EFFECT OF FINANCIAL INCLUSION ON FOOD SECURITY AMONG RURAL WOMEN FARMERS IN SOUTH EAST NIGERIA: A STYLED NESTED MODELLING APPROACH

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Abstract
The study assesses the impact of financial inclusion on food security among rural women farmers in Southeast Nigeria. A total of 266 rural women farmers participated in the research, which relied on primary data collected through a semi-structured questionnaire. The study spanned from August 2021 to August 2023. Various statistical methods, including Ordinary Least Squares (OLS) multiple regression, binary logistic regression, and ordinal probit regression, were employed to achieve the study's objectives. The findings reveal that 41.7% of the participants were food secure, while 58.3% were food insecure. There were significant differences in calorie consumption between the two groups, with food-secure households consuming significantly more calories than food-insecure households. The mean calorie consumption was 3,776.6 Kcal for food-secure households and 1,378 kcal for food-insecure households. In the Ordinary Least Squares multiple regression analysis, factors such as ownership of commercial bank accounts, savings within the past 12 months, farm income, and the proportion of credit utilized for its intended purpose were found to have a significant positive effect on the food security index of rural women farmers. The binary logistic regression model indicated significant associations between savings, access to professional financial advice, and credit utilization with food security levels. Similarly, the ordinal probit regression model showed that the explanatory variables jointly explained variations in food security levels, with mobile banking usage and ownership of commercial bank accounts emerging as significant factors. Overall, the study highlights the need for targeted government intervention—such as the provision of soft loans, grants, and incentives—alongside strengthened financial inclusion policies to alleviate food insecurity among rural women farmers.

Keywords: Financial Inclusion, Food Security Levels, Rural, Women, Farmers

INTRODUCTION

Smallholder farmers make up the majority of the agricultural sector in Nigeria, but their ability to expand their operations in terms of scale is constrained by their limited access to resources and poor income (Louis & Chartier, 2017). Agriculture's production has decreased as a result (Amoah, Korle, & Asiama, 2020). The primary barrier to agricultural growth has been identified as access to money, in addition to the various challenge's smallholder farmers confront in agricultural production. Typically, established financial organizations are the sources of funding for commercial agricultural output. Commercial banks, development banks, credit cooperatives, microfinance, and other savings institutions are only a few of the financial institutions in Nigeria (Cessda, Eric, NSD, Cessda, NSD, Nidi & Cessda, 2020). However, Commercial banks, microfinance banks, registered cooperatives, and development banks are the official financial institutions that are accessible to agricultural services (Dar & Ahmed, 2020). In addition to playing a crucial role in agricultural transformation, financial inclusion also plays a significant role in poverty reduction, commercialization of agriculture, food security, livelihood development, and lowering the vulnerability of the poor, particularly rural women (Demirguc-kunt, Klapper, Singer, Ansar, & Hess, 2018; Shemelis, 2019).

According to Masiyandima, Mlambo, and Nyarota (2017), financial inclusion entails providing low-income and unbanked members of society with financial services at reasonable prices. The capacity of people to utilize relevant mainstream financial goods and services is referred to as financial inclusion. Individuals need a variety of abilities, knowledge, and confidence in order to acquire and use financial goods, as well as access to a wide variety of suitable financial products in the financial mainstream. According to this definition of financial inclusion, a variety of actors—including people themselves, the government, and financial institutions—are responsible for advancing financial inclusion. These actors also work to improve people's lives through social policies and the provision of financial products. It is the antithesis of financial exclusion, which occurs when some categories of economic agents, notably low-income members of society, are not able to access or afford such services (Mhlanga, 2020a).

Theoretically, greater access to deposit facilities enhances the ability of financial intermediaries to mobilise savings, while better access to finance facilitates (financial inclusion) ensures economic growth by

increasing the ability of rural women farmers to undertake productive investments (Gebrehiwot & Makina, 2019). Prymostka, Krasnova, Prymostka, Nikitin, and Shevaldina (2020) noted further that access to a well-functioning financial system, by creating equal opportunities, enables socially and economically excluded people to integrate into the economy and actively contribute to economic development. This guarantees that the financial sector fulfils its responsibility for equitable growth, one of the key issues facing emerging and developing countries (Kaur, & Kapuria, 2020). When rural women farmers are excluded and marginalized from the financial system, an agricultural economy as a whole cannot thrive since they are the true foundation of the economy (Mhlanga & Dunga, 2020). Therefore, progress in financial inclusion is a special channel that may be utilized to formulate monetary policy in order to achieve its objectives (Cámara & Tuesta, 2018; Riley, 2019; World Bank, 2018; Ogundele & Badmus, 2020). Improving rural women's access to financial services or financial inclusion is a proven strategy for contributing to rural women's social and economic empowerment, as well as improving the livelihoods, food security, poverty escape and commercialization of their rural investment (Wokabi, 2019). Being financially included allows rural women to procure the inputs, labour and equipment they need for their agricultural or rural off-farm activities (Amurtiya, Yuniyus, Mark, & Zubaira, 2018). However, the availability of financial services is limited in rural areas, and the existing financial services intended for rural communities rarely benefit rural women (Anthonia, 2016). Women's access to these services is constrained by sociocultural, economic/legal and in some cases educational barriers which drastically affects sustainable development (Etim, Eyo & Enimu, 2017).

According to World Bank (2018), financial inclusion has been identified as a way to achieve 7 of the 17 Sustainable Development Goals (SDGs) [eliminating extreme poverty (SDG 1), reducing hunger and promoting food security (SDG 2), achieving good health and well-being (SDG 3), fostering quality education (SDG 4), promoting gender equality (SDG 5), promoting shared economic growth (SDG 8), and promoting innovation and sustainable industrialization (SDG 9)] (Farmers' Organization of the United Nations, 2017). Financial inclusion is crucial to strengthening people's livelihoods and, consequently, reducing poverty, enhancing food security, and improving food security, provides more evidence in support. According to Obisesan and Adeyonu (2018), the inability to obtain wholesome food in socially acceptable ways might be interpreted as food insecurity. The major objective of development agricultural economics, according to Olaniyi and Olaniyi (2017), also include discovering solutions to escape the semi-subsistence poverty trap that many rural women farmers especially rice and cassava farmers appear to be caught in. Rural rice and cassava women farmers face significant challenges when it comes to financial inclusion. These challenges can include limited access to formal financial institutions, lack of financial literacy and awareness, cultural and social barriers, and limited economic opportunities. Without access to financial services, these farmers struggle to diversify their income sources and improve their overall financial well-being making them food insecure. The research gap in this study lies in the limited focus on the intersection between financial inclusion and food security among rural women farmers in the specific context of Southeast Nigeria. While existing literature acknowledges the importance of financial inclusion for agricultural development and food security, there is a lack of comprehensive studies specifically targeting rural women farmers in this region. This research addresses this gap by examining the nuanced relationship between financial inclusion factors and food security outcomes among rural women farmers, providing insights that are essential for designing targeted interventions and policies to alleviate food insecurity and promote sustainable agricultural development. Furthermore, the study employs a combination of quantitative methods, including OLS multiple regression, Binary Logistic, and Ordinal Probit regression, to explore these dynamics comprehensively, thus contributing to filling the gap in empirical evidence on this critical issue. Given the foregoing, the following question is attempted to be addressed by this study:

i. what is the food security index, status and level of rural women farmers and
ii. what financial factors influencing their food insecurity?
iii. what financial factors influencing their food levels?

Objectives of the study

The broad objective of the study is to assess the effect of financial inclusion on levels of food security among rural women farmers in South east, Nigeria. The specific objective of the study is to examine the financial inclusion factors influencing food security index, status and levels of rural women farmers.

Structure of the study

Having outlined the background and objectives of the study. The study synthesized relevant existing literature to establish the theoretical framework. Following this, the methodology section details research design, data collection methods, sampling techniques, and analytical procedures, ensuring replicability. Findings were presented in the results section using tables, graphs, or statistical analyses. The discussion interprets these results within the context of research questions or hypotheses, addressing implications, limitations, and future directions. Lastly, the conclusion highlights key findings, their significance, and potential implications for theory, practice, or policy, while references list all cited sources according to a specific citation style. Choosing women rural

farmers as research respondents offers unique insights into gender disparities within agriculture and rural communities. By focusing on women, the study can better understand the specific challenges they face in accessing financial services, allocating resources within households, and ensuring food security for their families. This approach enables policymakers to develop targeted interventions that address the needs of women farmers, ultimately promoting gender equality, empowering women, and improving agricultural development outcomes. Overall, studying women rural farmers contributes to a more comprehensive understanding of agricultural livelihoods and facilitates efforts to achieve sustainable rural development and food security.

LITERATURE REVIEW

Financial inclusion and food security are two crucial dimensions that intersect in the context of rural development, particularly in regions like Southeast Nigeria where agriculture serves as a primary livelihood for many households. This literature review aims to explore existing studies and insights on the relationship between financial inclusion and food security among rural women farmers.

Financial Inclusion

Financial inclusion refers to the accessibility and availability of financial services, including banking, credit, savings, and insurance, to individuals and businesses, especially those in underserved or marginalized communities. In rural areas, financial inclusion plays a pivotal role in fostering economic growth, poverty reduction, and livelihood improvement by providing farmers with the necessary tools and resources to invest in their agricultural activities. Several studies have highlighted the significance of financial inclusion in enhancing the economic well-being of rural communities. For instance, research by Dar and Ahmed, (2021) ascertained the determinants of informal financial activities in India. A study by Kuznyetsova et al. (2022) focused on the development peculiarities of financial inclusion in relation to ensuring financial stability and provides recommendations to Ukraine.

Food Security

Food security encompasses the availability, accessibility, and affordability of nutritious food for individuals and households. In rural settings heavily reliant on agriculture, food security is intricately linked to agricultural productivity, income levels, market access, and social welfare systems. While agriculture serves as a primary source of livelihood for many rural households, food insecurity remains a persistent challenge, particularly among vulnerable groups such as women farmers. Numerous studies have examined the determinants and dimensions of food security in rural contexts. For example, Olanrewaju and Balana (2023) reviewed and synthesized the nature, spatial extent, and implications of conflicts on food security in Nigeria. Similarly, Chidiebere-Mark et al. (2022) aassessed the food security status and nutrition of smallholder farming households in Imo State, South-East Nigeria. We identified sources of food availability of the households, determined the food security status of the farming households and also determined factors affecting the food security status of the farmers. Also, Ingutia and Sumelius, (2022) addressed the determinants of food security status with reference to women farmers, the determinants of access to irrigation technology as a critical determinant of food security and the effect of cooperatives on nutritional status.

Intersection of Financial Inclusion and Food Security

The relationship between financial inclusion and food security among rural women farmers is multifaceted and dynamic. Financial inclusion can contribute to food security by providing farmers with access to credit for agricultural inputs, savings mechanisms for consumption smoothing, and insurance products to mitigate production risks. However, barriers such as limited financial literacy, inadequate infrastructure, and gender-based constraints may hinder women's participation in formal financial systems, thereby exacerbating food insecurity.

Recent studies have explored the nexus between financial inclusion and food security outcomes among rural women farmers. For instance, Oseni et al. (2019) examines the impact of microfinance services on women's empowerment and household food security in rural Nigeria, highlighting the positive association between access to credit and dietary diversity. Similarly, Akinola et al. (2020) investigate the role of mobile banking in enhancing food security among women farmers in Sub-Saharan Africa, emphasizing the potential of digital financial services to improve market access and income generation opportunities. Overall, while there is growing recognition of the importance of financial inclusion in promoting food security among rural women farmers, gaps remain in understanding the specific mechanisms and pathways through which financial services can effectively address underlying drivers of food insecurity. Further research is needed to explore context-specific interventions and policy strategies that leverage financial inclusion to empower women farmers, enhance agricultural productivity, and ensure sustainable food systems in Southeast Nigeria and similar regions.

Theoretical framework

These theoretical frameworks provide valuable insights into the complex dynamics linking financial inclusion and food security among rural women farmers in Southeast Nigeria.

Amartya Sen's Capability Approach: This framework emphasizes individuals' capabilities to achieve valuable functioning, including adequate nutrition and food security. Sen argues that access to resources, such as financial services, plays a crucial role in expanding individuals' capabilities, thereby influencing their ability to secure food and other basic needs (Sen, 1999). In the context of rural women farmers, financial inclusion can enhance their capability to invest in agricultural inputs, diversify income sources, and cope with shocks, ultimately contributing to improved food security.

Household Production Theory: This theory posits that households allocate resources to maximize utility, including food consumption (Becker, 1965). Financial inclusion can affect household production decisions by providing access to credit, savings, and insurance, which influence agricultural productivity, income levels, and consumption patterns (Hoddinott & Haddad, 1995). For rural women farmers, access to financial services can enable them to invest in productive assets, smooth consumption during lean periods, and improve overall household food security.

Feminist Economics Perspective: This perspective highlights the gendered dimensions of economic processes and outcomes, including access to financial resources and food security (Elson, 1991). Gender inequalities in access to financial services, land ownership, and decision-making power can exacerbate food insecurity among rural women farmers (Agarwal, 1997). Financial inclusion interventions should consider these gender disparities and address structural barriers to empower women economically, enhance their agency, and improve household food security outcomes.

Social Capital Theory: Social capital refers to the networks, norms, and trust within communities that facilitate cooperation and collective action (Putnam, 1993). Access to financial services can strengthen social capital among rural women farmers by promoting financial literacy, facilitating savings and credit groups, and fostering community-based initiatives for agricultural development (Woolcock & Narayan, 2000). Stronger social networks and support systems can enhance resilience to food insecurity by facilitating resource sharing, information exchange, and collective problem-solving.

Asset-based Livelihoods Approach: This approach focuses on individuals' assets, including human, social, natural, physical, and financial capital, and their contribution to livelihood strategies and well-being (Carney, 1998). Financial inclusion interventions can be viewed as strategies to build and diversify assets among rural women farmers, enabling them to enhance their livelihoods and food security through investments, savings, and risk management (De Janvry & Sadoulet, 2002). By strengthening asset portfolios, financial inclusion can empower women to better cope with food insecurity and improve their overall quality of life. By considering these perspectives, policymakers, practitioners, and researchers can design more effective interventions and policies to address the multifaceted challenges facing vulnerable populations and promote sustainable development outcomes.

Hypotheses of the study

The following null hypotheses were tested:

HO_1: financial inclusion factors do not significantly influence food security index of rural women farmers;
HO_2: financial inclusion factors do not significantly influence food security status of rural women farmers;
HO_3: financial inclusion factors do not significantly influence food security levels of rural women farmers;

RESEARCH METHODOLOGY

The study was carried out in South-East geographical zone of Nigeria. The target population of this study was all the rural women farmers in South-eastern states of Nigeria farming rice and cassava. The list was gotten from Agricultural Development in various states in South East. Sample size was drawn in a three-stage sampling process. The first stage involved the purposive selection of Anambra, Enugu and Ebonyi state because they have more rural farmers (cassava and rice) with higher agricultural credit provisions (Amurtiya et al., 2018). The second stage involved the random selection of two agricultural zones from each of the selected states. This makes it a total of six agricultural zones. From the list provided by ADP in various states, the study arrived at the following sample size using random sampling technique, 92, 88 and 86 rural women farmers using the Yamane (1967) formula at 10% margin of error and 95% confidence level giving us a total of 266 rural women farmers were sampled for the study (Table 1).

Table 1: Survey result

Selected States	ADPs	Pop. size of rural women farmers	Confidence level (%)	Margin error (%)	Sample size drawn
Anambra State	ANADEP	1737	95	10	92
Enugu State	ENADEP	932	95	10	88
Ebonyi State	EBADEP	764	95	10	86
Total		**3433**			**266**

Source: Author's computation using Online Survey Monkey (2022)

Primary data were used in the study. Well-trained enumerators gathered primary data from a sample of farmers. Data was gathered using a semi-structured questionnaire. OLS multiple regression, Binary Logistics and Ordinal Probit regression was used to examine the financial inclusion factors influencing food insecurity of rural women farmers (objective iii) while Principal component analysis was used to realize objective (iv). For the food security index measure, the recommended daily calorie intake of 2100 kcal per person was utilized as the food security line because it represents the threshold necessary to meet the basic energy needs of individuals, ensuring sufficient nutrition for optimal health and productivity according to established nutritional guidelines (Varghese et al. 2016)

Food Security Index (FSI)

The majority of food security research have mostly relied on two assessment techniques (Maxwell, 1996). The first step is to estimate the gross annual output and consumption of rural women farmers' families, as well as the increase or depletion of food supplies kept during that time. It is also assumed that any food that entered the households' possession and subsequently "disappeared" has been consumed. The alternative technique involves conducting a food consumption recall for each family member or for the entire household, and then calculating the calorie content of each food type reported. This study used a seven-day recall strategy. The recommended daily calorie intake of 2100 kcal per person was utilized as the food security line. The rural women farmers' consumption provided the calories needed by the households. The data were used to determine how much of each food item was consumed over the course of seven days by rural women farmers' households. Using the nutritional composition table of regularly consumed foods in Nigeria, the amounts were translated to kilograms and the calories were calculated. By dividing the projected total calorie consumption for the home by the number of occupants, per capita calorie intake was obtained. The household's daily per capita calorie consumption was calculated by dividing the household's per capita calorie intake by seven. Families were considered to be food secure if their daily per capita calorie intake did not fall below 2100 kcal, and food insecure if it did. The food security situation was binary, with 0 denoting food insecure families and 1 denoting food secure households. The study followed the model employed by Babatunde, Omotoshor, and Shaloton (2007).

It is expressed as follows:

$$Zi = Yi/R \quad \text{.....1}$$

Where;

Zi = food security status of ith households which take values 1 for food secure households or 0 for food insecure households.

Yi = daily per capita daily calorie of ith household.

R = recommended per capita daily calorie intake (2100 kcal).

Zi = 1 for Yi greater than or equal to R

Zi = 0 for Yi less than R other indices;

Head count method was used to measure food security status of the entire area under study and is expressed as:

$$FII = (FIH/TH)\,X\,100 \quad \text{.....2}$$

Where;

FII = Food Insecurity Index

FIH = Number of Food Insecure Households

TH = Total Households under study

Food Insecurity Gap measures the depth of food insecurity and is expressed as:

$$FIGi = (TCRi - TCCi)/TCRiX100/1 \quad \text{.....3}$$

Where;

FIGi = Food Insecurity Gap of ith food insecure household

TCRi = Total Calorie Requirement for ith food insecure household

TCCi = Total Calorie Consumption by ith food insecure household

Hence, the total food insecurity gap is expressed as:

$$TFIG = \Sigma\,\{(TCRi - TCCi)/TCRi\}/FIH \quad \text{.....4}$$

Squared Food Insecurity Gap, which indicates severity of food insecurity among the food insecure households is given as:

$SFIG = \Sigma (FIGi)\ 2/FIH$……...5

Ordinary Least Squares (OLS) multiple regression

The ordinary least square multiple regression model was used to estimate the effects of various socio-economic and institutional factors on food security index of rural women farmers in the study area, this is in accordance with a study done by Atagher (2013). The generalized form of the model is given as:

$Y = \alpha + \Sigma\beta X + e$ …….6

Where,

Y = Food security index

α = Intercept of equation

Σ = Summation sign

β = coefficients of the explanatory variables

X = the vector of explanatory variables in the model

e = Error term

The functional forms of the model

Three functional forms of the OLS model were fitted and these include: linear, semi-log and double-log. The equation of best fit was selected based on the magnitude of $R^2$and the statistical significance of the explanatory variables. The explicit forms of the functions are as follows:

Where:

Y	=	Food security index
X_1	=	frequency of bank mobile application usage (continuous variable: number of times bank mobile application is used for transaction);
X_2	=	ownership of account with commercial banks (continuous variable: number of accounts with commercial banks);
X_3	=	amount saved in the past 12 months (continuous variable: Naira);
X_4	=	means of saving (discrete variables: bank, home, group of friends);
X_5	=	farm income (continuous variable: ₦);
X_6	=	professional advice on finance management (continuous variable: number of times received professional advice on finance management);
X_7	=	Transport cost to financial institutions in a month (continuous variable: ₦);
X_8	=	level of savings with bank in the last 12 months (continuous variable: Naira)
X_9	=	Proportion of credit utilized (measured in percentages);
X_{10}	=	access to Insurance Policy (dummy variable; Yes = 1, No = 0);
e	=	error term.

Binary Logistic regression model

The logistic regression was used to analyse objective (iv) (estimate the determinants of commercialization/food security status among rural women farmers in the study area). The model is specified as follows: $Y = \beta\, Xi + \varepsilon i$ ……..7

Where ε - N (0, 1). Then Y can be observed as an indicator for whether this latent variable is positive:

Y = (Commercialized=1, Not commercialized=0)

X = Vector of explanatory variables;

β = Coefficients;

εi = Random error;

The model is specified explicitly as follows:

$Yi = \beta 1X1 + \beta 1X1 + \beta 1X1 + \beta 1X1 + \beta 1X1 + \cdots + \beta nXn$ …… 8

The explanatory variables for rural women farmers are:

X_1	=	frequency of bank mobile application usage (continuous variable: number of times bank mobile application is used for transaction);
X_2	=	ownership of account with commercial banks (continuous variable: number of accounts with commercial banks);
X_3	=	amount saved in the past 12 months (continuous variable: Naira);
X_4	=	means of saving (discrete variables: bank, home, group of friends);
X_5	=	farm income (continuous variable: ₦);
X_6	=	professional advice on finance management (continuous variable: number of times received professional advice on finance management);
X_7	=	Transport cost to financial institutions in a month (continuous variable: ₦);
X_8	=	level of savings with bank in the last 12 months (continuous variable: Naira)

X_9 = Proportion of credit utilized (measured in percentages);
X_{10} = access to Insurance Policy (dummy variable; Yes = 1, No = 0);

Food Security Status

Y = Food security status (food secure=1, food insecure=0)
X = Vector of explanatory variables;
β = Coefficients;
εi = Random error;

The model is specified explicitly as follows:

$Yi = \beta 1X1 + \beta 1X1 + \beta 1X1 + \beta 1X1 + \beta 1X1 + \cdots + \beta nXn$ ……..9

The explanatory variables for rural women farmers are:

X_1 = frequency of bank mobile application usage (continuous variable: number of times bank mobile application is used for transaction);
X_2 = ownership of account with commercial banks (continuous variable: number of accounts with commercial banks);
X_3 = amount saved in the past 12 months (continuous variable: Naira);
X_4 = means of saving (discrete variables: bank, home, group of friends);
X_5 = farm income (continuous variable: ₦);
X_6 = professional advice on finance management (continuous variable: number of times received professional advice on finance management);
X_7 = Transport cost to financial institutions in a month (continuous variable: ₦);
X_8 = level of savings with bank in the last 12 months (continuous variable: Naira)
X_9 = Proportion of credit utilized (measured in percentages);
X_{10} = access to Insurance Policy (dummy variable; Yes = 1, No = 0);

Ordered Probit regression model

Ordered Probit regression model was employed to achieve objective iv. The model was specified as follows:

$Y(\leq j) = ln(\frac{p(Y \leq j/X)}{p(Y > \frac{j}{X})}$…….. 10

It then means that:

$\Pr(Y \leq j) = \ln(\frac{\sum pr(Y \leq j/X)}{1 - \sum pr(Y \leq j/X)} = \alpha j + \beta 1X1 + \cdots \ldots + \beta 14X14$ …… 11

$j = 1, 2, 3$

Where;

Y = commercialization levels of rural women farmers (which is categorized into 3: high = 3, medium = 2 and low = 1)
$\beta 1 - \beta 14$= Estimated parameters

The explanatory variables for rural women farmers are:

X_1 = frequency of bank mobile application usage (continuous variable: number of times bank mobile application is used for transaction);
X_2 = ownership of account with commercial banks (continuous variable: number of accounts with commercial banks);
X_3 = amount saved in the past 12 months (continuous variable: Naira);
X_4 = means of saving (discrete variables: bank, home, group of friends);
X_5 = farm income (continuous variable: ₦);
X_6 = professional advice on finance management (continuous variable: number of times received professional advice on finance management);
X_7 = Transport cost to financial institutions in a month (continuous variable: ₦);
X_8 = level of savings with bank in the last 12 months (continuous variable: Naira)
X_9 = Proportion of credit utilized (measured in percentages);
X_{10} = access to Insurance Policy (dummy variable; Yes = 1, No = 0);

Food security levels

Y = Food security levels of rural women farmers (which is categorized into 3: high = 3, medium = 2 and low = 1)
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The explanatory variables for rural women farmers are:

X_1 = frequency of bank mobile application usage (continuous variable: number of times bank mobile application is used for transaction);
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X_7 = Transport cost to financial institutions in a month (continuous variable: ₦);
X_8 = level of savings with bank in the last 12 months (continuous variable: Naira)
X_9 = Proportion of credit utilized (measured in percentages);
X_{10} = access to Insurance Policy (dummy variable; Yes = 1, No = 0);

Food security status and financial inclusion factors influencing food security status of rural women farmers
Food security status of rural women farmers

Table 2 shows the research area's rural women farmers' food security index. The parameters for the two groups of homes under study are shown in the table along with their corresponding indicators. According to the USDA's (2000) methodology, there were two categories in terms of food security: those who had access to enough food and those who did not. The food secured groups consume 2100 kcals or more per person per day, whereas the food insecure groups, which are further divided into marginally, moderately, and severely food insecure groups, consume 2099 kcals or less per person per day and between 1800 kcals and 1500 kcals, respectively. Based on the food security groupings, the frequencies and percentages of rural women farmers were displayed. The lowest and maximum caloric intake of the rural women farmers' food-secure and food-insecure groups were displayed (Table 2). The food insecurity gap was displayed, demonstrating the prevalence, depth, and severity of food insecurity in percentages, as well as the average number of calories consumed and the food security score for each group.

Table 2: Food Security Status of Rural Women Farmers

Food Security Status (KCal)	**Frequency**	**Percentage**	**Mean**
674 - 1000.0	20	7.5	
1001.0 – 2000.0	193	72.6	
2001.0 – 3000.0	47	17.7	
3000.0 – 4000.0	5	1.9	
4001.0 – 5360.0	1	0.4	
Total	**266**	**100.0**	
Food insecurity parameters	***Food secured***	***Food insecure***	***Pooled***
Calorie requirement	2100.0	2100.0	2100.0
Minimum	2192.5	674.6	674.6
Maximum	5360.4	2082.1	5360.4
Mean Calorie consumption (MCC)	3776.5	1378.4	3017.5
Standard deviation	1,459.9	842.5	1,124.4
Head count ratio (Nfi/P) (%)	Incidence of FS (%)	58.3	
Food insecurity gap (TCRi-TCCi/TCRi) (%)	Depth of FS (%)	33.0	
Squared food insecurity gap	Severity of FS (%)	5.74	
MCC (Kcal); t value = 3.39 (p<0.05)	Rice=2504.4	Cassava=2391.3	

Where, TCRi=Total Calorie Requirement for *ith* food insecure household and TCCi denotes the Total Calorie Consumption by *ith* food insecure household; *Source: Field Survey Data, 2023.*
Food security status of rural women farmers

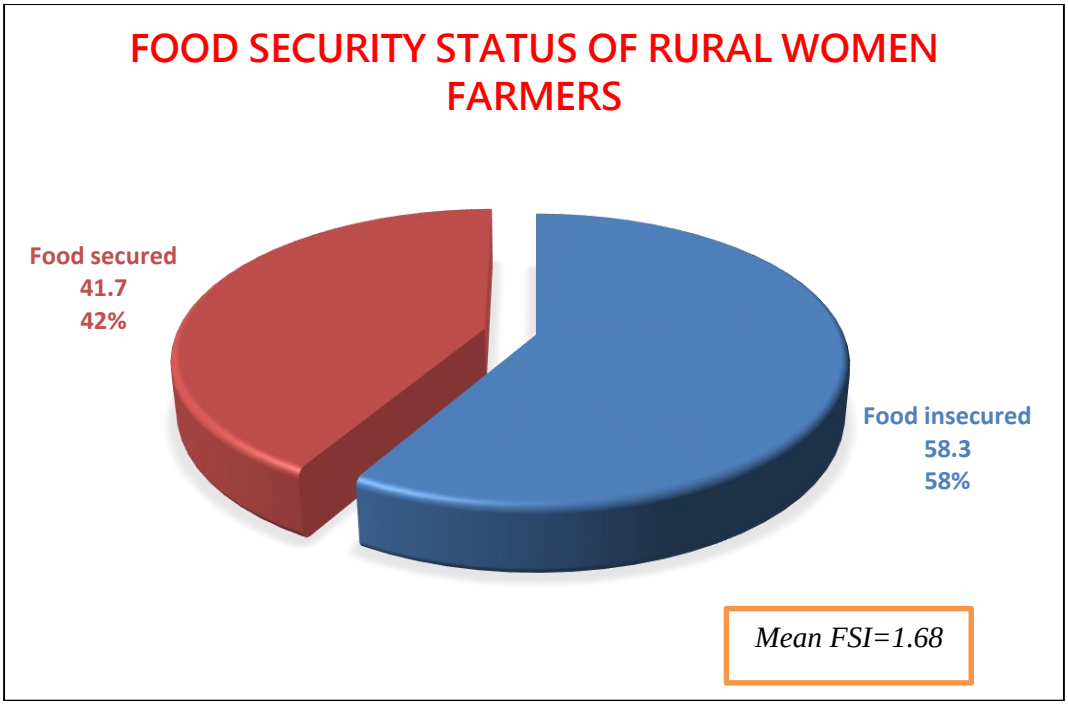

Figure 1: Food security status of rural women farmers; *Source: Field Survey Data, 2023*

Food Security Levels of Rural Women Farmers

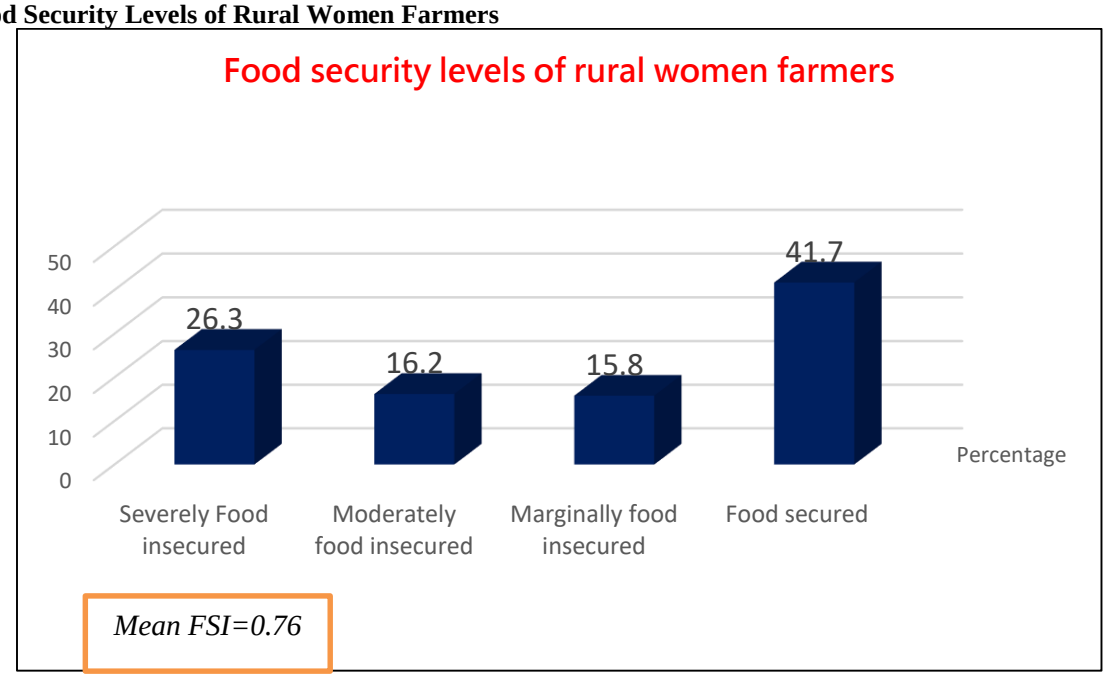

Figure 2: Food security levels of rural women farmers; *Source: Field Survey Data, 2023*

The food security status of rural women farmers in Southeast Nigeria was assessed based on their household's food consumption over the past seven days, converted into K/calorie amounts per adult equivalent using a minimum threshold of 2100 kcals per adult per day. Out of 266 rural women farmers surveyed, 41.7% were classified as food secure, while 58.3% were food insecure. Food secure households had a mean calorie intake of 3776.6 Kcal, significantly higher than the 1378 Kcal consumed by food insecure households, with standard deviations of 1459.9 kcals and 842.5 kcals, respectively. Furthermore, 58.6% of rural women farmers did not meet their daily energy needs, indicating substantial food insecurity in the region. This result is also consistent with that of Ibok et al. (2014), who discovered that in cross river state, Nigeria, 52.5% of rural food crop producing households were food secure and 47.5% were not. In their study on the impact of rural agriculture to household food insecurity in Ibadan city, Oyo state, Nigeria, Rose, Gunderson, and Oliveira (2020) observed that 62.5% were food secure while 37.5% were food insecure. Similarly, Idrisa, Gwary, and Ibrahim (2016) found that 42.5% of rural families in the Gwagwalada Area Council of the Federal Capital Territory, Abuja, Nigeria, were food

secure, 27.5% were moderately food secure and just 30.0% were non-food secure in their research of the food security status of rural households. According to FAO (2021), there is a correlation between education level and likelihood of finding decent work. Adebayo, Sanni, and Baiyegunhi (2012) found a comparable outcome among farmers in both rural and urban areas.

The study also revealed significant disparities in calorie consumption between rice and cassava-growing rural women farmers. Factors such as household income, education level, and engagement in diverse income-generating activities were associated with improved food security among rural women farmers. Higher household income and education levels were correlated with a higher likelihood of experiencing food security, suggesting the importance of socioeconomic factors in addressing food insecurity among rural women farmers. Additionally, engagement in diverse income-generating activities may provide rural women farmers with the means to afford sufficient and nutritious food, contributing to improved food security outcomes.

Financial inclusion factors influencing food security index of rural women farmers

The Ordinary Least Square multiple regression approach was used to determine financial inclusion factors affecting food security index of rural women farmers in the study area. The double-log function was chosen as the equation because it exhibited better diagnostic test statistic than other models. It has the highest coefficient of multiple determination, the lowest mean squared error of regression, the highest number of significant variables and significant Fischer's statistic value. The coefficient of multiple determination (R2) of the lead equation indicates that, about 52.4 percent of variability of the food security index among rural women farmers is attributed to the specified explanatory variables in the model. This shows that, the specified explanatory variables were important determinants of food security index among the respondents. The F-statistic value of 20.9 is statistically significant at 1 percent probability level, suggesting that the data fit the model and that the independent variables were important explanatory factors of the variations in food security index. The difference between R squared and adjusted R squared value is that R squared value assumes that all the independent variables considered affect the result of the model, whereas the adjusted R squared value considers only those independent variables which actually have an effect on the performance of the model. To balance that out, models are always compared with different number of independent variables with adjusted R2 and from previous studies (Adebayo, 2018; Adetunji, 2015; Beyene, & Muche, 2010) adjusted R2 increased as new variables improved the model more than would be expected by chance.

Table 2: OLS multiple Regression of Financial Inclusion Factors Affecting Food Security Status of Rural Women Farmers

Variable	Linear				Semi-log				Double-log+			
	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.
Frequency of bank mobile application usage	-7.735701	11.03944	-0.700733	0.4841	-4.973373	9.585849	-0.518824	0.6043	-0.086610	0.107049	-0.809062	0.4192
Ownership of account with commercial banks	17.20355	5.670745	0.033737	0.0027	6.929444	5.044337	1.373708	0.1707	0.150967***	0.056332	2.679931	0.0078
Amount saved in the past 12 months	6.83E-06	1.63E-05	0.420332	0.6746	7.226349**	2.880535	2.508683	0.0127	0.191881***	0.032168	5.964933	0.0000
Means of saving	2.041455	4.163872	0.490278	0.6244	1.054111	3.731810	0.282466	0.7778	0.044665	0.041675	1.071754	0.2848
Farm income	0.000110	3.81E-05	0.881064	0.0043	3.487740	2.915186	1.196404	0.2326	0.134985***	0.032555	4.146343	0.0000
Professional advice on finance management	24.90749***	7.696566	3.236182	0.0014	-0.460487	7.143914	-0.064459	0.9487	0.093744	0.079779	1.175046	0.2411
Transport cost to financial institutions in a month	4.918240	3.845080	1.279100	0.2020	1.293281	3.367924	0.383999	0.7013	0.019730	0.037611	0.524572	0.6003
Level of savings with bank in the last 12 months	10.08715**	4.219166	2.390791	0.0175	3.793797	3.689859	1.028169	0.3048	0.011513	0.041206	0.279399	0.7802
Proportion of credit utilized	78.63354*	8.765070	0.971239	0.0000	29.08610***	9.325642	3.118938	0.0020	0.391406***	0.104144	3.758335	0.0002
Access to Insurance Policy	-7.399261	7.566773	-0.977862	0.3291	-14.60948**	6.500606	-2.247402	0.0255	0.197159	0.072595	0.715867	0.0071
R-Squared	0.320659	Mean dependent var		64.38489	0.424576	Mean dependent var		64.38489	0.523979	Mean dependent var		1.755146
Adjusted R-squared	0.307088	S.D. dependent var		25.21347	0.400419	S.D. dependent var		25.21347	0.467010	S.D. dependent var		0.253924
S.E. of regression	29.48023	Akaike info criterion		9.642186	25.59408	Akaike info criterion		9.359468	0.285820	Akaike info criterion		0.369963
F statistic	22.2485.5	Schwarz criterion		9.776904	19.23042	Schwarz criterion		9.494186	20.91348	Schwarz criterion		0.504681
Sig.	0.000000	Hannan-Quinn criterion		9.696307	0.000000	Hannan-Quinn criterion		9.413590	0.000000	Hannan-Quinn criterion		0.424084
Log likelihood	-1272.411				-1234.809				-39.20504			
Durbin-Watson stat	1.486287				1.501429				1.493763			

Source: Field Survey Data, 2023

The Durbin-Watson (DW) statistic is used as a test for checking autocorrelation in the residuals of a statistical regression analysis. If autocorrelation exists, it undervalues the standard error and may cause us to believe that predictors are significant when in reality they are not. The value always lies between 0 and 4. If the Durbin–Watson statistic is substantially less than 2, there is evidence of positive serial correlation. As a rough rule of thumb, if Durbin–Watson is less than 1.0, there may be cause for alarm. The Durbin-Watson (DW) statistic in the model was 1.49, indicating positive autocorrelation following the rule of thumb according to Cameron & Trivedi (1986), who were of the view that values below 2.0 mean there is positive autocorrelation and above 2.0 indicates negative autocorrelation, while a value of 2.0 indicates zero autocorrelation. The Akaike/Schwartz or Bayesian Information Criterion/Hannan-Quinn information criterion, which is often used to choose between competing models, has a rule that the lower the value of these criteria, the better the model is. From this example, the

Akaike/Schwartz or Bayesian Information Criterion/Hannan-Quinn information criterion figures of 0.299297, 0.434015, and 0.353418 (<2) are the lowest of the three criteria among the other functional forms and therefore indicate that it is the best model to adopt in this case.

The empirical results show that the coefficients of ownership of accounts with commercial banks (0.150967), amount saved in the past 12 months (0.191881), farm income (0.134985), and proportion of credit utilized for actual collection intention (0.391406) have a significant positive effect at various significant levels on the food security index of rural women farmers in the study area. The coefficient of ownership of accounts with commercial banks (0.150967) was positive and significant at the 1.0% alpha level, implying that the probability of the food security of rural women farmers increased with the rise in the level of ownership of accounts with commercial banks by 0.150967. This finding is in line with a priori expectations. Having a bank account provides a secure place to store money. Instead of keeping cash at home, which can be susceptible to theft or loss, rural women farmers can deposit their funds in a bank account. This reduces the risk of financial loss and ensures that the money earmarked for food expenses is protected. Also, bank accounts offer a convenient means for individuals to save money. By depositing a portion of their income regularly, individuals can build up savings over time. This can serve as a financial safety net during emergencies or periods of income fluctuations, ensuring that there are sufficient funds to purchase food even in challenging times. Similar results were obtained by the following studies (Adebayo, 2018; Adetunji, 2015; Beyene & Muche, 2010).

Bank accounts provide access to a range of financial services that can support food security. For example, individuals can use their bank accounts to receive wages, government benefits, or remittances, ensuring a steady flow of income for purchasing food and ensuring food security. Bank accounts also enable individuals to make convenient and secure payments for groceries and other food-related expenses, reducing the risk of loss or theft associated with carrying cash. According to Carbo, Gardener, and Molyneux (2007), owning a bank account can improve access to credit facilities such as loans or overdrafts. This can be particularly beneficial for small-scale farmers or individuals engaged in food production activities. Access to credit can help them invest in agricultural inputs, equipment, or infrastructure, ultimately increasing their productivity and ensuring a stable food supply. Furthermore, in the views of Clement (2018); Cook et al. (2004), bank accounts enable individuals to track their income and expenses, facilitating better financial planning and budgeting. By having a clear overview of their financial situation, rural women farmers can allocate appropriate funds for food expenses, ensuring that they prioritize their nutritional needs. In conformity, ownership of a bank account can contribute to financial empowerment by providing individuals with a sense of control over their finances. This empowerment can positively impact decision-making related to food choices, ensuring that individuals can make informed decisions about purchasing nutritious and diverse food items (Dereje, 2021). It is important to note that while bank accounts can contribute to improving food security, there are also barriers to access, such as banking infrastructure, financial literacy, and affordability. Efforts to promote financial inclusion, enhance financial education, and address these barriers are crucial in ensuring that the benefits of bank account ownership translate into improved food security for rural women farmers.

The coefficient of the amount saved in the past 12 months (0.191881) had a positive sign and was statistically significant at the 1.0% risk level. This result indicates that a unit increase in the amount of money saved by rural women farmers yearly increases food security by 0.191881. By saving money in banks, rural women farmers can build emergency funds that can be used during times of financial hardship or unexpected expenses. This can help protect against food insecurity during times of crisis, such as job loss or medical emergencies, by providing a safety net to cover basic needs like food. In the words of Devereux and Sussex (2019), saving money in banks can provide rural women farmers with the necessary capital to invest in agricultural activities. Rural women farmers, for example, can use their savings to purchase seeds, fertilizers, equipment, or livestock, which can increase their agricultural productivity and ultimately improve their food production and income. This, in turn, can enhance food security not only for themselves but also for the larger community. Having a good savings history and a bank account can improve an individual's creditworthiness. This can make it easier for them to access credit from banks or financial institutions, which can be used for agricultural purposes or to start income-generating activities related to food production or processing. Access to credit can provide farmers with the necessary resources to expand their operations, invest in technology, or improve their farming practices, thus increasing their food production capacity. A higher amount saved in the bank can also contribute to overall financial stability. When rural women farmers have a financial cushion, they are less likely to face sudden financial crises or resort to negative coping mechanisms, such as selling productive assets or reducing food consumption. By maintaining financial stability, individuals can ensure a consistent and reliable food supply for themselves and their families. This is in tandem with Fakayode, Rahji, Oni, and Adeyemi (2009), who found out that households mostly save to smooth their food security.

The coefficient of farm income (0.134985) has a significant positive effect (at the 1% significance level) on the food security of rural women farmers. This is in conformity with a priori expectations. The result implies that a unit increase in the income of farmers, which may be as a result of increased yield, better access to credit, or being more financially inclusive, accelerates food security. High farm income can directly and indirectly

contribute to increasing food security in the following ways: when rural women farmers have high incomes, they are more likely to invest in their agricultural activities. They can purchase improved seeds, quality fertilizers, modern machinery, and advanced farming techniques. These investments can enhance agricultural productivity, leading to increased food production. With higher farm income, rural women farmers can also afford to adopt sustainable farming practices and invest in technologies that improve efficiency and reduce post-harvest losses. This, in turn, can contribute to a more secure food supply.

Furthermore, high farm income allows rural women farmers to have better access to crucial agricultural inputs and resources. They can afford to purchase high-quality inputs, such as fertilizers, pesticides, and irrigation systems, which can improve crop yields and overall productivity. Additionally, rural women farmers with higher incomes can access credit and financial services more easily, enabling them to invest in necessary resources for their farming operations. This access to inputs and resources can result in increased food production and improved food security. In the views of Fayeye and Ola (2017), with higher income, rural women farmers have the opportunity to diversify their agricultural activities. They can allocate resources to grow a variety of crops or engage in livestock rearing, aquaculture, or other income-generating activities. Diversification can help mitigate the risks associated with crop failures, market fluctuations, or climate change impacts. By having multiple sources of income, rural women farmers can better sustain themselves during challenging times, reducing the vulnerability of their food security. The result is in conformity with Feleke, Kilmer, and Gladwin (2019), who found out that higher farm income can lead to improved living standards for farmers and their families. It can enable them to meet their basic needs, including access to nutritious food, healthcare, and education. When rural women farmers have better access to essential resources, they can provide a more stable and healthier environment for their families. This, in turn, contributes to improved overall food security within the household. A similar argument was made by Gebre (2012), who was of the opinion that increased farm income can stimulate local economies, especially in rural areas where agriculture is a significant sector. When rural women farmers have higher incomes, they have more purchasing power to buy goods and services from local businesses. This can create a positive economic cycle, leading to job creation, increased incomes for non-agricultural workers, and improved access to food for the local community. Strong local food systems contribute to food security by reducing dependence on external food sources and promoting self-sufficiency. It is important to note that while high farm income can have positive impacts on food security, it should be accompanied by equitable distribution of resources, access to markets, and supportive policies to ensure that the benefits reach all stakeholders in the agricultural sector. Similar results have also been obtained by Gitu (2020), Guled (2021), and Hadebe and Mpofu (2019).

The coefficient of the proportion of credit utilized for the intended purpose (0.391406) is positive and statistically significant at the 1% probability level. This implies that as the proportion of credit utilized increases by a unit, there would be a corresponding increase in the food security of rural women farmers by 0.391406. This is in conformity with a priori expectations. The proportion of credit used for its intended purpose can play a crucial role in increasing food security in several ways. When rural women farmers obtain credit specifically for agricultural purposes, they can use it to invest in their farming operations. This can include purchasing quality seeds, fertilizers, machinery, irrigation systems, and other inputs necessary for increasing agricultural productivity. By utilizing credit for its intended purpose, rural women farmers can enhance their production capacity, improve crop yields, and ultimately contribute to a more secure food supply. In the words of Hanson, Sobal, and Frongillo (2021), credit utilized for what it was intended for by rural farmers can also be used to strengthen the agricultural value chain, which encompasses all the activities involved in bringing agricultural products from the farm to the consumer. Rural women farmers can utilize credit to establish or improve post-harvest infrastructure, such as storage facilities, processing units, and transportation systems. By investing in value chain development, farmers can reduce post-harvest losses, improve the quality of their produce, and ensure timely delivery to markets. This can lead to increased income, improved market access, and enhanced food security. Similar results have also been obtained by Idrisa, Gwary, and Shehu (2008) and Irohibe & Agwu (2014).

Binary Logistic Regression of Financial Inclusion Factors Affecting Food Security of Rural Women Farmers

Table 3 presents financial inclusion factors affecting food security status of rural women farmers in south east, Nigeria. The result of the Binary logistic regression model gave a log likelihood ratio (LR) statistic of -178.5808 and were significant at the 1% level of probability, an indication that the explanatory variables included in the model jointly explained the variations in the food security status of rural women farmers in the study area. The Pseudo R squared values of 0.376 indicate very good model fit.

Hypothesis and post estimation test

It was hypothesized that financial inclusion factors do not significantly influence food security status of rural women farmers in the study area. From the test of the analysis, it was observed that financial inclusion predictors had significantly influenced food security status of rural women farmers. This was justified by the Prob (LR statistic) which is the probability value that indicates the statistical significance of the LR statistic of the logistic regression model which was significant at the 1% significant level ($\rho<0.05$). Therefore, the null hypothesis was rejected and the alternate hypothesis accepted.

The mean dependent variance (0.417293) for rural women farmers indicates the average value of food security responses in the data showing a fairly food security status. The S. D. dependent variance of 0.494042 indicates the deviation from the average value of food security status in the data. The Akaike/Schwartz or Bayesian Information Criterion/Hannan-Quinn information criterion is often used to choose between competing models. The lower the value of these criteria, the better the model is. From this example, the Akaike information criterion (AIC) Figures of 1.417901 (<2) is the lowest of the criteria among rural women farmers. The Standard Error of regression (0.498566) summarizes the estimated variance of the residuals while the sum squared residuals (63.63352) is the explained variation in the food security status.

Table 3: Binary Logistic Regression of Financial Inclusion Factors Affecting Food Security Status of Rural Women Farmers

Variables	Coefficient	Std. Error	z-Statistic	Prob.	Marginal effect dy/dx
Frequency of Bank mobile application usage	-0.736500	0.772661	-0.953199	0.3405	-0.1945303
Ownership of account with commercial banks	0.119854	0.393522	0.304568	0.7607	0.0725384
Amount saved in the past 12 months	1.13E-07**	1.13E-06	3.099744	0.0265	1.05e-07
Means of Saving	0.199582	0.287719	0.693670	0.4879	0.0598095
Farm Income	-2.54E-06	2.66E-06	-0.957520	0.3383	-2.16e-07
Professional advice on finance management	1.269398**	0.554958	2.287375	0.0222	0.2181262
Transport cost to financial institutions in a month	0.159176	0.266682	0.596878	0.5506	0.0509471
Level of savings with bank in the last 12 months	-0.030093	0.293934	-0.102379	0.9185	-0.011126
Proportion of Credit utilized	0.700560***	0.610596	2.147338	0.0012	0.3437951
Access to Insurance Policy	0.069006	0.524714	0.131512	0.8954	0.0246403
Mean dependent var	0.417293	S.D. dependent variance		0.494042	
S.E. of regression	0.498566	Akaike info criterion		1.417901	
Sum squared residual	63.63352	Schwarz criterion		1.552619	
Log likelihood	-178.5808	Hannan-Quinn criterion		1.472022	
Deviance	357.1616	Restricted deviance		361.4425	
Avg. log likelihood	-0.671356				
Number of observations	266				
LR Chi2 (10)	6.38				
Prob > Chi2	0.0027				
Pseudo R2	0.3176				

Source: Field Survey Data, 2023

Out of the ten explanatory variables included in the model, three were found to be significant at various levels of probability. These variables include: amount saved in the past 12 months (1.13E-07), professional advice on finance management (1.269398) and proportion of credit utilized (1.989708) were significant at 5%, 5% and 1% probability levels respectively.

The coefficient of amount saved in the past 12 months (1.13E-07) had a positive sign and was statistically significant at 5.0% risk level. This result indicates that a unit increase in the amount of money saved by rural women farmers yearly increases food security by 1.13E-07. With respect to the marginal effect, an additional unit increase in the annual savings in the bank by rural women farmers, the more their food security level which increases by 1.05e-07. According to Joachim, Howarth, Shubh and Rajul (2020), when rural women farmers save more money in the bank, they increase their creditworthiness and can access larger credit facilities from commercial banks. This can help them to finance their agricultural activities, such as purchasing inputs, hiring labour, and investing in new technologies. With access to more credit, rural women farmers can expand their production and be more food secured. In the words of Kaloi, Tayebwa and Bashaasha (2019) by saving more money, rural women farmers can invest in new technologies that can increase their productivity and efficiency. For example, they can invest in new irrigation systems, tractors, or other equipment that can help them to produce more crops with less labour. This can lead to increased food security as rural women farmers are able to produce more and sell their products to a wider market. In consonance with the afore mentioned, when rural women farmers save more money, they can use their savings to diversify into other businesses. For instance, rural women farmers can also invest in livestock rearing, fish farming, or other non-agricultural activities that can provide additional income streams. This can lead to increased food security as rural women farmers are able to generate more income and invest in their agricultural activities. Rural women farmers having high amount of savings can also use their savings to manage risks associated with agricultural production such as covering unexpected losses due to weather, pests, or other factors that can affect their crops. This can help them to avoid financial setbacks and continue their agricultural activities, leading to increased food security over time. Overall, an increase in the amount saved in a bank can provide farmers with access to credit, investment in new technologies, diversification,

and risk management strategies, all of which can increase their food security. By increasing food security, rural women farmers can improve their income, standard of living, and contribute to the growth of the agricultural sector thereby causing them to be more food secured. This is in tandem with Kioko (2019) who found out that households mostly save to smoothen their food security.

The coefficient of professional advice on financial management (1.269398) had a significant positive (5%) effect on the food security status of rural women farmers in the study area. This result indicates that the more the professional advice received by rural women farmers on financial management, the more food secured they become by 1.269398. The marginal effect shows that an increase in the professional advice given to rural women farmers on financial management the bank, the more their food secured they become or rather food security increases by 21.8%. This means that a higher food security status is predicted among rural women farmers who have more professional advice on financial management. This is in tandem with apriori expectations. Professional advice on financial management can help rural women farmers and individuals involved in food production to develop effective financial plans. This includes budgeting, cost analysis, and forecasting, which can lead to better allocation of resources and increased productivity. By effectively managing their finances, rural women farmers can invest in better agricultural practices, purchase quality inputs, and maximize their yields, ultimately contributing to food security. According to Kirwan and Maye (2019), professional advice can also guide rural women farmers in accessing credit and investment opportunities that can enhance their agricultural activities. Financial advisors can help rural women farmers understand the loan application process, assess the viability of investment options, and create business plans that attract financial institutions. With access to credit, rural women farmers can invest in modern farming techniques, purchase equipment, and improve infrastructure, all of which can increase food production and security. Furthermore, financial advisors can assist rural women farmers in developing risk management strategies to mitigate potential financial losses. They can help farmers understand insurance options, create emergency funds, and diversify their income sources. By being prepared for unforeseen events such as natural disasters or market fluctuations, rural women farmers can safeguard their livelihoods and maintain food production even in challenging circumstances.

Professional advice on financial management often includes market analysis and pricing strategies. Financial advisors can also provide insights into market trends, consumer preferences, and pricing mechanisms. This information allows rural women farmers to make informed decisions about crop selection, timing of sales, and negotiating fair prices. By optimizing their market strategies, rural women farmers can increase their profitability and ensure a stable income, contributing to long-term food security. Finally, financial advisors can also provide valuable training and capacity building opportunities for rural women farmers. They can educate rural women farmers on financial literacy, record keeping, and investment strategies. By enhancing rural women farmers' financial knowledge and skills, professional advice empowers them to make informed decisions, effectively manage their resources, and improve their overall financial well-being, which in turn contributes to food security. However, Maharjan and Chhetri (2016) reported contrary result.

The coefficient of proportion of credit utilized (0.700560) is positive and statistically significant at 1% probability level. This implies that as the proportion of credit utilized increases by a unit, there would be corresponding increase in the food security status of rural women farmers by 0.700560. With respect to the marginal effect, an additional unit increase in the proportion of credit utilized for its intended purpose by rural women farmers lead to a corresponding increase in their food security status by 34.3%. This is in conformity with apriori expectations. This implies that credit utilized properly can increase the food security of rural women farmers, but it depends on how the credit is used. If the credit is used effectively, it will help farmers increase their productivity, expand their operations, and access new markets, which can lead to higher profits and increased food security. However, if the credit is not used effectively, it can lead to over-indebtedness and financial distress, which can harm farmers' food security efforts. High proportion of Credit utilized can help rural women farmers invest in their farming operations by purchasing high-quality inputs, upgrading their equipment, and adopting modern farming practices. This can help them increase their productivity and efficiency, leading to higher yields and better profits. According to Majda (2019), credit can help farmers invest in market development activities such as branding, packaging, and marketing. This can help them access new markets and increase their sales, leading to higher food security. Similar result has also been obtained by Maxwel (2020); Muhammed-Lawal, and Omotesho, (2008); Mutisya, Kandala, Ngware, and Kabiru, (2020).

Financial Inclusion Factors Affecting Food Security Levels of Rural Women Farmers

Table 4 presents financial inclusion factors affecting food security levels of rural women farmers in South east Nigeria. The result of the ordinal Probit regression model gave a log likelihood of -338.9623 and was significant at the 1% level of probability, an indication that the explanatory variables included in the model jointly explained the variations in food security levels of rural women farmers in the study area. The Pseudo R squared values of 0.281313 indicates good model fit. The cut points can be interpreted in terms of Z-scores for rural women farmers which tells whether the observation is above or below the mean.

Table 4: Ordinal Probit Regression of Financial Inclusion Factors Affecting Food Security Levels of Rural Women Farmers

Variables	Coefficient	Std. Error	z-Statistic	Prob.	Marginal effect
Frequency of Bank mobile application usage	-0.699864**	0.023872	-1.651122	0.0987	-0.2259496
Ownership of account with commercial banks	0.446645**	0.227416	1.964001	0.0495	0.1442771
Amount saved in the past 12 months	2.94E-07	6.25E-07	0.470261	0.6382	9.50e-08
Means of Saving	0.150707	0.159907	0.942467	0.3460	0.0475582
Farm Income	-2.53E-07	1.58E-06	-0.160102	0.8728	-8.16e-08
Professional advice on finance management	0.997036	0.333191	-0.992382	0.0028	0.3218909
Transport cost to financial institutions in a month	0.065013	0.148545	0.437666	0.6616	0.0208531
Level of savings with bank in the last 12 months	0.171028	0.163956	1.043134	0.2969	0.0536301
Proportion of Credit utilized	0.736669	0.046354	0.650413	0.0989	0.2378319
Access to Insurance Policy	0.112810	0.085892	0.394588	0.6931	-0.0352314
Cut 1	-0.528405	0.281494	-1.877142	0.0605	
Cut 2	-0.061586	0.279839	-0.220075	0.8258	
Cut 3	0.347352	0.280799	1.237013	0.2161	
Pseudo R-squared	0.281313	Akaike info criterion		2.646333	
Schwarz criterion	2.821466	Log likelihood		-338.9623	
Hannan-Quinn criterion	2.716691	Restricted log likelihood		-346.3438	
LR statistic	14.76291	Avg. log likelihood		-1.274294	
Prob (LR statistic)	0.000948				

Source: Field Survey Data, 2023

A Z-score of zero equals the mean. A z-score of +2 indicates that the data point falls two standard deviations above the mean while a -2 z-score signifies it is two standard deviations below the mean. The study for rural women farmers food security levels indicated cut 1 and cut 2 to have Z-scores of less than 2 (-0.528405) standard deviations below the mean.

Hypothesis and Post estimation test

It was hypothesized that financial factors have no significant influence on food security levels among rural women farmers in the study area. From the test of the analysis, it was observed that financial factors had significantly influence food security levels of rural women farmers. This was justified by the Prob > Chi^2 which is the probability value that indicates the statistical significance of the LR statistic Chi^2 of the ordinal Probit regression model which was significant at the 1% significant level ($P<0.05$). Therefore, the null hypothesis was rejected and the alternate hypothesis accepted.

Out of the ten explanatory variables included in the model, two of the variables were found to be significant at various levels of probability for rural women farmers. The two significant variables include: frequency of bank mobile application usage (-0.699864) and ownership of account with commercial banks (0.446645) which had a negative and positive significant relationship with the probability of food security levels respectively. Below is a brief discussion on the independent variables used in the ordinal Probit regression model and their apriori expectation about the direction of effect to food security levels.

The coefficient of frequency of bank mobile application usage (-0.699864) was negative and statistically significant at 5% probability level. This implies that the more the frequency of bank mobile application usage, the lower the food security levels by 0.699864. With respect to the marginal effect, an additional unit increase in rural women farmers frequency of bank mobile application usage leads to a corresponding decrease in their food security levels by 22.5%. The result was not in conformity with apriori expectations. According to Nwambeke, Enyosa, Duruzor, and Oko (2016) the high frequency of bank mobile application use itself does not directly reduce food security. However, there can be indirect ways in which the use of mobile banking apps may impact food security. If rural women farmers are heavily reliant on mobile banking apps for their financial transactions, such as payments and transfers, they may incur transaction fees or charges. These additional financial burdens can impact their overall budget and potentially reduce the amount of money available for purchasing food or meeting other essential needs. Also, increased reliance on mobile banking applications may result in reduced access to physical bank branches, especially in rural or remote areas. This can be problematic for rural women farmers who prefer or require in-person assistance for their banking needs. Limited access to banking services can hinder financial inclusion and may indirectly affect their ability to manage their finances effectively, potentially impacting their food security.

According to Nwankwo (2013), not every rural women farmer has access to smartphones or reliable internet connections required for mobile banking application usage. This digital divide can create barriers for individuals who do not have the necessary technology or digital literacy skills to utilize these applications. They may face

challenges in accessing banking services and managing their finances, which can indirectly affect their ability to secure an adequate food supply. Furthermore, while mobile banking applications can provide convenience and accessibility, there is also a risk of individuals mismanaging their finances. Easy access to bank accounts through mobile application may lead to impulsive spending or poor financial decisions, potentially resulting in financial instability and a negative impact on food security.

This result was not in tandem with the findings of Odeleye and Olusoji (2018). Therefore, it is important to note that mobile banking applications can also bring benefits, such as increased financial inclusion and improved access to banking services. However, the potential negative impacts on food security can arise if individuals face financial burdens, limited access to physical banks, technological barriers, or poor financial management as a result of their application usage. It's crucial to address these challenges through financial education, improved access to banking services, and policies that promote equitable digital inclusion to mitigate any adverse effects on food security.

The coefficient of ownership of account with commercial banks (0.446645) was positive and significant at 5.0% alpha level, implying that the probability of the rural women farmers food security level increased with rise in level of ownership of account with commercial banks by 0.150967. With respect to the marginal effect, an additional unit increase in rural women farmers frequency of bank mobile application usage leads to a corresponding decrease in their food security level by 14.2%. The result is in conformity with apriori expectations. Having a bank account provides a secure place to store money. Instead of keeping cash at home, which can be susceptible to theft or loss, rural women farmers can deposit their funds in a bank account. This reduces the risk of financial loss and ensures that the money earmarked for food expenses is protected. Also, bank accounts offer a convenient means for individuals to save money. By depositing a portion of their income regularly, individuals can build up savings over time. This can serve as a financial safety net during emergencies or periods of income fluctuations, ensuring that there are sufficient funds to purchase food even in challenging times.

Bank accounts provide access to a range of financial services that can support food security. For example, individuals can use their bank accounts to receive wages, government benefits, or remittances, ensuring a steady flow of income for purchasing food and ensuring food security. Bank accounts also enable individuals to make convenient and secure payments for groceries and other food-related expenses, reducing the risk of loss or theft associated with carrying cash. According to Okon, Frank, Etowa, and Nkeme (2017) owning a bank account can improve access to credit facilities such as loans or overdrafts. This can be particularly beneficial for small-scale farmers or individuals engaged in food production activities. Access to credit can help them invest in agricultural inputs, equipment, or infrastructure, ultimately increasing their productivity and ensuring a stable food supply. Furthermore, in the views of Omonona, Agoi, and Adetokunbo (2017), bank accounts enable individuals to track their income and expenses, facilitating better financial planning and budgeting. By having a clear overview of their financial situation, individuals can allocate appropriate funds for food expenses, ensuring that they prioritize their nutritional needs. In conformity, ownership of a bank account can contribute to financial empowerment by providing individuals with a sense of control over their finances. This empowerment can positively impact decision-making related to food choices, ensuring that individuals can make informed decisions about purchasing nutritious and diverse food items (Owotoki, 2019). This finding compares favourably with result obtained by Oyebanjo, Ambali, and Akerele, (2019; Reliefweb, (2021).

Conclusion and Recommendations

According to the food security index, a slightly higher-than-average proportion of respondents experienced food insecurity. In the study area, the mean calorie consumption of rural women farmers cultivating rice and cassava differed significantly. The study found that the proportion of credit utilized for its intended purpose, the amount saved in the past 12 months, farm income, and ownership of commercial bank accounts all had significant positive effects on the food security index of rural women farmers in the study area. However, savings in the past 12 months, access to professional financial advice, and the proportion of credit utilized were also found to have significant negative effects at varying levels of significance. Additionally, ownership of a commercial bank account and the frequency of mobile banking usage were found to have a significant influence on the level of food security among the respondents.

Policy Implications

i. The government should implement soft loan provisions tailored to the needs of rural women farmers to alleviate food insecurity. These loans should be accessible and affordable, supporting agricultural activities and enhancing financial inclusion.
ii. In addition to financial inclusion policies, targeted grants and incentives should be provided to rural women farmers. These could include subsidies for agricultural inputs, training programs, and infrastructure development to improve food security levels.

iii. Policymakers should review and enhance existing financial inclusion policies to specifically address the needs of rural women farmers. Promoting access to formal banking services, encouraging savings, and facilitating easier access to credit for agricultural activities are essential components.

Practical Implications

i. Practical interventions such as capacity building programs should be implemented to enhance financial literacy and management skills among rural women farmers. Workshops, training sessions, and extension services focusing on financial planning, savings, and investment can be effective.
ii. Promoting the use of mobile banking applications among rural women farmers can significantly impact food security levels. Partnerships with telecommunication companies to improve access and usability of mobile financial services should be encouraged.
iii. Initiatives such as community outreach programs should be employed to disseminate information about available financial services and support mechanisms. Collaboration with local community leaders, extension workers, and NGOs can effectively reach remote rural areas.

Theoretical Implications

i. This study underscores the theoretical relationship between financial inclusion factors and food security levels among rural women farmers. It emphasizes the importance of considering financial access and capabilities in addressing food insecurity issues in agricultural communities.
ii. Further exploration of the role of savings and credit mechanisms in improving food security outcomes among rural women farmers is warranted. Developing more nuanced models and theories can guide policy and practice in this area effectively.

Future Recommendations

i. Conducting longitudinal studies to track the long-term impact of financial inclusion interventions on food security outcomes among rural women farmers is recommended. This would provide valuable insights into the sustainability and effectiveness of different policy measures over time.
ii. Complementary qualitative research methods, such as focus group discussions and in-depth interviews, can offer deeper insights into the underlying factors influencing food security and financial inclusion among rural women farmers. This can inform more targeted interventions.
iii. Continual evaluation of existing policies and interventions is essential to identify gaps and areas for improvement. Future studies should focus on assessing the implementation and outcomes of policy measures aimed at enhancing financial inclusion and food security among rural women farmers.

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