Federal Ministry of Science and Technology.

Food and Agriculture Organization (FAO). (2017). The state of food and agriculture 2017: Leveraging food systems for inclusive rural transformation. FAO.

Guta, D. D. (2014). Effect of fuelwood scarcity and socio-economic factors on household bio-based energy use and energy substitution in rural Ethiopia. Energy Policy, 75, 217–227.

Igbaukum, S., Akenji, L. and Adewuyi, S. (2024). Gender and household fuel use: Insights from Benue State, Nigeria. Energy Policy, 67, 98–106.

International Energy Agency (IEA). (2022). World Energy Outlook 2022. https://www.iea.org/reports/world-energy-outlook-2022

International Energy Agency (IEA), World Bank, and United Nations Development

Programme. (2021). Tracking SDG 7: The energy progress report 2021. IEA. https://www.iea.org/reports/tracking-sdg-7-the-energy-progress-report-2021

Jinadu, A. M., Olorunfemi, F. B. and Adeyemo, O. (2019). Urban energy poverty and household fuel use in Nigeria: A case study of Ibadan Metropolis. *Journal of Geography and Regional Planning, 12(2), 23–31.*

Mensah, J. T., and Adu, G. (2015). An empirical analysis of household energy choice in Ghana. Renewable and Sustainable Energy Reviews, 51, 1402–1411.

Megbowon, E. T., Ajakaiye, D. O. and Adenikinju, A. (2018). Household energy choice and consumption intensity in Nigeria. Energy Policy, 114, 206–217.

Niambe, O. K., Gbaa, E. N., Niambe, R. S., Ityowuhe, G. T. and Kaa, A. E. (2024). Evaluation of charcoal usage and its influence on deforestation in Makurdi Metropolis, Benue State, Nigeria. *American Journal of Environment and Climate*, 3(2), 9–17.

Nnaji, C. E., Ukwuaba, S. I. and Osuagwu, J. C. (2021). Impact of charcoal production on the environment and rural livelihood in Nigeria: A case study of Benue State. Environmental Challenges, 5, 100250.

Rose, A., Jordan, M. and Adjei, M. (2022). Charcoal consumption in Sub-Saharan Africa: Trends, challenges, and policy responses. Energy Policy, 164, 112877.

Sufiyan, A. I., Olanrewaju, T. O. and Yusuf, T. A. (2021). Constraints to the adoption of clean cooking energy in Nigerian cities: Evidence from Ilorin metropolis. *Journal of Cleaner Production,* 278, 123944.

Tee, N.T, Ancha, P.U. and Asue, J. 2009: Evaluation of Fuelwood Consumption and Implications on the Environment: a case study of Makurdi area in Benue state. *Journal of Applied Biosciences 19: 1041 - 1048*

Tsue, P. T., Gidado, E. H. and Abah, D. (2016). Cooking energy demand among rural farmers in Gboko Local Government Area, Benue State, Nigeria. *Journal of Agricultural Economics, Extension and Science (JAEES),* 2(1), 71–80.

United Nations. (2022). World population prospects 2022: Highlights. United Nations. https://population.un.org/wpp/Publications/Files/WPP2022_Highlights.pdf

Vihi, S. K., Momoh, Y. O., Markwin, F. M., Chomini, E. A., Onuwa, G. C., Seilzing, P. M. and Ochelle, B. (2022). Analysis of household fuelwood consumption of cooking energy and the implications on the environment: A case of Vandeikya Local Government Area of Benue State, Nigeria. UMYU Scientifica, 1, 241–253.

World Health Organization (WHO). (2018). Household air pollution and health. WHO. https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health

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ASSESSMENT OF ADOPTION OF IMPROVED AGRICULTURAL TECHNOLOGIES AND HOUSEHOLD FOOD SECURITY AMONG FARMERS IN AKWA IBOM STATE, NIGERIA

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Abstract

The study assessed adoption of improved agricultural technologies and household food security among farmers in Akwa Ibom State, Nigeria. The Population of this study consisted of all rural farmers in Akwa Ibom State, Nigeria. Using a multistage sampling technique, 335 farmers were selected across six Local Government Areas and data were collected using a structured questionnaire. Analysis was conducted using descriptive statistics, Technology Adoption Index (TAI), food security measurement tools (HFIAS, HDDS, FCS) and multiple regression analysis. The findings revealed that the average age of farmers was 44.2 years old, with a mean farm size of 2.3 hectares, a monthly income of ₦82,700 and a household size of 5.6 persons, respectively. Based on Technology Adoption Index (TAI), 26.3% of the farmers had low adoption, 48.4% had medium adoption and 25.3% had high adoption levels. Food security assessment showed varied household outcomes regression results identified income, education, farm size and adoption level as significant predictors of food security ($P < 0.05$). The study concluded that moderate adoption of improved technologies was associated with improved food security outcomes among farming households. Based on the findings, it was recommended that agricultural extension services be strengthened to promote awareness and practical application of underutilized but impactful technologies such as irrigation and climate-smart practices which should be adopted.

Keywords: Assessment, Adoption, Improved Agricultural Technologies, Household, Food Security

1.0 Introduction

The global demand for sustainable food systems and enhanced agricultural productivity has increasingly underscored the critical role of improved agricultural technologies in addressing food security challenges, particularly in developing regions. Innovations such as improved seed varieties, mechanization, fertilizer application, pest control measures, irrigation systems and digital farming tools have demonstrated potential to boost crop yields, enhance resource use efficiency and reduce vulnerability of farming households to climatic and economic shocks (Rizzo *et al*., 2024; Adeyemo *et al*., 2024). However, diffusion and adoption of these technologies, vary widely due to multiple socio-economic, institutional and environmental factors (Bogado *et al*., 2024; Ruzzante *et al*., 2021).

Adoption is more than mere access to technology, it involves sustained use of innovations in daily agricultural practices (Fadeyi *et al*., 2022). Evidence suggests that adoption levels are influenced by demographic attributes (e.g., education, age), farming experience, market access, extension services and awareness about food security (Aboagye-Darko and Mkhize, 2025; Smidt and Jokonya, 2021). Consequently, understanding these drivers is essential for tailoring interventions that support agricultural transformation and ensure sustainable food systems.

Food security is defined by the FAO as a situation where all people have physical, social and economic access to sufficient, safe and nutritious food, remains a pressing concern in Sub-Saharan Africa (Onyeaka *et al*., 2024; Gassner *et al*., 2019). Despite the expansion of agricultural technologies, rural farming households continue to experience varying degrees of food insecurity due to low adoption rates, limited farm productivity and systemic inequalities (Ehiwario *et al*., 2024; Kimani, 2024). The linkage between technology adoption and food security outcomes has been acknowledged, but remains underexplored in context-specific settings, especially when considering the depth of multidimensional food security measures such as dietary diversity and access (Pawlak and Kołodziejczak, 2020; Eze and Abe, 2024).

Previous studies have affirmed that enhanced adoption of agricultural innovations can lead to improvements in food availability and access, thereby enhancing household welfare (Muzari, 2016; Chen and Li, 2022). However, the adoption process is often constrained by institutional limitations and socio-economic disparities, making it crucial to assess both the extent of technology use and its tangible effects on food security (Bello *et al*., 2024). An

understanding of these dynamics will inform policies aimed at transforming agriculture into a more inclusive and resilient sector.

In Akwa Ibom State, where agriculture remains a primary livelihood source, existing research suggests notable efforts in technology dissemination; yet, empirical data on actual adoption levels and food security outcomes remain sparse and fragmented. For example, Effiong and Iheme (2024) highlighted the role of media technologies in agricultural production, but do not delve into how these innovations translate into household food security. Asa (2023) provided valuable insights with determinants of food security, but did not explicitly account for the role of technology adoption. Furthermore, Kenneth and Abia (2018) focused on sustainable rural development but did not empirically evaluate specific technology adoption patterns or their direct food security implications. These gaps underscore the need for a comprehensive study that evaluates the types and levels of improved agricultural technologies adopted by farmers and investigates how these influence household food securities in the State.

2.0 The Objective of the Study

The broad objective of this study was to assess adoption of improved agricultural technologies and household food security among farmers in Akwa Ibom State, Nigeria. The specific objectives of the study were to:

i. describe the socio-economic characteristics of farmers.

ii. identify types of improved agricultural technologies, adoptedamong farmers.

iii. determine food security status of farming households in the study area.

iv. identify factors influencing household food security among farmers.

3.0 Methodology

3.1 The Study Area

The study was carried out in Akwa Ibom State, Nigeria. The State is located in the South-South geopolitical zone of the country. The State is bounded by Cross River State to the East, Abia State to the North, Rivers State to the West and the Atlantic Ocean to the South. Covering an area of approximately 7,081 square kilometers, Akwa Ibom is predominantly agrarian, with a large proportion of its population engaged in smallholder and subsistence farming. The target population comprised farmers registered with the All Farmers Association of Nigeria (AFAN),

Akwa Ibom State Chapter, who are actively involved in agricultural production across rural and urban communities in the State.

A multistage sampling technique was employed to select respondents for the study. First, six Local Government Areas (LGAs) were purposively selected. These include: Abak, Etinan, Eket, Ikot Ekpene, Oron and Uyo. These LGAs were chosen based on their high agricultural activity and the concentration of AFAN-registered farmers. In the second stage, 30% of the registered farmers were proportionately selected from each LGA, resulting in a total sample size of 335 respondents. The decision to use 30% was guided by Krejcie and Morgan's (1970) recommendation for determining adequate sample size from a known population, ensuring representativeness, while maintaining manageability for fieldwork.

Primary data were collected using a structured questionnaire data analysis was conducted using the Statistical Package for Social Sciences (SPSS) version 26. Descriptive statistics such as frequency counts, percentages, means and standard deviations were used to summarize socio-economic characteristics. For the assessment of the level of adoption of improved technologies, a Technology Adoption Index (TAI) was computed by assigning weighted scores to the frequency of adoption of various technologies using a Likert-type scale ranging from "Not Adopted" (1) to "Fully Adopted" (4). Farmers were then categorized into low, medium and high adopters based on their cumulative adoption scores using percentile cut-offs. To determine household food security status, three validated tools were employed: the Household Food Insecurity Access Scale (HFIAS), the Household Dietary Diversity Score (HDDS) and the Food Consumption Score (FCS). HFIAS scores were categorized into food secure, mildly insecure, moderately insecure and severely insecure based on FAO guidelines. HDDS classified respondents based on the number of different food groups consumed in the past 24 hours, while FCS was computed from the frequency and nutritional weight of food groups consumed over the past seven days. Cross-tabulations were used to explore the distribution of food security status across different adoption categories.

Multiple regression analysis was employed to identify the socio-economic and technological factors influencing household food security. The model was specified as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \epsilon$$

Where:

- Y = Household Food Security Score (dependent variable),
- X_1 to Xn = explanatory variables (age, gender, education level, household size, farm size, farming experience, monthly income and adoption level of improved technologies),
- β_0 = constant,
- β_1 to βn = coefficients of the explanatory variables,
- ϵ = error term.

This model enabled the estimation of the relative contribution of each variable to household food security outcomes.

4.0 Results and Discussion

4.1 Socio-economic Characteristics of Farmers

Table 1 shows that 32.8% of the farmers were aged 41–50 years, with a mean age of 44.2 years. Males made up 59.1% of the respondents. Education levels were relatively high—35.8% had secondary and 35.5% tertiary education, while only 8.7% had non formal education. Most farmers (42.7%) cultivated 1–2 hectares, with a mean farm size of 2.3 hectares. Monthly income averaged ₦82,700, with 42.7% earning ₦50,000–₦100,000. Households typically had 4–6 members (51.3%), with an average size of 5.6 persons. Farming experience averaged 11.4 years, with 32.8% having 6–10 years of experience.

The socio-economic profile of farmers in Akwa Ibom State, as reflects a population that is both relatively youthful and experienced in agricultural practice. With the majority aged between 31–50 years and an average age of 44.2 years, the farming population is largely within economically productive age brackets. This age structure presents a demographic advantage for the adoption of improved agricultural technologies, as younger and middle-aged farmers tend to be more open to innovation, consistent with Rogers' Diffusion of Innovation theory, which emphasizes the role of adopter categories in technology uptake.

The dominance (59.1%) of male respondents suggests a gender imbalance in farming participation, though the participation of females (40.9%) remains substantial. This observation supports findings by Lahai *et al*. (2000) and Awuor *et al*. (2021), who emphasized persistent gender disparities in agricultural participation and access to resources. While men are often more visible in farming, women's significant involvement highlights the importance of gender-

sensitive agricultural extension strategies to ensure inclusive technology dissemination and training.

The high level of formal education among the respondents, where over 70% had at least secondary education, indicates a relatively literate farming population. This has positive implications for technology adoption since educational attainment enhances farmers' capacity to access, interpret and apply agricultural innovations effectively, as supported by Sennuga *et al*. (2020) and Adeyemo *et al*. (2024). Educated farmers are more likely to benefit from extension services and adopt improved practices, which can boost productivity and resilience.

Table 1 also shows that most (42.7%) farmers were smallholders, with cultivating 1–2 hectares and a mean farm size of 2.3 hectares. This aligns with the structure of Nigerian agriculture, which is largely characterized by small-scale, subsistence-oriented production systems. The limited landholding capacity may constrain large-scale adoption of some capital-intensive technologies, yet the prevalence of smallholders also provides a strategic entry point for scalable, low-cost innovations suitable for small-scale production.

Table 1 further reveals that a substantial proportion (42.7%) earn between ₦50,000 and ₦100,000 monthly, while only 10.4% earn above ₦150,000. This moderate income profile underscores the importance of cost-effective technologies that are financially accessible. As Isiorhovoja *et al*. (2020) pointed out, farmers' economic behavior, particularly savings and investment capacity, influences their ability to invest in improved practices. Moreover, income levels affect household food security, reinforcing the need for technology packages that enhance productivity and profitability.

Table 1 also indicates that majority (51.3%) of the farming households had 4–6 members, with an average size of 5.6 persons. This moderate household size may provide adequate labor for farming activities, while also posing food security challenges if productivity is low. Larger households, although having more labor, require greater food and income resources, making adoption of yield-enhancing technologies critical for meeting family needs. The majority (61.8%) of the respondents had over six years of farming experience, with a mean of 11.4 years. Farming plays a significant role in farmers' decision-making and openness to innovation. As observed by Echebiri and Onu (2019), experienced farmers are better positioned to assess the risks and benefits associated with new technologies. However, prolonged reliance on traditional practices may also lead to resistance if innovations are perceived as complex or incompatible with existing systems.

Table 1: Socio-economic Characteristics of Farmers in Akwa Ibom State (n = 335

Variable	Category	No.	%	Mean
Age (years)	21–30	45	13.4	44.2
	31–40	82	24.5	
	41–50	110	32.8	
	51–60	72	21.5	
	>60	26	7.8	
Sex	Male	198	59.1	
	Female	137	40.9	
Educational Level	Non formal education	29	8.7	
	Primary	67	20.0	
	Secondary	120	35.8	
	Tertiary	119	35.5	
Farm Size (ha)	<1	81	24.2	2.3
	1–2	143	42.7	
	3–5	89	26.6	
	>5	22	6.5	
Monthly Income (₦)	<50,000	92	27.5	82,700
	50,000-100,000	143	42.7	
	100,001-150,000	65	19.4	
	>150,000	35	10.4	
Household Size	1–3	48	14.3	5.6
	4–6	172	51.3	
	7–9	89	26.6	
	>9	26	7.8	
Farming Experience	1–5 years	52	15.5	11.4
	6–10 years	110	32.8	
	11–15 years	97	29.0	
	>15 years	76	22.7	

4.2 Types of Improved Agricultural Technologies adopted Among Farmers

Table 2 shows that the most adopted technologies among 335 farmers were improved seeds (π = 3.43), chemical fertilizers (π = 3.31), and pest/disease control (π = 3.10), indicating high adoption. The least adopted were irrigation (π =1.66), agroforestry (π =1.79), and climate-smart technologies (π = 1.90), showing low adoption.

The findings revealed that improved seeds and chemical fertilizers were the most commonly adopted technologies among farmers in Akwa Ibom State. This pattern is consistent with the findings of Obayelu (2016), who noted high adoption rates of improved crop varieties and fertilizers among Nigerian smallholder farmers due to their direct and visible impact on yield and income. Similarly, Wainaina *et al*. (2016) highlighted that improved seeds and fertilizers often complement each other in enhancing farm productivity, which likely explains their widespread adopted among the farmers studied. The high adoption of pest and disease control methods aligns

with the findings of Akinwalere (2025), who emphasized the importance of integrated pest management practices in improving crop resilience and productivity among cocoa farmers in Ondo State, Nigeria.

On the other hand, the low adoption of irrigation technologies, agroforestry practices and climate-smart technologies points to a gap in technological diffusion in areas that address long-term sustainability and resilience to climate variability. This result corroborates the findings of Oladeji *et al*. (2023), who observed low adoption of climate-smart maize varieties in the Southern Guinea Savannah of Nigeria, attributing the trend to limited awareness, financial constraints and lack of institutional support. Likewise, Omotayo *et al*. (2023) found that adoption of agroforestry practices among smallholder farmers was hindered by low technical knowledge and inadequate access to extension services.

The moderate level of overall adoption among the majority of respondents reflects a similar pattern observed by Lawi *et al*. (2021) in Kilombero District, Tanzania, where most rice farmers exhibited a medium level of adoption due to gradual exposure to new technologies and limited access to credit and machinery. This suggests that while awareness and partial utilization of improved technologies are present, full integration across multiple technology types remains constrained.

Moreover, the relatively low mean scores for mechanized tools and soil conservation techniques suggest infrastructural and capital barriers. Madhukar *et al*. (2021) similarly identified capital investment, inadequate technical know-how and high maintenance costs as major barriers to the adoption of mechanized technologies. This implies that without targeted support mechanisms, the adoption of capital-intensive technologies may continue to lag in Akwa Ibom State.

Taken together, the adoption patterns observed support the premise of the Diffusion of Innovation Theory that adoption is not uniform but varies depending on individual farmer characteristics, the nature of the innovation and the enabling environment. This reinforces the findings of Masere and Worth (2022), who argued that innovation uptake among resource-constrained farmers is heavily influenced by socio-economic context, access to resources and perception of innovation benefits. The predominance of medium adopters in this study thus reflects the transitional state of technology diffusion in the area, where some innovations are well integrated, while others remain on the periphery due to systemic barriers.

Table 2: Distribution of Farmers According to Types of Improved Agricultural Technologies adopted (n = 335)

Technology Type	Not Adopted No. (%)	Rarely Adopted No. (%)	Often Adopted No. (%)	Fully Adopted No. (%)	Mean Score
Improved seeds	10 (3.0%)	22 (6.6%)	115 (34.3%)	188 (56.1%)	3.43
Chemical fertilizers	15 (4.5%)	30 (9.0%)	126 (37.6%)	164 (48.9%)	3.31
Organic fertilizers	140 (41.8%)	97 (29.0%)	66 (19.7%)	32 (9.6%)	1.96
Mechanized tools	125 (37.3%)	78 (23.3%)	78 (23.3%)	54 (16.1%)	2.18
Irrigation technologies	202 (60.3%)	67 (20.0%)	43 (12.8%)	23 (6.9%)	1.66
Pest and disease control methods	35 (10.4%)	39 (11.6%)	121 (36.1%)	140 (41.8%)	3.10
Post-harvest storage techniques	78 (23.3%)	82 (24.5%)	94 (28.1%)	81 (24.2%)	2.53
Agroforestry practices	180 (53.7%)	74 (22.1%)	51 (15.2%)	30 (9.0%)	1.79
Soil conservation techniques	113 (33.7%)	77 (23.0%)	78 (23.3%)	67 (20.0%)	2.30
Climate-smart technologies	160 (47.8%)	82 (24.5%)	58 (17.3%)	35 (10.4%)	1.90

4.3 Food Security Status of Farming Households in the Study Area

Table 3 shows that only 28.1% of households were food secure, while 71.9% experienced varying levels of food insecurity: mild (30.1%), moderate (25.4%), and severe (16.4%). Table 3 indicates a strong link between technology adoption and food security, 41.2% of high adopters were food secure, compared to 13.6% of low adopters. Severe food insecurity was highest among low adopters (30.7%).

Table 3 also sowed that 39.4% had high diversity, 42.4% medium, and 18.2% low. Table 3 further reveals that 47.1% of high adopters had high dietary diversity, compared to just 12.9% of low adopters. Conversely, 33.0% of low adopters had low dietary diversity, versus 12.9% of high adopters.

Based on WFP thresholds Table 3 shows that majority (56.7%) of households had acceptable food consumption, 29.3% were borderline, and 14.0% had poor consumption. Table 3 shows that 70.6% of high adopters had acceptable food consumption, compared to 34.1% of low adopters. Poor consumption was more common among low adopters (27.3%) than high adopters (7.1%).

The findings from this study demonstrate a clear pattern where higher adoption of improved

agricultural technologies is associated with better household food security outcomes. The HFIAS results showed that a substantial proportion of farming households experienced food insecurity, with 71.9% falling into mild, moderate, or severe food insecurity categories. This aligns with the findings of Kabalo *et al*. (2019), who reported seasonal fluctuations and high levels of food insecurity in rural Ethiopia, indicating that food insecurity remains a significant challenge in agrarian settings. The correlation between low technology adoption and increased food insecurity observed in this study is similarly reflected in their findings, as food insecurity was exacerbated by limited agricultural capacity and seasonal constraints.

The observed distribution across food insecurity categories supports earlier findings by Chinnakali *et al*. (2014), who reported high levels of food insecurity in urban resettlement areas in India and identified economic vulnerability and limited access to resources as key drivers. The pattern in this study, where low adopters were more likely to experience severe food insecurity, reinforces the assertion that access to and adoption of productivity-enhancing innovations can mitigate food insecurity among vulnerable households.

The HDDS analysis further supports the positive influence of improved technology adoption on dietary quality. High adopters exhibited higher dietary diversity, implying improved nutritional access and variety. This observation is consistent with the findings of Otekunrin *et al*. (2021), who emphasized the role of agricultural innovation in enhancing food and nutrition security. Their study concluded that improved technology adoption contributed significantly to access to diverse food groups, particularly protein-rich sources such as legumes, meat and fish. The relatively low consumption of milk products and eggs in the current study, despite moderate to high adoption rates, also resonates with their findings that economic factors, cultural practices and availability may still limit access to certain food groups even among households with acceptable dietary diversity.

Furthermore, the Food Consumption Score (FCS) results affirm that improved agricultural technology adoption positively influences overall food availability and dietary adequacy. The finding that 70.6% of high adopters had acceptable food consumption aligns with the evidence presented by Otekunrin *et al*. (2021), who observed similar improvements in food consumption patterns among adopters of improved technologies. The reduced proportion of poor consumption among high adopters in this study also mirrors their conclusion that agricultural interventions targeted at promoting adoption can serve as an effective tool to combat chronic food insecurity

and malnutrition.

Taken together, the results across all three food security indicators, HFIAS, HDDS and FCS, demonstrate consistency with the body of literature, particularly the studies by Kabalo *et al*. (2019), Chinnakali *et al*. (2014) and Otekunrin *et al*. (2021). These studies provide corroborative evidence that the adoption of improved agricultural technologies leads to enhanced food security outcomes by increasing food availability, accessibility and dietary quality. The findings from this study further underscore the importance of promoting technology dissemination and adoption among farming households to address persistent food insecurity and improve livelihoods in rural Nigeria.z

Table 3: Household Food Insecurity Access Scale (HFIAS) Classification of Respondents (n = 335)

Food Security Status	Score Range	No.	%
Food Secure	0 – 1	94	28.1%
Mildly Food Insecure	2 – 7	101	30.1%
Moderately Food Insecure	8 – 14	85	25.4%
Severely Food Insecure	15 – 27	55	16.4%
Total		**335**	**100.0**

Cross-tabulation of Food Security Status by Adoption of Improved Agricultural Technologies (n = 335)

Food Security Status	Low Adopters No. (%)	Medium Adopters No. (%)	High Adopters No. (%)
Food Secure (0–1)	12 (13.6%)	47 (29.0%)	35 (41.2%)
Mildly Food Insecure (2–7)	19 (21.6%)	61 (37.7%)	21 (24.7%)
Moderately Food Insecure (8–14)	30 (34.1%)	38 (23.5%)	17 (20.0%)
Severely Food Insecure (15–27)	27 (30.7%)	16 (9.9%)	12 (14.1%)
Total	88 (100.0%)	162 (100.0%)	85 (100.0%)

Household Dietary Diversity Score (HDDS) Categories of Respondents (n = 335)

Dietary Diversity Category	Food Groups Consumed	No.	%
Low Dietary Diversity	≤ 3	61	18.2%
Medium Dietary Diversity	4 – 5	142	42.4%
High Dietary Diversity	≥ 6	132	39.4%
Total		**335**	**100.0**

Cross-tabulation of Dietary Diversity by Adoption of Improved Agricultural Technologies (n = 335)

Dietary Diversity Category	Low Adopters No. (%)	Medium Adopters No. (%)	High Adopters No. (%)
Low Diversity (≤ 3)	29 (33.0%)	21 (13.0%)	11 (12.9%)
Medium Diversity (4 –5)	34 (38.6%)	74 (45.7%)	34 (40.0%)
High Diversity (≥ 6)	25 (28.4%)	67 (41.4%)	40 (47.1%)
Total	88 (100.0%)	162 (100.0%)	85 (100.0%)

Food Consumption Score (FCS) Classification of Respondents (n = 335)

Food Security Category	Score Range	No.	%
Poor Consumption	0 – 21	47	14.0%
Borderline Consumption	21.5 – 35	98	29.3%
Acceptable Consumption	> 35	190	56.7%
Total		**335**	**100.0**

Cross-tabulation of Food Consumption Score by Adoption of Improved Agricultural Technologies (n = 335)

Food Security Category	Low Adopters No. (%)	Medium Adopters No. (%)	High Adopters No. (%)
Poor Consumption (≤ 21)	24 (27.3%)	17 (10.5%)	6 (7.1%)
Borderline (21.5 –35)	34 (38.6%)	45 (27.8%)	19 (22.4%)
Acceptable (> 35)	30 (34.1%)	100 (61.7%)	60 (70.6%)
Total	88 (100.0%)	162 (100.0%)	85 (100.0%)

4.4 Factors Influencing Household Food Security Among Farmers

Table 4 shows that education, farm size, income, and adoption of improved technologies positively and significantly influenced household food security, while household size had a negative effect. Key predictors included education ($\beta = 0.146$, $p = 0.003$), farm size ($\beta = 0.278$, $p = 0.003$), income ($\beta = 0.00001$, $p = 0.001$), and adoption level ($\beta = 0.243$, $p = 0.000$). Household size negatively affected food security ($\beta = -0.109$, $p = 0.002$). The model explained 39.2% of the variation in food security (adjusted $R^2 = 0.392$, $p < 0.001$).

This finding agrees with Asa (2023), who identified educational attainment, income and adoption of improved agricultural practices as critical determinants of food security among rural households in Akwa Ibom State. Similarly, Ehiwario *et al*. (2024) affirmed that socio-economic and technological factors, particularly education and technology adoption, positively influenced food security status in Delta and Edo States. The significant positive relationship between education and food security corroborates the view of Oke and Ogundokun (2023), who found that education improves knowledge, decision-making and adoption of food security-enhancing practices among farming households in Oyo State.

The positive effect of farm size on food security aligns with of Kuwornu *et al*. (2013), who noted that larger farm sizes often translate into higher food production, leading to improved household food availability and access. Furthermore, Sarmin *et al*. (2024) in their comparative study in Bangladesh observed that households with larger landholdings and higher income levels reported better food security outcomes, thereby reinforcing the present study's result on the significance of farm size and income.

The finding that household size negatively affects food security is in line with Ukonu *et al*. (2024), who reported that larger households tend to experience more pressure on food resources, increasing the risk of food insecurity. This is also supported by Ingutia and Sumelius (2022), who identified household size as a critical constraint to food access and dietary adequacy in rural Kenya, especially when income and productivity are limited.

The strong positive association between the adoption level of improved agricultural technologies and food security resonates with the meta-analysis by Ruzzante *et al*. (2021), which concluded that adoption of improved technologies significantly contributes to increased agricultural productivity and household food security across developing countries. Bukchin and Kerret (2020) similarly emphasized that technology adoption enhances sustainability and food resilience among smallholder farmers, supporting the observed impact in this study.

The insignificance of sex, age and farming experience in this study contrasts with some previous findings. For instance, Chinnakali *et al*. (2014) found sex disparities in food security outcomes, suggesting that female-headed households were more vulnerable to food insecurity. However, the current study's insignificance of sex may indicate a narrowing of gender-based food security gaps in the study area. Additionally, the non-significant effect of farming experience diverges from Sariyev *et al*. (2025), who highlighted experience as an enabler of better resource management and adaptive strategies that promote food security...

Table 4: Multiple Regression Analysis Showing Factors Influencing Household Food Security among Farmers in Akwa Ibom State (n = 335)

Explanatory Variable	Unstandardized Coefficient (β)	Standard Error (SE)	Standardized Coefficient (β)	t-value	p-value
Age (years)	-0.021	0.019	-0.051	-1.105	0.270
Sex	0.384	0.272	0.059	1.412	0.159
Educational Level	0.146**	0.048	0.152	3.042	0.003
Household Size	-0.109**	0.035	-0.167	-3.114	0.002
Farm Size	0.278**	0.092	0.132	3.022	0.003
Farming Experience	0.035	0.028	0.058	1.250	0.212
Monthly Income	0.00001***	0.000003	0.198	3.333	0.001
Adoption Level of Improved Technologies	0.243***	0.055	0.215	4.418	0.000

Model Summary: $R = 0.637$; $R^2 = 0.406$; Adjusted $R^2 = 0.392$; $F(8, 326) = 27.80$; $p < 0.001$.

Note: *$p < 0.01$, $p < 0.05$, significant at 1% and 5% levels respectively.

5.0 Conclusion and Recommendations

5.1 Conclusion

The study assessed adoption of improved agricultural technologies and household food security among farmers in Akwa Ibom State, Nigeria. Findings revealed that while a majority of farmers had adopted key technologies such as improved seeds, chemical fertilizers and pest and disease control methods, the adoption of irrigation, agroforestry and climate-smart technologies remained significantly low.

Food security analysis indicated that only 28.1% of the farming households were food secure, with the majority experiencing mild to severe levels of food insecurity. A significant relationship was observed between technology adoption and food security status, as farmers with high adoption levels were more likely to be food secure. The study concludes that increased adoption of improved agricultural technologies plays a critical role in enhancing household food security among farming households.

5.2 Recommendations

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

i. Enhance Access and Incentives for Low-Adopted Technologies: Government and development agencies should promote adoption of low-utilized, but impactful technologies such as irrigation systems, climate-smart practices and agroforestry through subsidized inputs, awareness campaigns and demonstration farms. These interventions are crucial for year-round production and long-term food security resilience.

ii. Strengthen Agricultural Extension Services: Agricultural extension agents should be adequately trained and deployed to provide tailored support and capacity-building programs for farmers, especially in underutilized technologies. Continuous education will help farmers understand the benefits and practical application of these technologies to improve adoption rates. and

iii. Promote Farmer-Led Technology Clusters: Encouraging formation of farmer groups or cooperatives that focus on specific improved technologies can foster peer learning and collective investment. These clusters can serve as innovation hubs that accelerate adoption and, consequently, improve food availability, diversity and household nutrition outcomes.

References

Aboagye-Darko, D. and Mkhize, P. (2025). Unearthing the determinants of digital innovation adoption in the agricultural sector: The role of food security awareness and agricultural experience. *Heliyon, 11*(1), 1 – 12.

Adeyemo, J. T., Ahmed, A., Abaver, D. T., Riyadh, H. A., Tabash, M. I. and Lawal, A. I. (2024). Technological innovation and agricultural productivity in Nigeria amidst oil transition: ARDL analysis. *Economies, 12*(9), 253 – 267.

Akinwalere, B. O. (2025). Role of agricultural extension service in the adoption of integrated pest management practices among cocoa farmers in Ondo State, Nigeria. *International Journal of Applied Science and Research, 42*, 1 – 9.

Asa, U. (2023). Determinants of food security status of farming households in rural areas of Akwa Ibom State, Nigeria. *Indo-Am. J. Agric. and Vet. Sci.,* 4(2), 1 – 10.

Awuor, J. O., Mulwa, R. M. S. and Openda, N. O. (2021). Gender disparity in cassava farmers' access to agricultural productive resources in Rongo Sub County, Migori County, Kenya. *African Journal of Agricultural Research, 17*(9), 1161–1171.

Bello, M., Yahaya, J. and Adamu, I. (2024). An analysis of sustainable agricultural productivity and food security in Nigeria. *2*, 2992–4618.

Bogado, A. C. S., Estrada-Carmona, N., Beillouin, D., Chéron-Bessou, C., Rapidel, B. and Jones, S. K. (2024). Farming for the future: Understanding factors enabling the

adoption of diversified farming systems. *Global Food Security, 43*, 1 – 13.

Bukchin, S. and Kerret, D. (2020). Character strengths and sustainable technology adoption by smallholder farmers. *Heliyon, 6*(8), 1 – 8.

Chen, X. and Li, T. (2022). Diffusion of agricultural technology innovation: Research progress of innovation diffusion in Chinese agricultural science and technology parks. *Sustainability, 14*(22), 45 – 59.

Chinnakali, P., Upadhyay, R. P., Shokeen, D., Singh, K., Kaur, M., Singh, A. K., Goswami, A., Yadav, K. and Pandav, C. S. (2014). Prevalence of household-level food insecurity and its determinants in an urban resettlement colony in north India. *Journal of Health, Population and Nutrition, 32*(2), 227–236.

Echebiri, R. N. and Onu, D. O. (2019). Risk management strategies among smallholder arable crop farmers in Ibiono Ibom Local Government Area, Akwa Ibom State, Nigeria. *Nigerian Agricultural Journal, 50*(1), 22–29.

Effiong B. J., Iheme N. M. (2024). Effectiveness of New Media Technologies on Agricultural Production among Rural Households in Akwa Ibom State, Nigeria. *Agricultural Science Digest. 44*(6), 1050-1055

Ehiwario, F. A., Onemolease, E. and Onyemekonwu, R. C. (2024). Socio-economic and technological factors affecting food security among farming households in Delta and Edo States, Nigeria: Technology adoption in agricultural extension. *Journal of Agricultural Extension, 28*(3), 88–97.

Eze, F. and Abe, G. (2024). Green agricultural technology and food security: Implications for Nigeria. *African Journal of Agriculture and Food Science, 7*, 389–410.

Fadeyi, O., Ariyawardana, A. and Aziz, A. (2022). Factors influencing technology adoption among smallholder farmers: A systematic review in Africa. *Journal of Agriculture and Rural Development in the Tropics and Subtropics, 123*, 13–30.

Gassner, A., Harris, D., Mausch, K., Terheggen, A., Lopes, C., Finlayson, R. F. and Dobie, P. (2019). Poverty eradication and food security through agriculture in Africa: Rethinking objectives and entry points. *Outlook on Agriculture, 48*(4), 309–315.

Isiorhovoja, R. A., Ebewore, S. O. and Nwachi, S. (2020). Farmers' attitude and behavior toward savings in Ika South Local Government Area of Delta State, Nigeria. *Asian Journal of Agriculture and Rural Development, 10*(1), 406–419.

Kabalo, B. Y., Gebreyesus, S. H. and Loha, E. (2019). Performance of an adapted household food insecurity access scale in measuring seasonality in household food insecurity in rural Ethiopia: A cohort analysis. *BMC Nutrition, 5*, 54 – 63.

Kenneth, B. and Abia, R. (2018). Agriculture and sustainable rural development in Ini Local Government Area of Akwa Ibom State, Nigeria. *International Journal of Advance Research and Innovative Ideas in Education, 4*, 1 – 8.

Kimani, S. (2024). The role of agricultural innovation in enhancing food security in Sub-Saharan Africa. *International Journal of Developing Country Studies, 6*, 58–73.

Kohles, J. C., Bligh, M. C. and Carsten, M. K. (2013). The vision integration process: Applying Rogers' diffusion of innovations theory to leader–follower communications. *Leadership, 9*(4), 466–485.

Lahai, B. A. N., Goldey, P. and Jones, G. E. (2000). The gender of the extension agent and farmers' access to and participation in agricultural extension in Nigeria. *The Journal of Agricultural Education and Extension, 6*(4), 223–233.

Lawi, S. M., Mtae, H. G. and Haule, C. (2021). Levels of adoption of new rice farm management technologies among smallholder farmers in Kilombero District, Tanzania. *International Journal of Agricultural Policy and Research, 9*(7), 173–181.

Madhukar, B., Reddy, P. B., Lakshmi, T. and Yammela, R. (2021). Constraints in adoption of farm mechanization and suggestions to overcome the constraints. *Journal Title Missing*, *Volume Missing*, 376–379.

Mesa, R. and Esparcia, J. (2023). Theoretical framework and methods for the analysis of the adoption-diffusion of innovations in agriculture: A bibliometric review. *Boletín de la Asociación de Geógrafos Españoles*, *96*, 1 - 13.

Muzari, W. (2016). Agricultural productivity and food security in Sub-Saharan Africa. *International Journal of Science and Research (IJSR), 5*, 1769–1776.

Obayelu, A. (2016). Determinants and the perceived effects of adoption of selected improved food crop technologies by smallholder farmers along the value chain in Nigeria. *Journal of Agriculture and Environment for International Development, 110*, 155–172.

Oke, M. A. and Ogundokun, E. O. (n.d.). Assessment of households' socio-economic characteristics and food security status in Atiba Local Government Area of Oyo State. *Journal of Agricultural Science and Food Research, 11*(1), 40–67.

Omotayo, A., Bayei, J., Aluwong, S., Makarau, B., Ojokojo, P., Olumuyiwa, S. and Ibeh, C. (2023). Farm level adoption of agroforestry production technology among smallholder farmers in Kaduna State, Nigeria**.** *Australian Journal of Science and Technology, 7*(2), 87 – 93.

Onyeaka, H., Siyanbola, K. F. and Akinsemolu, A. A. (2024). Promoting equity and justice: Harnessing the right to food for Africa's food security. *Agriculture and Food Security, 13*, 52 – 68.

Pawlak, K. and Kołodziejczak, M. (2020). The role of agriculture in ensuring food security in developing countries: Considerations in the context of the problem of sustainable food production. *Sustainability, 12*(13), 5488 – 5497.

Rizzo, G., Migliore, G. and Schifani, G. (2024). Key factors influencing farmers' adoption of sustainable innovations: A systematic literature review and research agenda. *Organic Agriculture, 14*, 57–84.

Ruzzante, S., Labarta, R. and Bilton, A. (2021). Adoption of agricultural technology in the developing world: A meta-analysis of the empirical literature. *World Development, 146*, 1 – 12.

Sariyev, O., Asravor, J. and Zeller, M. (2025). Poverty and food security impacts of sustainable intensification: Evidence from Ethiopia. *Food Security, 17*, 405–420.

Sennuga, O., Olayemi and Oyewole, S. O. (2020). Exploring the effectiveness of agricultural technologies training among smallholder farmers in Sub-Saharan African communities. *European Journal of Training and Development, 7*, 1–15.

Smidt, H. J. and Jokonya, O. (2021). Factors affecting digital technology adoption by small-scale farmers in agriculture value chains (AVCs) in South Africa. *Information Technology for Development, 28*(3), 558–584.

Wainaina, P., Tongruksawattana, S. and Qaim, M. (2016). Tradeoffs and complementarities in the adoption of improved seeds, fertilizer and natural resource management technologies in Kenya. *International Association of Agricultural Economists, 47*(3), 351-362.