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The Determinants of Technology Adoption in Cassava Flake (Gari) Production: Evidence from Nigeria

Ernest Azuma Samuel
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Dissertation submitted to the Applied Economics Graduate Program of the Universidade Federal de Viçosa in partial fulfillment of the requirements for the degree of *Magister Scientiae*.

Adviser: Mateus de C. Reis Neves

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ABSTRACT

SAMUEL, Ernest Azuma, M.Sc., Universidade Federal de Viçosa, October, 2024. **The Determinants of Technology Adoption in Cassava Flake (Gari) Production: Evidence from Nigeria**. Adviser: Mateus de Carvalho Reis Neves. Co-adviser: Leonardo Chaves Borges Cardoso.

This study empirically analyzed the determinants of technology adoption in cassava flake (gari) production in Nigeria. Specifically, the study sought to describe the socio-economic characteristics of gari producers and analyze the factors that affect the adoption of new technologies in the study area. We used a multi-stage sampling technique to estimate a sample size of 250 respondents. Data was collected from primary sources using well-structured questionnaires. We used both descriptive and inferential statistics for the data analysis. The main objective was to analyze using descriptive statistics and statistical tools such as means, frequencies, and percentages. Then, primary data was analyzed using the logistic regression model. Results of the study showed that the factors that contributed majorly to adopting cassava-processing improved technologies among the respondents include income, experience, household size, marital status, age, and education level. Specifically, the study revealed that with a 1% increase in respondent's education level, income, marital status and farming experience, the probability of adoption of new cassava-processing technologies in the area increases by 4.6%, 3.6%, 2.1%, and 2.1% respectively; implying that these factors positively and significantly affect technology adoption in the study area. However, the results also showed that household size and the respondent's age negatively and significantly affect the probability of new cassava-processing technology adoption, as a 1% increase in these variables decreases the probability of adoption by 2.4% and 2.3%, respectively. The study recommended that the government implement policies that can ease access to new technology for the respondents through investments in education and technical assistance, as such policies would help increase technology adoption in the area, amongst other recommendations.

Keywords: cassava flakes; technology adoption; dual-purpose processor

RESUMO

SAMUEL, Ernest Azuma, M.Sc., Universidade Federal de Viçosa, outubro de 2024. **Os determinantes da adoção de tecnologia na produção de flocos de mandioca (gari): evidências da Nigéria**. Orientador: Mateus de Carvalho Reis Neves. Coorientador: Leonardo Chaves Borges Cardoso.

Este estudo analisou empiricamente os determinantes da adoção de tecnologia na produção de flocos de mandioca (gari) na Nigéria. Especificamente, o estudo procurou descrever as características socioeconómicas dos produtores de gari e analisar os factores que afectam a adopção de novas tecnologias pelos produtores de gari na área de estudo, respectivamente. Usamos uma técnica de amostragem em vários estágios para estimar um tamanho de amostra de 250 entrevistados. Os dados foram coletados de fontes primárias por meio de questionários bem estruturados. Utilizamos estatística descritiva e inferencial para a análise dos dados. O objetivo principal foi analisado por meio de estatística descritiva e ferramentas estatísticas como médias, frequências e porcentagens. Em seguida, os dados primários foram analisados por meio do modelo de regressão logística. Os resultados do estudo mostraram que os factores que mais contribuíram para a adopção de tecnologias melhoradas de processamento de mandioca entre os entrevistados incluem rendimento, experiência, tamanho do agregado familiar, estado civil, idade e nível de escolaridade. Especificamente, o estudo revelou que com um aumento de 1% no nível de escolaridade, rendimento, estado civil e experiência agrícola do inquirido, a probabilidade de adopção de novas tecnologias de processamento de mandioca na área aumenta em 4,6%, 3,6%, 2,1% e 2,1%. respectivamente; implicando que esses fatores afetam positiva e significativamente a adoção de tecnologia na área de estudo. No entanto, os resultados também mostraram que o tamanho do agregado familiar e a idade do inquirido afectam negativa e significativamente a probabilidade de adopção de novas tecnologias de processamento de mandioca, uma vez que o aumento de 1% nestas variáveis diminui a probabilidade de adopção em 2,4% e 2,3%, respectivamente. O estudo recomendou que o governo implemente políticas que possam facilitar o acesso às novas tecnologias para os entrevistados através de investimentos na educação e assistência técnica, uma vez que tais políticas ajudariam a aumentar a adopção de tecnologias na área, entre outras recomendações.

Palavras-chave: flocos de mandioca; adoção de tecnologia; processador de dupla finalidade

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SUMMARY

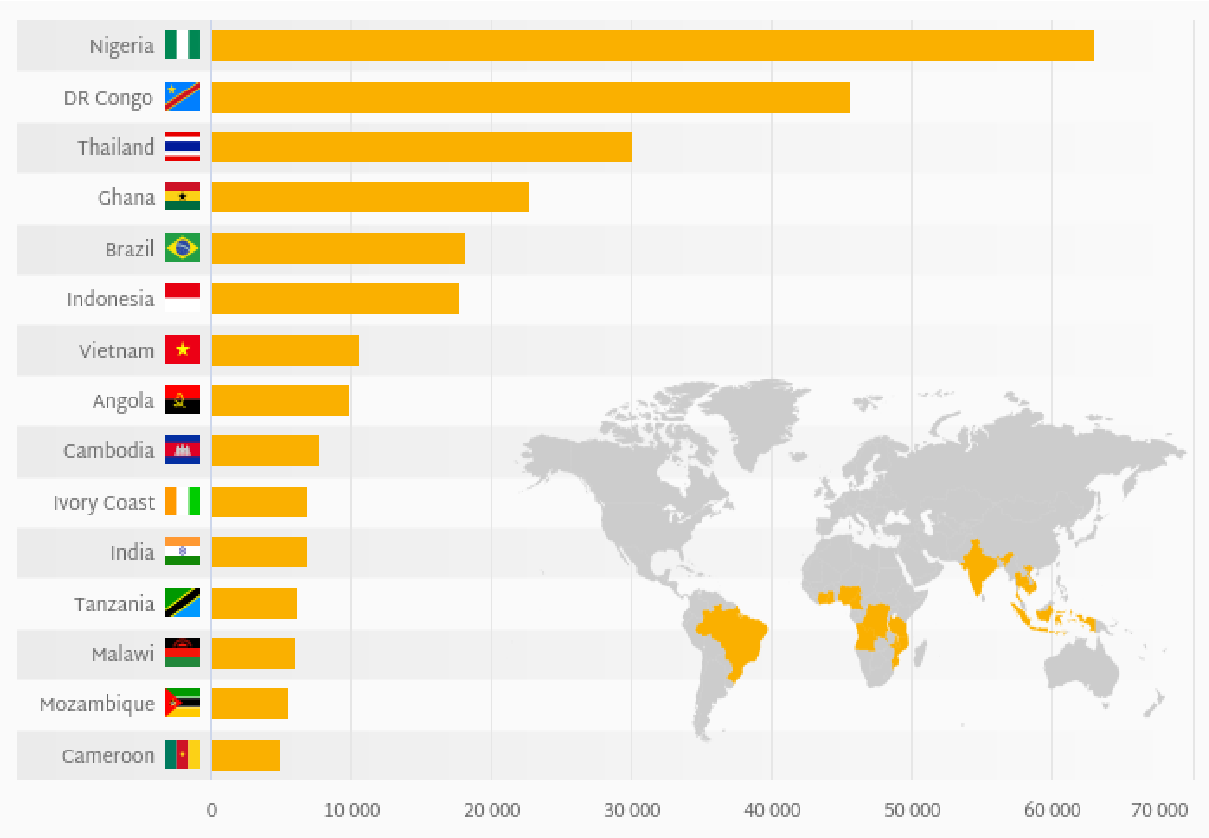
1 INTRODUCTION

Technology has made pertinent contributions to national progress, and its usefulness has attained universal recognition at both national and international levels. In many developing countries, including Nigeria, the lack of appropriate technological and scientific knowledge application limits agricultural and economic progress. Continuous research in food production and efficient extension services is highly desirable to keep pace with the rapid rate of food demand that is attendant upon rapid population growth and help to improve the gloomy food situation and its consequences.

Agriculture constitutes a significant sector of Nigeria's economy. The sector is significant in terms of employment of labor contribution to gross domestic product, and until early 1970, agricultural export was the primary source of foreign exchange earnings (Amaza & Olayemi, 2002). However, in more recent years, there has been a decline in the performance of Nigeria's agriculture. The contribution of agriculture to the GDP, which stood at an average of 50% between 1960 and 1964, declined to 47% in 1965-1969 and, more rapidly, to 32% between 1995 and 1998, Amaza and Olayemi (2002), it then moved to 31.9% in 2011 (Central Intelligence Agency [CIA], 2011). The agricultural sector's changing shares of GDP, which is partly a reflection of relative productivity, is directly related to production efficiency (Amaza & Olayemi, 2002). In Nigeria, the demand for agricultural products is continually rising due to the population increase. This augment has resulted in the need to allocate farm resources efficiently.

Recently, the world cassava production stands at 300 million tonnes, with leading countries like Nigeria, Congo DR, Thailand, and Indonesia ranked 1st, 2nd, 3rd and 4th, respectively, with production in Africa (200 million tonnes in 2022) regarded as the world largest Cassava growing region and unarguably Nigeria remained the highest producer of Cassava in the world with about 60 million tonnes in 2022 (Food and Agriculture Organization [FAO], 2021). The graphical illustration of the cassava production world ranking is presented in Figure 1.

Figure 1 – The cassava production ranking in the world



Source: FAO (2021).

In Nigeria, there are two colors of gari (cassava flake): white and yellow. The yellow is prepared by adding palm oil to the mashed cassava pulp after the manual peeling with a knife to expose the pulp and washing in clean water and then grinding in a machine, while some add palm oil during frying to prevent burning and to reduce the hydrocyanic acid (HCN), which makes it to be considered superior in some areas (Fokunang et al., 2002). Gari occupies a significant part of the diet of West African people, both the urban and rural populace. This is popular because it is cheaper than other food, has easy storage, and is easy to prepare for consumption (Agbo, 2008). Gari is known for its high nutritional content, with crude protein content of 7.4%, 75-84% starch content, and vitamin C content ranging from 13.0 – 24.7 mg/100g (Osagie, 1992).

According to recent studies, modern agricultural technology has contributed significantly to agricultural development, and the gap between developed and developing countries in agricultural production can be attributed mainly to differences in the level of technological development, adaptation and transfer process in Nigeria. In developed nations, there is an advanced level of technical know-how and widespread application of technological innovations, resulting in high productive capability in agriculture and industry. This is not so in Nigeria, where these technologies are rarely available to farmers. Where they are made available, few farmers, usually excluding the users, who are usually women, have access to them (Adekanye, 1983).

Reasons adduced for this low level of access to and subsequent adoption of technological innovations, particularly among users (women), include the lack of access to factors of production- land, labor, capital and limited decision-making authority (Odebode, 2008). Users also find such innovations challenging to maintain even when appropriate for local conditions due to a lack of maintenance and skill training. Consequently, the levels of agricultural production in most developing countries remain low.

Gari (cassava flakes) processing in Cross River State still depends mainly on labor-intensive or traditional techniques. Many aspects of production require considerable labor inputs, like peeling, grating/grinding, and mashing. However, as the labor force in the rural area becomes scarcer and more expensive, the price of inputs increases and the cost of gari in the market also increases consequentially. The quality of gari varies from place to place depending on the nature of the soil. In Cross River State, gari is produced in abundance in the Ikom agricultural zone, which comprises Abi, Obubra, Boki, Ikom, Etung and Yakurr Local Government Areas and gari is produced in the Ogoja agricultural zone, which comprises Ogoja Obanliku, Bekwara, Obudu and Yala Local Government Areas respectively. These locations have good soil characteristics and favorable climatic conditions, which allow for good-quality Cassava production. In the Calabar Agricultural Zone, only a few locations like Akpabuyo, Biase, Akampka and Odukpani can produce desirable quality Cassava, which is, in turn, processed into gari although in smaller quantities when compared to other Agricultural Zones in the State, however, their soil and climate favor vegetable and other tree crops (Neoyi, 2012).

Cassava flake production activities play a crucial role in Nigeria's farming sector in general. It helps feed people, creates jobs, and boosts income for many in rural areas (Nweke et al., 2002; International Institute of Tropical Agriculture [IITA], 2017). Cassava is one of Nigeria's main food crops, forming a big part of the country's farm economy. It is about 20% of the world's output (FAO, 2021). As a staple food, gari is a must-have in daily meals across Nigeria. This is true in Cross River State, where cassava growing is common (Akpan et al., 2012). However, in rural parts, like Akpabuyo Local Government Area, making cassava flakes still needs manual work and yields little. Often, the methods used to process it are not efficient. This limits how much local farmers and processors can make and earn (Adeoti, 2008; Adegbite & Ogunniyi, 2014).

1.1 The problem and its background

The recent food crisis is increasing with alarming speed and force, leading as many as **828 million people to bed hungry every night**. The number of those facing acute food insecurity has soared - from 135 million to 345 million - since 2019. A total of **50 million people in 45 countries are teetering on the edge of famine (**World Food Program [WFP], 2022). While needs are sky-high, resources have hit rock bottom. The World Food Program requires **US$22.2 billion to reach 152 million people in 2022**.

However, with the global economy reeling from the COVID-19 pandemic, the gap between needs and funding is more significant. This has, in turn, necessitated nations and international organizations all over the globe to respond with a strategic and long-term approach. It has been observed that the current crisis is caused by a web of interconnection forces involving COVID-19 pandemic, agriculture, energy, climate change, trade and new market demands from emerging markets and, therefore, has given implications for economic growth and development, international security and social progress in developing countries (Center for Strategic and International Studies [CSIS], 2021). Nigeria, too, is currently experiencing a food crisis. This has been attributed to low productivity in the agricultural sector, necessitating substantial food imports.

Gari, a major staple in Nigeria, is vital to agricultural policy decisions. Despite Gari's economic potential to improve the economic activities of the critical and predominantly female processors, all is not well (Egharevba, 1992; (Ahmed & Wang, 2004)). This is because gari producers are plagued with the long problem of inadequate availability of modern cassava processing equipment such as dual-purpose processors and graters as well as the seasonal variation in product prices, a phenomenon that has been identified as the "cycle effect" in previous studies (RTEP, 2001; Emokaro & Erhabor, 2007). Consequently, processors in the study area are often uncertain whether to engage in the gari business to avoid a market glut.

Embracing new ideas in cassava flake production in rural Nigeria impacts boosting output, improving product quality, and increasing income for small farmers. In the Akpabuyo Local Government Area of Cross River State, cassava flakes, often called "gari," play a vital role in the local community. It serves as a primary food source and generates significant income. Nevertheless, people are slow to adopt new methods and tools in cassava processing. These innovations could make production more efficient, reduce work demands, and increase profits.

A bunch of things shape how new ideas catch on in this field. These include how farmers can get information and training, money problems, whether they can access modern processing technologies, and what people think about trying innovations. On top of that, outside issues like bad roads, prices that go up and down, and trouble getting loans make folks even more unsure about trying new ways. Getting a handle on all this is critical to creating an environment that supports new ideas in making cassava flakes.

Although several studies have been done on cassava processing, such as Peter et al. (2010), Ojo and Ogunyemi (2014), Emokaro et al. (2008), Okpeke and Oyeagocha (2010) and Mbang (2014), there is still paucity of information available on gari production particularly regarding the determinants of adoption of modern cassava processing equipment such as dual-purpose processors and automatic graters, in the study area.

This study investigates the main determinants that impact how people take up new ideas, like a machine that can do two jobs for making cassava flakes (a dual-purpose processor) in Akpabuyo, Nigeria. By finding and checking these parts, the research will show what stops and what helps people use new technologies. It will also advise people who make rules and others involved to push for the use of tech and ways of doing things that can last. Ultimately, this could improve work, help the economy stay strong, and ensure enough food in the area. By working on these problems, the study sought to advise farmers and policymakers based on facts. This will help boost how much cassava flakes are made, ensuring people can keep making a living and have enough food in the area for a long time. Lastly, this research will help us better understand the issues and potential strategies to promote sustainable practices in the cassava industry by identifying the social, economic, financial, and organizational factors influencing people’s adoption of the new technology (a dual-purpose processor).

Given the problem, the study seeks to find possible answers to the research question: what factors affect the adoption of new technologies (dual-purpose processors and automatic graters) by gari producers in the study area?

1.2 Initial hypothesis

The age of the household head, gender, marital status, household size, educational attainment, monthly income of the processor, the experience of the processors, and primary occupation of the cassava processor have significant relationships with the adoption of innovation in the study area.

1.3 Objectives

1.3.1 Primary objective

Analyze the determinants of technology adoption in cassava flake (gari) production in Akpabuyo, Nigeria.

1.3.2 Specific objectives

- Describe the socio-economic characteristics of gari producers in the study area.
- Analyze the factors that affect the adoption of new cassava flakes processing technology (a dual-purpose processor) by gari producers in the study area.

2 LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Theoretical framework

2.1.1 Theory of production

Production combines resources to create a commodity that an individual, organization or society needs Lavison, (2013).

The production function stipulates the technical relationship between inputs and output in the production process (Abang et al., 2008). A production function is a mathematical statement of the physical relationship, given by technologies, between a firm input of productive resources and the output of goods and services per unit of time. Given existing technology, a firm's production function establishes the rate of output flow and the rate of flow of corresponding inputs needed to produce it, Lavison, (2013).

Also, Akpan (2006) defines production as any that creates output or value that encompasses any work whose result people want and would give money in exchange for that end or result. This theory involves some of the most fundamental principles of economics, including the relationship between the prices of productive factors used to produce them and the relationship between the prices of commodities and productive factors.

2.1.2 Theory of processing

Agricultural processing transforms agricultural products into food or one form of food into other forms. Food processing includes many forms of processed food, from grinding grain to making raw flour to home cooking to complex industrial methods used to make convenience foods.

The aims of the food industry today, as in the past, are fourfold:

1) To extend the period during which food remains wholesome (the shelf life) by preservation techniques that inhibit microbiological or biochemical changes and thus allow time for distribution, sales and home storage.
2) To increase variety in the diet by providing a range of attractive flavors, colors, aromas and textures in food (collectively known as eating quality, sensory characteristics or organoleptic quality); a related aim is to change the form of the food to allow further processing (for example the milling of grains to flour).

3) To provide the nutrients required for health (termed nutritional quality of a food).
4) To generate income for the manufacturing company. Each aim exists to a greater or lesser extent in all food production but processing a given product may emphasize some more than others. For example, frozen vegetables are intended to have sensory and nutritional qualities that are as close as possible to fresh products but with a shelf life of several months instead of a few days or weeks. The primary purpose of freezing is, therefore, to preserve the food. In contrast, sugar confectionery and snack foods are intended to provide variety in the diet, and many shapes, flavors, colors and textures are produced from basic raw materials. All food processing involves a combination of procedures to achieve the intended changes to the raw materials. These are conveniently categorized as unit operations, each having a specific, identifiable, predictable effect on food. Unit operations are grouped to form a process. The combination and sequence of operations determine the nature of the final product. In industrialized countries, the market for processed foods is changing, and in contrast to earlier years, consumers no longer require a shelf life of several months at ambient temperature for most of their foods. Changes in family lifestyle and increased ownership of freezers and microwave ovens are reflected in demands for foods that are convenient to prepare, are suitable for frozen or chilled storage, or have a moderate shelf life at ambient temperatures. Consumers increasingly demand foods with fewer synthetic additives or have undergone fewer changes during processing.

2.2 Review of related studies

2.2.1 Socio-economic characteristics of gari producers

According to Okpeke and Oyeagocha (2010), in a study on the analysis of processing cassava tubers to gari in Isoko North Local government area of Delta State, Nigeria, found that 95% of the respondents were females. This could be attributed to the fact that food processing is believed to be the responsibility of women in the society (Erhabor et al., 2004), which showed an aging population among cassava processors in Edo state with a predominantly female population. The results also showed that the highest age of the respondents was between 50-60 years. Most of the farmers had their level of education at the secondary level.

2.2.2 Determinants of agricultural technology adoption

A vast body of literature exists on factors determining agricultural technology adoption. According to Loevinsohn et al. (2012), farmers' decisions about whether and how to adopt new technology are conditioned by the dynamic interaction between the characteristics of the technology itself and the array of conditions and circumstances. Diffusion itself results from a series of individual decisions to begin using the new technology, often the result of comparing the uncertain benefits of the invention with the uncertain costs of adopting it (Hahn & Khan, 2002). Understanding the factors influencing this choice is essential for economists studying the determinants of growth and for the generators and disseminators of such technologies (Hahn & Khan, 2002).

Sadeghi et al. (2007) found that more educated farmers would likely adopt the selected technologies. Education provides human capital and skills that enable farmers to evaluate their production-related decisions properly. Wealth and access to credit through social networks were also found to positively and significantly influence technology adoption.

Furthermore, the farm size, as measured by the land area, was found to have significant and positive impacts on technology adoption. Jaleta et al. (2009) used rural Ethiopian household data and found that farmers with more education, access to credit, and other means of assistance from informal institutions were more likely to adopt a mill. They also found that the location of farmers, social participation, and religious beliefs influenced technology adoption. Gonzales et al. (2003) suggest that the participation of organizations and local networks can affect patterns of diffusion and learning. Their research also assumes that benefits increase with the income and education of the farmer.

Several empirical studies have been conducted on technology adoption in agriculture, but few have focused on gari production in Nigeria. One of the studies on gari production includes Dube (2013). The available studies, which focused on technology adoption in agriculture, generally found a few universally applicable, theoretically supported, and empirically validated factors explaining differences in technology uptake in the sector. Caswell, et al. (2001) used farm-level data from Thailand and found that wealthy entrepreneurs have better access to credit and information, have a more flexible risk-taking capacity, and have more suitable risk attitudes when adopting new technologies. Hence, wealth was found to positively and significantly influence technology adoption. The study also found that educational attainment and access to credit through social networks positively and significantly influence technology adoption.

Traditionally, economic analysis of technology adoption has sought to explain adoption behavior with personal characteristics and endowments, imperfect information, risk, uncertainty, institutional constraints, input availability, and infrastructure (Feder et al., 1985; Koppel, 1994; Foster & Rosenzweig, 1995; Kohli & Singh, 1997; Rogers, 2003; Uaiene, 2011). More recent literature has included social networks and learning as the factors determining technology adoption (Uaiene, 2011). Some studies classify these factors into different categories. For example, Akudugu et al. (2012) grouped the determinants of agricultural technology adoption into three categories: economic, social and institutional factors.

Although there are many categories for grouping determinants of technology adoption, there is no clear distinguishing feature between variables in each category. Categorization is done to suit the current technology being investigated, the location, and the researcher's preference, or even to suit client needs (Bonabana-Wabbi, 2002). For instance, some researchers have classified a farmer's education level as human capital, while others classified it as a household-specific factor. This study will review the factors determining agricultural technology adoption by categorizing them into technological, economic, institutional, and household-specific factors. This will enable an in-depth review of how each factor influences adoption.

2.2.2.1 Technology factors

The characteristics of technology are preconditions for adopting it. The degree to which a potential adopter can try something on a small scale before adopting it entirely is a significant determinant of technology adoption (Doss, 2003). In studying determinants of adopting Imazapyr-Resistant maize (IRM) technology in Western Kenya, Mignouna et al. (2011) stated that the characteristics of the technology play a critical role in the adoption decision process. They argued that farmers who perceive technology as consistent with their needs and compatible with their environment will likely adopt it since they find it a positive investment. Farmers' perception of the performance of the technologies significantly influences their decision to adopt them. A study by Adesina and Zinnah (1993) showed that farmers' perception of the characteristics of modern rice variety significantly influenced their decision to adopt it.

2.2.2.2 Economic factors

Farm size plays a critical role in adopting new technology. Many authors have analyzed farm size as an essential determinant of technology adoption. Farm size can affect and, in turn, be affected by the other factors influencing adoption (Lavison, 2013). Some technologies are called scale-dependent because of farm size's great importance in their adoption (Bonabana-Wabbi, 2002). Many studies have reported a positive relationship between farm size and agricultural technology adoption (Kasenge, 1998; Gabre-Madhin & Haggblade, 2001; Ahmed, 2004; Uaiene, 2011; Mignouna et al., 2011). Farmers with large farm sizes are likely to adopt new technology as they can afford to devote part of their land to trying new technology, unlike those with smaller farm sizes (Uaiene, 2011).

A key determinant of adopting new technology is the net gain to the farmer from adoption, including all costs of using the new technology (Foster & Rosenzweig, 1995). The cost of adopting agricultural technology is a constraint to technology adoption. For instance, the elimination of subsidies on prices of seed and fertilizers since the 1990s due to the World Bank-sponsored structural adjustment programs in sub-Saharan Africa has widened this constraint (Muzari et al., 2012). Previous studies on determinants of technology adoption have also reported the high cost of technology as a hindrance to adoption.

2.2.2.3 Institutional factors

Acquisition of information about new technology is another factor that determines technology adoption. It enables farmers to learn about technology's existence and practical use, facilitating its adoption. Farmers will only adopt the technology they know or have heard about. Access to information reduces the uncertainty about a technology's performance and hence may change an individual's assessment from purely subjective to objective over time (Caswell et al., 2001; Bonabana-Wabbi, 2002).

Access to extension services has also been a critical aspect of technology adoption. Farmers are usually informed about the existence, practical use, and benefit of new technology through extension agents. An extension agent acts as a link between the innovators (researchers) of technology and users of that technology. All of this helps reduce transaction costs incurred when passing the information on the new technology to a large heterogeneous population of farmers (Genius et al., 2014). Extension agents usually target specific farmers who are recognized as peers (with whom a particular farmer interacts) exerting a direct or indirect influence on the whole population of farmers in their respective areas (Genius et al., 2014).

Many authors have reported a positive relationship between extension services and technology adoption. A good example includes the adoption of Imazapyr-Resistant Maize Technologies (IRM) by Mignouna et al. (2011). Other examples include factors determining technology adoption among Nepalese (Karki & Siegfried, 2004; Uaiene, 2011); the adoption of improved maize and land management in Uganda (Sserunkuuma, 2005); and the adoption of modern agricultural technologies in Ghana (Akudugu et al., 2012). Exposing farmers to information based on innovation-diffusion Theory is expected to stimulate adoption (Uaiene, 2011). The influence of extension agents can counterbalance the negative effect of a lack of years of formal education in the overall decision to adopt some technologies (Yaron et al., 1992; Bonabana-Wabbi, 2002).

Access to credit has been reported to stimulate technology adoption (Mohamed & Temu, 2008). Access to credit is believed to promote the adoption of risky technologies by relaxing the liquidity constraint and boosting household risk-bearing ability (Simtowe & Zeller, 2006). This is because, with the option of borrowing, a household can do away with risk-reducing but inefficient income diversification strategies and concentrate on more risky but efficient investments (Simtowe & Zeller, 2006). However, access to credit is gender biased in some countries where credit institutions discriminate against female-headed households, and as such, they cannot finance yield-raising technologies, leading to low adoption rates (Muzari et al., 2012).

2.2.2.4 Household-specific factors

The human capital of the farmer is assumed to have a significant influence on farmers' decision to adopt new technologies. Most adoption studies have attempted to measure human capital through the farmer's education, age, gender, and household size (Fernandez-Cornejo et al., 1994; Fernandez-Cornejo et al., 2007; Mignouna et al., 2011; Keelan et al., 2009). Education of the farmer has been assumed to influence farmers' decision to adopt new technology positively. The education level of a farmer increases his ability to obtain, process and use information relevant to adopting new technology (Mignouna et al., 2011; Lavison, 2013; Namara et al., 2003).

On the other hand, some authors have reported insignificant or adverse effects of education on the rate of technology adoption (Grieshop et al., 1988; Khanna, 2001; Banerjee et al., 2008; Samiee et al., 2009; Ishak & Afrizon, 2011). Studying the effect of education on technology adoption, Uematsu and Mishra (2010) reported a negative influence of formal education towards adopting genetically modified crops. Since the above empirical evidence has shown mixed results on the influence of education and the adoption of new technology, more studies must be done to produce a more consistent result.

Age is also assumed to be a determinant of adopting new technology. Older farmers are assumed to have gained knowledge and experience over time and are better able to evaluate technology information than younger farmers (Mignouna et al., 2011; Kariyasa & Dewi, 2011). On the contrary, age has a negative relationship with technology adoption. This relationship is explained by Mauceri et al. (2005) and Adesina and Zinnah (1993): as farmers grow old, there is an increase in risk aversion and a decreased interest in long-term investment in the farm. On the other hand, younger farmers are typically less risk-averse and are more willing to try new technologies. For instance, Alexander and Van Mellor (2005) found that adopting genetically modified maize increased with age for younger farmers as they gained experience and increased their stock of human capital but declined with age for those farmers closer to retirement.

Gender issues in agricultural technology adoption have been investigated for a long time, and most studies have reported mixed evidence regarding the different roles men and women play in technology adoption (Bonabana-Wabbi, 2002).

In the same vein, different authors have also undertaken independent studies to ascertain, specifically, the determinants of the adoption of new technologies for cassava processing in various countries and regions. Some of these studies are as follows.

The study by Ehinmowo and Fatuase (2016), on “Adoption of Improved Cassava Processing Technologies by Women Entrepreneurs in South-West, Nigeria”, revealed that about 67% of the women entrepreneurs adopted improved technologies, with cassava mechanical grater being the most used improved technology while the factors affecting adoption of the technologies were educational status, source of information, credit and raw material.

Furthermore, Abdoulaye et al. (2013) undertook a study on the awareness and adoption of improved cassava varieties and processing technologies in Nigeria; results revealed that male sexes of respondents were more likely to adopt the innovation than female sexes, but the probability is not significant, while training of farmers and processors through R4D programs has led to increased use of improved technologies.

Also, the study by Obisesan (2014) on gender differences in technology adoption and welfare impact among Nigerian farming households showed that the adoption of new cassava processing technology was significantly influenced by gender, participation in off-farm activities, distance to market, land area cultivated, years of farming experience, access to credit, cassava yield and level of education.

Moreover, Owombo et al. (2012) also studied the Economic Impact of Agricultural Mechanization Adoption on Maize Farmers in Ondo State, Nigeria. The result of the logistic regression revealed that education, extension visits, and machine access were significant determinants of the adoption of mechanization practices.

In addition, the study done by Ojo and Ogunyemi (2014), on the "Analysis of Factors Influencing the Adoption of Improved Cassava Production Technology in Ekiti State, Nigeria", revealed that the result of the probit model showed that age, marital status, household size, membership of cooperative society, ownership status, primary occupation, contact with extension agent and feedback from the extension personnel were the significant determinants of adoption of improved cassava production technology in the study area.

Finally, Adebayo (2009), in his study on the dynamics of technology adoption in rural-based cassava processing enterprises in South-West Nigeria, revealed a significant and positive relationship between the adoption of the cassava grater and processors' household income level.

3 METHODOLOGICAL FRAMEWORK

3.1 Area of study

Akpabuyo Local Government Area became autonomous on Tuesday, August 27, 1991, following its creation from the former Odukpani Local Government Area. It became the 14th and 589th Local Government Area in Cross River State and Nigeria, respectively. Akpabuyo has a population of 374,598 people and is in the Southern Senatorial District with headquarters at Ikot Nakanda.

Akpabuyo Local Government Area lies between latitude 4°5’ and 5°40’ and longitude 8°25’ and 8°32’ East. It lies within the vegetation belt of southern Nigeria and shares the Atlantic coastline with Bakassi to the East and the Republic of Cameroon to the West. Akpabuyo Local Government Area, which measures approximately 28.5 square kilometers, is predominantly agricultural and known as the Food Basket of Cross River State.

It consists of 10 (ten) Council Wards, namely: Idundu/Anyananse, Atimbo East, Atimbo West, Ikot Edem Odo, Eneyo, Ikot Nakanda, Ikot Eyo, Ikang North, Ikang South and Ikang Central.

3.1.1 Potentials of Akpabuyo Local Government Area in Cassava production and processing

Akpabuyo Local Government Area (LGA), in Cross River State, Nigeria, has a lot to offer in cassava production and processing in turning cassava into “gari”, a food many Nigerians eat often. Farmers in Akpabuyo have grown cassava for a long time, thanks to good weather, rich soil, and the fact that many people there rely on farming to live and make money. The area’s good location and social setup allow it to grow more cassava and build a strong processing industry. This could help locals earn more, have enough food, and boost the economy.

3.1.1.1 Good farming conditions

Akpabuyo has a tropical climate with plenty of rain, which creates a perfect setting to grow cassava. Cassava can thrive in different types of soil and weather conditions, and it does well with the rainfall and soil found in Cross River State (Odoemenem & Otanwa, 2011). The warm temperatures and year-round growing season allow cassava farmers in Akpabuyo to produce big harvests. Also, the soil in Akpabuyo suits cassava well, being rich in nutrients and suitable for root crops. Research shows that these natural benefits make Akpabuyo one of the most promising areas in Nigeria to boost cassava production (IITA, 2017).

3.1.1.2 Strong cultural reliance on cassava and gari production

In many places in Nigeria, including Akpabuyo, cassava is a huge deal. Many people consider cassava more than simply a crop; it is an essential component of their daily diet. They use it to make tapioca, gari, and fufu, among other things. In Akpabuyo, gari is incredibly well-liked and appears in almost every home. In addition to being delicious, it satisfies their energy and nutritional requirements. Because of this close relationship, making flakes out of cassava has become an essential aspect of local life. It sustains a whole market for cassava goods and maintains a constant demand (Nweke et al., 2002).

3.1.1.3 Availability of labor and interest in agricultural entrepreneurship

Akpabuyo is a rural area, and there is much unemployment. This situation means a ready and willing workforce is essential for the hands-on work of cassava processing. Many young people are looking for jobs that could help boost cassava production and processing.

More agricultural entrepreneurship has been encouraged recently by governmental and non-governmental organizations, and it is relevant to see that young people in the area are increasingly engaged in agribusiness. On that note, the cassava flake business may benefit greatly from focused programs emphasizing agricultural entrepreneurship. It could be pretty beneficial to teach young adults about modern processing methods, corporate management, and even market development (Akinola et al., 2019).

3.1.1.4 Potential for mechanized processing and value addition

The processing is traditionally done in the villages of Akpabuyo. There is, however, much opportunity to apply mechanized means and process the cassava flakes more efficiently. Mechanization would decrease the processing time, lessen the cost of labor, and enhance the quality and consistency of gari so it can compete in both local and external markets. Besides, there is a high-value addition that could be achieved through better packaging, branding, and diversification of the product, making Akpabuyo a leading center in cassava flake production and attracting investment to enhance local people's incomes (Oyewole & Odunfa, 2014).

3.1.1.5 Increasing demand for cassava-based products

The increasing demand for gari and other cassava-based products within Nigeria and other neighboring areas thus presents a potentially viable market outlet for Akpabuyo. This has driven high demand for cassava flakes, an affordable and accessible staple food, nationally and in the surrounding West African countries. This is also further guaranteed through the Nigerian government's policy, which creates favorable conditions for indigenous cassava production, like many other foodstuffs, by introducing import restrictions in various forms. Hence, such market demand will likely attract Akpabuyo's products and stimulate further cassava production and investment into state-of-the-art processing facilities (International Fund for Agricultural Development [IFAD], 2016).

3.1.1.6 Possible government and NGO support

Being a rural area, Akpabuyo has the potential to collaborate with governmental and non-governmental programs set aside to support agricultural development. Most governmental policies, like those initiated through the Anchor Borrowers' Program by the Central Bank of Nigeria, have their basis in providing credit facilities to farmers in staple crops, such as cassava (Central Bank of Nigeria [CBN], 2019). Other international organizations, such as IFAD and IITA, are also very active in cassava research, dissemination of improved cassava varieties, and promotion of sustainable agricultural practices. This can be a means of accessing improved breeds, modern technologies for processing cassava, and market linkages to enhance Akpabuyo's capacity for cassava development (IFAD, 2016; IITA, 2017).

3.1.1.7 Socio-economic benefits and poverty alleviation

Cassava flake production could reduce poverty in Akpabuyo through employment and income improvements for the rural population and ultimately ensure food security. Each stage of the cassava value chain, from farming to processing and marketing, can contribute significantly to household income, especially for women and youth, who are identified as the most valuable players along the cassava processing value chain. This might create more employment, diversification of livelihood means, and a reduction in the region's poverty levels to improve local communities' socio-economic living standards (Nwankwo et al., 2020).

3.2 Data description, treatment and sources

Akpabuyo is known to be the highest contributor to the State's cassava flake manufacturing industry. For one reason or another, Akpabuyo has become the center of cassava flake production:

- **Agricultural potential**: Akpabuyo presents highly fertile land suitable for cassava crop production. Cassava is the primary raw material in the production of cassava flakes. Based on soil and climatic features, Akpabuyo is suitable for cultivating the cassava crop.
- **Cassava supply**: Most small-scale farmers in the area engage in cassava planting; the tuber is very much available there. A steady and reliable source for the roots is a very viable avenue to set up to produce cassava flakes and further allows for sustainability in Akpabuyo.
- **Infrastructure support**: Akpabuyo has a lot of road networks and transport infrastructure; hence, access to moving cassava from farms to the centers where the processing is carried out is not hard. Infrastructure provides manufacturers with practical and timely cassava delivery, enabling smooth production.
- **Processing facilities**: There are several cassava processing factories in the local government for flake production. These are equipped with modern machinery and technology to facilitate large-scale cassava flake production.
- **Job opportunities**: The cassava flake-producing industry has brought various forms of employment to the people of Akpabuyo. These are from the on-farm laborers used in tilling the soil and planting cassava to the off-farm used in the various levels of processing.
- **Market access**: Akpabuyo enjoys being proximal to Calabar, the seat of Cross River State. Such proximity to Calabar ensures that access to cassava flakes produced within the locality is easy for a vast market. The attractiveness of Akpabuyo as a producer is thus an added advantage due to the high demand for cassava flakes within and around Calabar.

Akpabuyo Local Government Area has established itself as a significant hub for cassava flake production in Cross River State, Nigeria, due to suitable agricultural conditions, abundant cassava supply, supportive infrastructure, processing facilities, employment opportunities, and market access.

A multi-stage sampling technique was adopted to select the respondents for the study. The sample size was predetermined using the Yamane (1967) method developed for statistical purposes. It is given as thus:

$$n = \left(\frac{N}{1 + Ne^2}\right)$$

Where n = 250 = collected sample size; N = 2567 = population size; and e = margin of error (MoE), e = 0.06 based on the research condition.

The first stage of the sampling employed was the purposive sampling technique, which was carried out by deliberately selecting five council wards out of the 10 council wards (namely: Idundu/Anyananse, Atimbo East, Atimbo West, Ikot Edem Odo, Eneyo, Ikot Nakanda, Ikot Eyo, Ikang North, Ikang South and Ikang Central) in the study area (villages where gari production is still active). A purposive selection was aided by a comprehensive data list of Council Wards in the area with a higher population of households engaging in cassava flake production obtained from the Ministry of Agriculture of the State. Afterward, the second stage of the sampling was executed, where fifty well-structured questionnaires were randomly distributed to cassava processors in the five villages purposefully selected from the first stage, amounting to two hundred and fifty respondents in the study area.

Before the main survey exercise, a presurvey was done through a focus group meeting two weeks before the survey, during which ten selected households in the area were given the first draft of the questionnaires to fill in their answers. This exercise immensely helped in adjusting the questions on the questionnaire to suit the requirements of this study.

3.2.1 Data collection

Cross-sectional data was used for this study. A survey design was used to obtain the data through questionnaires, focused group discussions (FGDs) and oral interviews of 250 respondents in the study area.

3.2.2 Sample frame

The targeted population that was used in the study comprises all cassava processors in Akpabuyo Local Government Area.

3.2.3 Cassava processing equipment

Table 1 below generally briefly highlights the difference between traditional and modern equipment used in the production process of cassava flakes in the study area. In this vein, and more specifically, the difference between using a dual-purpose cassava flake processor and traditional equipment in terms of productivity is explained in the following paragraphs.

Table 1 – Traditional and improved cassava processing technologies / equipment in the study area

S/N	Processing stages	Traditional technology	Improved technology
1	Peeling	Knife made of bamboo, flint	Mechanical peeler Motorized peeler Hand peeler Hand raster
2	Washing	Local calabash bowl	Aluminum tank
3	Grating	Rough stone, the prickly trunk of palms sheet/tin iron pierced with a nail on one side	Mechanized grater Motorized grater Hammer mill Disk grater Hand grater
4	Fermentation	Heavy stone on heavyweight cloth or nylon bag	Batch fermentation in an aluminum tank, locally made hydraulic or mechanical
5	Dewatering/pressing	Heavy stone on heavyweight cloth nylon bag (for several days)	Hydraulic jack press screw press, parallel board press, upgraded traditional press that presses for few minutes
6	Sieving	Woven baskets, suspended cloth	Improved pulverizer, e.g., drum sieve, rotating sieve
7	Frying	Cast iron pan over a wood fire	Upgraded roaster, solar dryer, and kiln-type dryer
8	Sifting	Woven basket	Improved pulverizer and sifter

Source: field survey (2023).

In the Akpabuyo Local Government Area of Cross River State, cassava is conventionally processed by hand or semi-manually, and most operations are done with simple laboring equipment for peeling, grating, and frying. This is very time-consuming and laborious, characterized mainly by a decline in the quality of the products. The conventional processing methods have high human involvement and relatively low returns; hence, local processors' overall productivity and profitability limitations have been constrained.

On the contrary, a dual-purpose cassava flake processor is a much more efficient way to process cassava. This equipment is designed to combine multiple units or sequences of work such as peeling, grating, and frying to minimize the time and effort spent handling one batch. Automation and the combination of several stages by the dual-purpose processor save labor and yield larger output per unit of time in cassava flakes, hence, more productivity. This is so because a processor can process more cassava within a relatively short period than it would have been done with traditional methods.

This greatly enhances productivity because more output can be realized quickly, helping Cassava processors meet the increased demand and probably higher returns. Most importantly, it enhances quality control through automation, producing uniform flakes that appeal to local and export markets. It also reduces labor costs since the processor requires less manual effort, creating a healthier work environment for employees. It reduces downtime and processing delays and is highly time-efficient, especially at peak demand periods. The faster the processor processes the cassava, the less post-harvest loss the crop will incur, and more of it can be freed for practical use.

In general, the dual-purpose processor contributes to local economic development in Akpabuyo by enhancing productivity and profitability, which, in effect, increases employment opportunities and income levels in the community.

3.2.4 Analytical techniques

Analytical techniques employed in this study include descriptive statistics and the logit regression model.

3.3 Model specification

3.3.1 Logit regression model

The logit regression model will be used to analyze the objective, which is analyzing the factors that affect the adoption of new technologies by gari processors in the study area. Some researchers have also used this model in the past, such as Hosmer and Lemeshow (2000), Dumitrescu et al. (2022) and Menard (2010), and it has been proven reliable. The logit model can generally be expressed as:

$$P(Y_i = 1) = e^{\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k} / (1 + e^{\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k}) \quad (1)$$

Where $P(Y_i = 1)$ = the probability that the dependent variable for an entity with characteristic i will take the value 1; β_0, β_1..., β_k = model parameters; x_1, …, x_k = independent variables.

The left-hand side of the equation represents the conditional probability that the dependent variable (Y) takes the value 1 given specific values of the independent variables (x_1, x_2, ..., x_k).

However, this model can be specified as thus:

$$\text{logit}(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \varepsilon \quad (2)$$

In this model, logit(Y) represents the log-odds of the dependent variable Y (new cassava processing technology-dual purpose processor). The β_0, β_1, β_2, β_3, β_4, β_5, β_6, β_7, and β_8 are the coefficients or parameters associated with the respective independent variables X_1, X_2, X_3, X_4, X_5, X_6, X_7, and X_8 respectively. ε represents the error term.

3.3.2 Selection of explanatory variables

The explanatory variables specified as determinants of the adoption level of the Federal Government Cassava Processing Transformation Initiative in the study area are defined thus:

X_1 = gender (male 0, female 1)

X_2 = age of the household head (years)

X_3 = educational attainment (years in school)

X_4 = marital status (married 1, otherwise 0)

X_5 = household size (number of persons)

X_6 = main occupation (farming = 1, otherwise = 0)

X_7 = experience of the processors (years)

X_8 = monthly income of the processor (₦)

4 RESULTS AND DISCUSSIONS

This research topic comprises a presentation and detailed discussion of the results obtained from the data analyzed.

4.1 An overview of the new technology (dual-purpose cassava processor) in the study area

Installing a dual-purpose cassava processor in the Akpabuyo Local Government Area of Cross River State, Nigeria, has resulted in substantial innovation in the manufacturing of cassava flake. This processor is intended to increase the efficiency and efficacy of cassava processing.

First, by optimizing the cassava processing workflow, the dual-purpose cassava processor improves efficiency. It combines numerous phases of the processing chain into a single machine, including peeling, washing, grating, dewatering, and frying. Automating these procedures reduces manual labor, saving time and effort tremendously. This increased efficiency enables processors to fulfill the growing demand for cassava flakes by increasing production capacity.

In addition, by maintaining uniform quality and eliminating post-harvest losses, the processor improves the efficiency of cassava processing. The unique design combines characteristics that improve the peeling and washing operations, resulting in cleaner and more uniform cassava roots. This aids in removing contaminants and improves the general quality of the finished product. The dewatering and frying steps are also precisely regulated to obtain the cassava flakes' correct moisture content and crispiness. As a result, processors can constantly make high-quality cassava flakes that suit consumer expectations.

Implementing this dual-purpose cassava processor has improved cassava processing in Akpabuyo Local Government Area. It has improved production efficiency, allowing processors to handle higher amounts of Cassava and effectively meet market demand. Furthermore, increased cassava flake quality ensures customer happiness and increases market competitiveness. This innovation contributes to the local community's economic growth and development by minimizing post-harvest losses and boosting processing capacities.

The dual-purpose cassava processor in Akpabuyo Local Government Area is believed to be an efficient and effective solution for cassava flake manufacturing. It combines several processing stages, optimizing the workflow and increasing production. With its ability to reliably generate high-quality cassava flakes, this technology has become an invaluable resource to cassava processors in the area.

4.2 Description of the socio-economic characteristics of the respondents

The result in Table 2 below revealed that the majority (50.4%) of the respondent farmers' households' heads were male, although there is no significant difference between the number of households headed by males and that headed by females. This indicated that cassava processing activities in the study area are not gender specific. This finding aligns with Chah et al. (2014), who revealed that men engage in farming more than women. However, the result contradicts that of the study of Okpeke and Oyeagocha (2010), who found that 95% of the respondents were females and the assertion of Erhabor et al. (2004) that the high participation rate of women could be attributed to the fact that the processing of food is believed to the responsibility of women in the society.

The result further revealed that the mean age of the respondents was 48 years, implying that most of the household heads were youths, which could contribute to the high innovation adoption rate in the area. This result does not align with that of Nnaemeka (2022), who found that most respondents were old.

The result showed that most (88%) respondents attained at least primary formal education, implying that most were literate. Meanwhile, the average household size was seven members. This high rate of formal education attainment could be because the study area is very close to the State's capital, which helps create easy access to schools. Interestingly, this result agrees with that of Nnaemeka (2022) and disagrees with the other, as he found out that most respondents had a household of 6. His results also showed that few respondents in the country attended primary school, and 2 out of the 77 had no education. This suggests that most of the farmers in Nigeria are not educated, and as such, one of the reasons for food insecurity and the high poverty rate. Also, Ogunkoya (2014) revealed that most farmers are not educated. This contraction could be due to differences in the study areas.

Similarly, the result also revealed that most (36%) processors have more than 14 years of cassava-processing business experience, with an average of about 12 years. Meanwhile, the majority (36%) were traders. This implies that most of the respondents in the area may not have taken farming as their primary source of income. However, the experience could significantly affect the area's adoption rate of improved cassava processing technology.

Table 2 – Socio-economic characteristics of the respondents

Characteristic	Frequency	Percentage	Mean
Sex			
Male	126	50.40	**N/A**
Female	124	49.60	
Total	**250**	**100.00**	
Innovation			
Adopters	212	84.80	**N/A**
Non-adopters	38	15.20	
Total	**250**	**100.00**	
Age(yr)			
Between 20-30	12	4.80	**48**
Between 31-40	64	25.60	
Between 41-50	93	37.20	
Above 50	81	32.40	
Total	**250**	**100.00**	
Education level(yr)			
No formal education	30	12.00	**N/A**
Primary	135	54.00	
Secondary	73	29.20	
Post-secondary	12	4.80	
Total	**250**	**100.00**	
Marital status			
Married	195	78.00	**N/A**
Divorced	8	3.20	
Single	17	6.80	
Others	30	12.00	
Total	**250**	**100.00**	
Household size (nº)			
< 4	92	36.95	**7**
Between 5-9	141	56.63	
≥ 10	17	6.43	
Total	**250**	**100.00**	
Main occupation			
Farming	64	25.60	**N/A**
Civil service	42	16.80	
Trade	90	36.00	
Others	54	21.60	
Total	**250**	**100.00**	
Experience (yr)			
< 5 years	21	8.40	**12**
Between 5-9	81	32.40	
Between 10-14	56	22.40	
> 14	92	36.80	
Total	**250**	**100.00**	
Monthly income (₦)			
Very low < 30,000 (min. wage)	16	6.40	**155,255**
Low (between 30,000-80,000)	40	16.00	
Medium (between 81,000-120,000)	66	26.40	
High (> 120,000)	128	51.20	
Total	**250**	**100.00**	

Source: Field survey (2023).

Finally, the result revealed that the majority (78%) were married. Most processors had a monthly income above ₦120,000, with an average of about ₦155,000. This result again contradicts that of Nnaemeka (2022), as he found in his study that most farmers received an annual average income of ₦21,000 – ₦29,000.

4.3 Factors affecting improved technology adoption for cassava processing

The result in Table 3 below reveals that as the sex (X_1) increases by 1% from female to male, the probability of the respondents adopting improved cassava-processing technology in the study area decreases by about 0.03%. This result is, however, not statistically significant, implying that the sex of a respondent does not affect innovation adoption in the area. This result aligns with that of Abdoulaye et al. (2013) on the awareness and adoption of improved cassava varieties and processing technologies in Nigeria. Their results revealed that male respondents are more likely to adopt the innovation than female respondents, but the probability is not significant, with a coefficient of 0.236. However, this contradicts that of Obisesan (2014) on gender differences in technology adoption and welfare impact among Nigerian farming households, as he found out that the gender of the farmer is significant ($p<0.01$) and has a positive sign, implying that males are more likely to adopt the use of improved cassava production technology than their female counterparts. As a result, being a male farmer will increase adoption by 13.83%. This shows that male farmers have better access to information and other resources on improved cassava production technology and are likelier to adopt new technology than their female counterparts. This result agrees with Tesfaye et al. (2001), Mesfin (2005), and Omonona et al. (2006).

Furthermore, the result shows that the age (X_2) of the respondent has a generally negative and significant impact on the probability of adopting improved cassava-processing technology in the area. Specifically speaking, the result reveals that as the respondent's age advances from age below 30 years to ages of 50 years and above, he or she tends to have a lower probability of adopting the innovation, revealing that 1% increase in the respondent above 40 years decreases the probability of adoption of the technology by about 2.3%. This result aligns with that of Adebayo (2009) on the dynamics of technology adoption in rural-based cassava processing enterprises in South-West Nigeria, who discovered that there was a significant and negative relationship between the adoption of the cassava grater and processors' age.

Table 3 – Factors affecting technology adoption for cassava processing

Factors	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
Sex	-.312	.546	-0.57	.568	-1.383	.758	
Age							
2 (30-40 yrs old)	-.766	1.194	-0.64	.521	-3.105	1.573	
3 (41-50 yrs old)	-2.29	1.088	-2.10	.035	-4.424	-.157	*
4 (> 50 years)	-2.306	1.316	-1.75	.08	-4.884	.273	**
Education level							
2 (primary)	2.577	.79	3.26	.001	1.028	4.126	**
3 (secondary)	3.11	1.471	2.11	.035	.226	5.994	***
4 (post-secondary)	4.638	1.146	4.05	0	2.391	6.885	***
Marital status	2.068	.59	3.51	0	.912	3.223	***
Family size	.854	.668	1.28	.201	-.456	2.164	
2 (5-9 members)							
3 (≥ 10 members)	-2.443	1.115	-2.19	.029	-4.629	-.257	**
Main occupation	.442	.697	0.63	.526	-.924	1.808	
Experience							
2 (5-9 years)	-.194	.805	-0.24	.81	-1.771	1.383	
3 (10-14 years)	.776	.997	0.78	.436	-1.178	2.729	
4 (> 14 years)	2.055	1.229	1.68	.092	-.338	4.448	*
Income							
2 (low income)	2.64	1.059	2.49	.013	.564	4.715	**
3 (medium income)	2.929	.972	3.01	.003	1.024	4.835	***
4 (high income)	3.591	1.056	3.40	.001	1.52	5.661	***
Constant	-3.861	1.347	-2.87	.004	-6.501	-1.22	***

Mean dependent var	0.847	SD dependent var	0.360
Pseudo r-squared	0.484	Number of obs	250
Chi-square	102.973	Prob > chi2	0.000
Akaike crit. (AIC)	145.778	Bayesian crit. (BIC)	209.092

Source: Author’s survey (2023).

*Note: *** p<.01, ** p<.05, * p<.1;* X_1 *= gender,* X_2 *= age of the household head,* X_3 *= educational attainment,* X_4 *= marital status,* X_5 *= household size,* X_6 *= main occupation,* X_7 *= experience of the processors,* X_8 *= monthly income of the processor.*

More so, the result reveals that education (X_3) attainment plays a positive and significant role in the adoption of innovation by the respondents in the study. This is because, from the result obtained, respondents who have attained a formal education tend to have a higher probability of adopting the technology over those without formal education, and the percentage of adoption also increased as the respondent moves from primary (2.6%), through secondary (3.1%) to post-secondary (4.6%) respectively for every 1% increase of the three levels of education. This could be because the more formal education one attains, the more one seems to get knowledgeable about being open about innovation adoption, ceteris paribus. This result aligns with that of Abdoulaye et al. (2013) on the awareness and adoption of improved cassava varieties and processing technologies in Nigeria. Their results revealed that the probability of cassava farmers adopting improved cassava processing technology when educated was higher and more significant than illiterate farmers at a 1% level with a coefficient of 0.15. It also agrees with Obisesan's (2014) findings. Also, Owombo et al. (2012), in their study on the economic impact of agricultural mechanization adoption: evidence from maize farmers in Ondo State, Nigeria, revealed that education was a significant determinant of the adoption of mechanization practices.

In addition, the result shows that a 1% increase in married heads of households will lead to about 2.1% of the probability of adopting the technology, which is significant at 1%. This implies that marital status (X_4) significantly impacts the adoption of improved cassava-processing technology in the area, all things being equal. This could be because married people tend to be more responsible, leading to more responsiveness to the innovation adoption process. This result contradicts that of Ojo and Ogunyemi (2014) in their study analysis of factors influencing the adoption of improved cassava production technology in Ekiti State, Nigeria, who found a significant but negative relationship between marital status and the probability of adopting improved cassava processing technology.

Moreover, Table 3 also reveals that households with less than 10 members seem to have more significant tendencies to adopt the innovation than those whose family members are greater or equal to ten. As shown in the result, a 1% increase in household sizes (X_5) ≥ 10 leads to a decrease of about 2.4% in the probability of innovation adoption, more than that observed when the house size is less than five members. This implies that many households may not want to adopt the improved technology as they can make do with the high availability of family labor to carry out the cassava processing activities. This agrees with Adebayo (2009) on the dynamics of technology adoption in rural-based cassava processing enterprises in South-West Nigeria, who found a significant and negative relationship between the adoption of the cassava grater and processors' household size.

Again, the result indicates that the respondent's main occupation(X_6) does not significantly influence improved cassava-processing technology adoption in the area. This implies that irrespective of the main occupation of the household, it does not affect the respondent's decision to adopt an improved cassava processor machine in the area. This result contradicts that of Ojo and Ogunyemi (2014), in their study analysis of factors influencing the adoption of improved cassava production technology in Ekiti State, Nigeria, found that the more the number of farmers who take farming as a significant occupation, the higher the probability of adopting improved cassava processing technology.

In the same vein, the result shows that respondents with a high level (that is, above 14 years) of experience in the study area have a likelihood of adopting new technology than those with little or no experience in the Cassava processing business, which is positive and significant at the 10% level. This generally implies that experience (X_7) gained by the respondents over time significantly impacts the probability of adopting improved cassava-processing technology in the area. This means that the number of years a respondent has been in the cassava processing business does not affect whether he or she adopts the innovation. This result agrees with the findings of Chilot (1994) and Obisesan (2014), as well as those of Ehinmowo and Fatuase (2016).

Finally, the result reveals that the respondents' monthly income (X_8) positively and significantly influences the probability of innovation adoption. The result further indicates that as the respondent's income increases from meager income to low income through medium income to finally high income, the adoption of innovation increases more probability than that of people with very low monthly income earners. This is because as the respondent's income increases too low, through medium income to finally high income, 1% of those respective increments lead to 2.64%, 2.92% and 3.59% increase in the probability of innovation adoption more than the respondents with very low monthly earners in the study area. This implies that high income gives the respondents the flexibility of investing in technology adoption, thereby giving them an edge over those with meager income regarding the ease of adopting improved cassava-processing machines in the area. This agrees with Adebayo (2009) on the dynamics of technology adoption in rural-based cassava processing enterprises in South-West Nigeria, who found a significant and positive relationship between the adoption of the cassava grater and processors' household income level.

5 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary and conclusion

The research study analyzed the determinants of technology adoption in cassava flake (gari) production: evidence from Nigeria. Specifically, the study sought to describe the socio-economic characteristics of gari producers in the study area and analyze the factors that affect the adoption of new technologies by gari producers in the study area respectively. The data used for this study was obtained from primary sources with a well-structured questionnaire. The sampling technique employed was a multi-stage sampling technique. The first stage was the purposive sampling technique used in the study area (villages where gari production is still active). A purposive selection of five villages was carried out from each of the ten wards in the study area. Then, five structured questionnaires were randomly distributed to cassava processors in the five villages, amounting to two hundred and 250 respondents in the study area.

The collected data was then analyzed using both descriptive and inferential statistics. Specifically, the first objective was analyzed using descriptive statistics using tools such as frequency tables, percentages, and means, while the second objective was analyzed using inferential statistics using the logit model.

The socio-economic characteristics of the respondents in the study area revealed that the majority (50.4%) of the respondent farmers' household heads were male. However, there is no significant difference between the number of households headed by males and that headed by females. This indicated that cassava processing activities in the study area are not gender specific. This finding aligns with the result of Chah et al. (2014), who revealed that men engage in farming more than women.

The result further revealed that the mean age of the respondents was 48 years, implying that most of the household heads were youths, which could contribute to the high innovation adoption rate in the area.

The result showed that most (88%) respondents attained at least primary formal education, implying that most were literate. Meanwhile, the average household size was seven members. Similarly, the result also revealed that most (36%) processors have more than 14 years of cassava-processing business experience, with an average of about 12 years. Meanwhile, the majority (36%) were traders. This implies that most of the respondents in the area may not have taken farming as their primary source of income.

Finally, the result revealed that the majority (78%) were married. Most processors had a monthly income above ₦120,000, with an average of about ₦155,000.

The logit regression analysis showed that the respondent's age (X2) has a generally negative and significant impact on the probability of adopting improved cassava-processing technology in the area. Specifically speaking, the result reveals that as the respondent's age advances from age below 30 years to ages of 50 years and above, he or she tends to have a lower probability of adopting the innovation, revealing that 1% increase in the respondent above 40 years decreases the probability of adoption of the technology by about 2.3%.

More so, the result reveals that education (X3) attainment plays a positive and significant role in the adoption of innovation by the respondents in the study. This is because, from the result obtained, respondents who have attained a formal education tend to have a higher probability of adopting the technology over those without formal education, and the percentage of adoption also increased as the respondent moves from primary (2.6%), through secondary (3.1%) to post-secondary (4.6%) respectively for every 1% increase of the three levels of education. This could be because the more formal education one attains, the more one seems to get knowledgeable about being open about innovation adoption, ceteris paribus.

In addition, the result shows that a 1% increase in married heads of households will lead to about 2.1% of the probability of adopting the technology, which is significant at 1%. This implies that marital status (X4) significantly impacts the adoption of improved cassava-processing technology in the area, all things being equal. This could be because married people tend to be more responsible, leading to more responsiveness to the innovation adoption process.

Moreover, the result also reveals that households with less than 10 members seem to have more significant tendencies to adopt the innovation than those whose family members are greater or equal to 10. As shown in the result, a 1% increase in household sizes (X5) ≥10 leads to a decrease of about 2.4% in the probability of innovation adoption, more than that observed when the house size is less than five members. This implies that numerous household members may not want to adopt the improved technology as they can make do with the high availability of family labor to carry out the cassava-processing activities.

Again, the result indicates that the respondent's main occupation (X6) does not significantly influence improved Cassava-processing technology adoption in the area. This implies that irrespective of the main occupation of the household, it does not affect the respondent's decision to adopt an improved cassava processor machine in the area.

In the same vein, the result shows that respondents with a high level (that is, above 14 years) of experience in the study area have a likelihood of adopting the new technology than those with little or no experience in the Cassava processing business, which is positive and significant at 10% level. This generally implies that experience (X7) gained by the respondents over time significantly impacts the probability of adopting improved cassava-processing technology in the area.

Finally, the result reveals that the respondents' monthly income (X8) positively and significantly influences the probability of innovation adoption. As the respondent's income increases to low, through medium income to finally high income, 1% of those respective increments lead to 2.64%, 2.92% and 3.59% increase in the probability of the innovation adoption more than the respondents with very low monthly earners in the study area. This implies that high income gives the respondents the flexibility of investing in technology adoption, thereby giving them an edge over those with very low incomes regarding the ease of adopting improved cassava-processing machines in the area.

In conclusion, the study showed that the factors contributing majorly to adopting cassava-processing improved technologies among the respondents include income, experience, household size, marital status, and education level.

5.2 Recommendations

Based on the results of the study, the following recommendations were made:

– Since the respondent's income is a significant determinant for cassava-processing innovation (dual-purpose processor), the government should implement policies that can ease access to the new technology to the respondents, such as policies that promote subsidy of the technology or those that provide easy access to credit facilities to the processors in the study area.
– Efforts must be made to motivate cassava processors in the area through extension agents to embrace improved cassava processing innovation, which will increase cassava flake (gari) production.
– Since education is an essential factor that affects the adoption rate of new technology in the area, the government should provide accessible formal educational facilities that will aid the improvement of the understanding of the importance of adopting innovations that will increase the productivity of cassava flake.

- The government should also invest in education and technical assistance in using the new technology (the cassava processor), as this would help increase the level of adoption in the area.

REFERENCES

Abang, S. O., Agom, D. I., Enyenihi, E., & Ele, I. E. (2008). *Introduction to farm management: Principles, plans, budgets and control*. Calabar King of Judah Publishers Cross River State.

Abdoulaye, T., Abass, A., Maziya-Dixon, B., Tarawali, G., Okechukwu, R., Rusike, J., Alene, A., Manyong, V., & Ayedun, B. (2013). The awareness and adoption of improved cassava varieties and processing technologies in Nigeria. *Journal of Development and Agricultural Economics*, 6(2), 67-75.

Adebayo, K. (2009). The dynamics of technology adoption in rural-based cassava processing enterprises in South-West Nigeria. *International Journal of Agricultural Economics and Rural Development*, 204875512.

Adegbite, D. A., & Ogunniyi, L. T. (2014). Assessment of the cassava processing industry in South-Western Nigeria. *Journal of Agricultural and Food Information*, 15(2), 140-149.

Adekanye, T. O. (1983). Innovation and rural women: Cassava processing and food production. In I. Ahmed (Ed.), *Technology and rural women: Conceptual and empirical issues*. Technology and Employment Bank.

Adeoti, A. I. (2008). Factors influencing adoption of improved cassava processing technology in Nigeria. *African Journal of Agricultural Research*, 3(12), 531-536.

Adesina, A., & Zinnah, M. M. (1993). Technology characteristics, farmers' perceptions and adoption decisions: A tobit model analysis in Sierra Leone. *Agricultural Economics*, 9(4), 297-311.

Africa's Best-Kept Secret, East Lansing: Michigan State University press.

Agbo, E. O. (2008). Food composition spoilage. *The Nigerian Agricultural Journal*, 1(2), 230-234.

Ahmed, P. K. & Wang, C. L., (2004). The development and validation of organisational innovativeness construct using confirmatory factor analysis. *European Journal of Innovation Management*, 7(4), 303–313. https://doi.org/10.1108/14601060410565056/FULL/XML

Akinola, A. A., Alene, A. D., & Adeyemo, R. (2019). Adoption and intensity of improved cassava production technologies in the Nigerian Niger Delta region. *Journal of Agricultural Economics*, 50(2), 353-369.

Akpan, O. E. (2006). *Economics of production: Theory principles and application*. Universal Wiser Publisher.

Akpan, S. B., Patrick, I. V., & Agom, D. I. (2012). Determinants of garri output in Akwa Ibom State, Nigeria. *International Journal of Agricultural Economics and Extension*, 5(1), 47-54.

Akudugu, M. A., Guo, E., & Dadzie, S. K. (2012). Adoption of modern agricultural production technologies by farm households in Ghana: what factors influence their decisions. *Journal of Biology, Agriculture and Healthcare*, 2(3).

Alexander, C., & Van Mellor, T. (2005). Determinants of corn rootworm resistant corn adoption in Indiana. *AgBioForum*, 8(4), 197-204.

Amaza, P. S., & Olayemi, J. K. (2002). Analysis of technical inefficiency in food crop production in Gombe State, Nigeria. Applied Economics Letters, 9(1), 51–54. https://doi.org/10.1080/13504850110048523

Arene, C. J., & Okukpara, B. C. (2006). Economics of agricultural production resources and development: an introduction to micro and macro level perspectives prize publishers, Nigeria.

Banerjee, B., Martin, S., Roberts, R., Larkin, S., Larson, J., Paxton, K., English, B., Marra, M., & Reeves, J. (2008). A binary logit estimation of factors affecting adoption of GPS guidance systems by cotton producers. *Journal of Agricultural and Applied Economics*, 40(1), 345-355.

Bonabana-Wabbi, J. (2002). Assessing factors affecting adoption of agricultural technologies: The case of Integrated Pest Management (IPM) in Kumi District. [Master's thesis, Virginia Polytechnic Institute and State University]. http://hdl.handle.net/10919/36266

Caswell, M., Fuglie, K., Ingram, C., & Kascak, C. (2001). Adoption of agricultural production practices: Lessons learned from the U.S. Department of Agriculture Area Studies Project. U.S. Department of Agriculture Economic Research Service.

Center for Strategic and International Studies. (2021). *Global food and water security program*. https://www.csis.org/programs/global-food-and-water-security-program.

Central Bank of Nigeria. (2019). *Anchor borrowers' program*. https://inarafoundation.ng/anchor-borrowers-program/.

Central Intelligence Agency. (2011). The world fact book. https://www.cia.gov/the-world-factbook/.

Chah, J. M., Ani, N. A,, Irohibe, J. I., & Agwu, A. E. (2014). Exploitation of bush mango (Irvingia wombolu and Irvingia gabonensis) among rural household in Enugu State, Nigeria. *Journal of Agricultural Extension*, 18(2), 44-56.

Chilot, Y. (1994). Factors influencing adoption of new wheat technologies in the Wolemera and Addis Alem areas of Ethiopia. MSc Thesis, Alemaya University.

Doss, C. R. (2003). *Understanding farm level technology adoption: Lessons learned from CIMMYT's microsurveys in Eastern Africa*. International Maize and Wheat Improvement Center.

Dube, G. (2013). *Impact of off-farm income on technology adoption intensity and productivity: Evidence from rural maize farmers in Uganda*. International Food Policy Research Institute.

Dumitrescu, E., Sullivan, H., Hurlin, C., & Tokpavi, S. (2022). Machine learning for credit scoring: Improving logistic regression with non-linear decision-tree effects. *European Journal of Operational Research*, 297(3), 1178-1192.

Egharevba, R. K. A. (1992). Reported occupational health hazards of women in agricultural crop production among the Binis. In M. N. Kisekka (Ed.). *Women's health issues in Nigeria*. Tamaza.

Ehinmowo, O. O., & Fatuase, A. I. (2016). Adoption of improved cassava processing technologies by women entrepreneur in South-west, Nigeria. *World Journal of Agricultural Research*, 4(4), 109-113.

Ekanem, O. T., & Iyoba, M. A. (2000). *Microeconomic theory*. Mathematical Capsules Mark Publishers.

Emokaro, C. O., Iluobe, R. O., & Alufohai, G. O. (2008). *Profitability and constraints in gari and edible starch processing by women in Egor and Oredo Local Government Areas of Edo State* [Proceedings]. Proceedings of the 22nd Annual National Conference of Farm Management Association of Nigeria, Makurdi, September 2008.

Emokaro, E. O., & Erhabor, P. O. (2007). Relative technical efficiency of cassava farmers in the three agro-ecological zones of Edo State, Nigeria. *Journal of Applied Sciences*, 7(19), 2818-2823.

Erhabor, P. O., Emokaro, C. O. & Abiola, M. O. (2004). *Feasibility study on the marketability of root and tuber crops and their processed products (a case study of Cassava)*. Edo State Agricultural Development Programme.

Feder, G., Just, R. E., & Zilberman, D. (1985). Adoption of agricultural innovations in developing countries: A survey. *Economic Development and Cultural Change*, 33(2), 255-298.

Fernandez-Cornejo, J., Daberkow, S., & Huang, H. (1994). The adoption of IPM techniques by vegetable growers in Florida, Michigan and Texas. *Journal of Agricultural and Applied Economics*, 26(1), 158-172.

Fernandez-Cornejo, J., Mishra, A., Nehring, R., Hendricks, C., Southern, M., & Gregory, A. (2007). *Off-farm income, technology adoption, and farm economic performance*. United States Department of Agriculture.

Fokunang, C. N., Dixon, A. G. O., Ikotun, T., Tembe, E. A., & Akem, C. N. (2001). Anthracnose: An economic disease of Cassava in Africa. *Pakistan Journal of Biological Sciences*, 4(7), 920-925.

Food and Agriculture Organization. (2021). *Cassava production statistics for Nigeria*. https://www.fao.org/4/a0154e/A0154E05.htm

Foster, D., & Rosenzweig, M. (1995). Learning by doing and learning from others: Human capital and technical change in agriculture. *Journal of Political Economy*, 103(6), p. 1176-1209.

Gabre-Madhin, Z., & Haggblade, S. (2001). *Success in African agriculture: Results of an expert survey*. International Food Policy Research Institute.

Genius, M., Koundouri, P., Nauges, C., & Tzouvelekas, V. (2014). Information transmission in irrigation technology adoption and diffusion: Social learning, extension services, and spatial effects. *American Journal of Agricultural Economics*, 96(1), 328-344.

González del Río, P. (2005). Analysing the factors influencing clean technology adoption: A study of the Spanish pulp and paper industry. Business Strategy and the Environment, 14(1), 20–37. https://doi.org/10.1002/bse.426

Grieshop, J. I., Zalom, F., & Miyao, G. (1988). Adoption and diffusion of integrated pest management innovations in agriculture. *Bulletin of Entomological Society of America*, 34(2), 72-79.

Hahn, B. H., & Khan, B. (2002). *Adoption of new technology*. National Bureau of Economic Research.

Hosmer, D. W., & Lemeshow, S. (2000). *Applied logistic regression*. John Wiley & Sons.

https://innovation.wfp.org/climate. https://www.wfp.org/news/un-wfp-launches-programme-strenghten-food-security-changing-climate-under-adaptation-fund

International Fund for Agricultural Development. (2016). *Agricultural technology adoption in developing countries: Successes and challenges*. https://www.sciencedirect.com/science/article/pii/S0305750X2100214X

International Institute of Tropical Agriculture. (2017). *Cassava research for development in sub-Saharan Africa*. https://www.iita.org/wp content/uploads/2017/The_Cassava_Monitoring_Survey_in_Nigeria.pdf

Ishak, A., & Afrizon. (2011). Perception and Level of Farmer Adoption on System of Rice Intensification (SRI) Implementation in Bukit Peninjau I Village, Sukaraja District, Seluma Regency. Agricultural Informatics, 20(2), 76-80.

Jaleta, M., Gebremedhin, B., & Hoekstra, D. (2009). *Smallholder commercialization: Processes, determinants and impact*. International Livestock Research Institute.

Kariyasa, K., & Dewi, A. (2011). Analysis of factors affecting adoption of integrated crop management farmer field school (Icm-Ffs) in swampy areas. *International Journal of Food and Agricultural Economics*, 1(2), 29-38.

Karki, l. B., & Siegfried, B. (2004). *Technology adoption and household food security. Analyzing factors determining technology adoption and impact of project intervention: A case of smallholder peasants in Nepal* [Paper]. Paper presented in The Deutscher Tropentag, Berlin, October 2004.

Kasenge, V. (1998). *Socio-economic factors influencing the level of soil management practices on fragile land* [Proceedings]. Proceedings of the 16th Conference of Soil Science Society of East Africa, Tanga, Tanzania, December 1998.

Keelan, C., Thorne, F. S., Flanagan, P., Newman, C., & Mullins, E. (2009). Predicted willingness of Irish farmers to adopt GM technology. *AgBioForum*, 12(3&4), 394-403.

Khanna, M. (2001). Sequential adoption of site-specific technologies and its implications for nitrogen productivity: A double selectivity model. *American Journal of Agricultural Economics*, 83(1), 35-51.

Kohli, D. S., Singh, N., (1997). "The Green Revolution in Punjab, India: The Economics of Technological Change." Journal of Punjab Studies, vol. 12, 2005, pp. 285-307.

Koppel, B.M. (Ed), (1994). Induced Innovation Theory and International Agricultural Development: A Reassessment the Johns Hopkins University Press, Baltimore.

Lavison, R. (2013). *Factors influencing the adoption of organic fertilizers in vegetable production in Accra*. [Master's thesis, University of Ghana].

Loevinsohn, M., Sumberg, J., & Diagne, A. (2012). *Under what circumstances and conditions does the adoption of technology result in increased agricultural productivity?* University of London.

Mauceri, M., Alwang, J., Norton, G. Barrera, V. (2005). Adoption of Integrated Pest Management Technologies: A Case Study of Potato Farmers in Carchi, Ecuador; Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Providence, Rhode Island, July 24-27, 2005.

Mbang, J. I. (2014). *Productivity analysis of gari based production system in Yakurr LGA of cross river state*. University of Calabar.

Menard, S. (2010). *Logistic regression: From introductory to advanced concepts and applications*. Sage.

Mesfin A. (2005). "Analysis of factors Influencing Adoption of Triticale and its Impact.The Case Farta Wereda". Msc. Thesis (Unpublished) Presented to School of Graduate Studies of Alemaya University.

Mignouna, B., Manyong, M., Rusike, J., Mutabazi, S., & Senkondo, M. (2011). Determinants of adopting imazapyr-resistant maize technology and its impact on household income in Western Kenya. *AgBioforum*, 14(3), 158-163.

Mohamed, K., & Temu, A. (2008). Access to credit and its effect on the adoption of agricultural technologies: The case of Zanzibar. *African Review of Money Finance and Banking*, 45-89.

Muzari, W., Gatsi, W., & Muvhunzi, S. (2012). The impacts of technology adoption on smallholder agricultural productivity in Sub-Saharan Africa: A review. *Journal of Sustainable Development*, 5(8), 69-77.

Namara, E., Weligamage, P., & Barker, R. (2003). *Prospects for adopting system of rice intensification in Sri Lanka: A socio-economic assessment*. International Water Management Institute.

Neoyi, R. (2012). Cassava is a crop for household food security. *The Nigerian Journal of Agriculture*, 1(3), 1-2.

Nnaemeka, N. O. (2022). Empirical factors influencing food security in Nigeria. Do local farmer investors in farming activities mitigate food shortages? Evidence in the short and long Run. *American Journal of Agriculture*, 4(1), 24-46.

Nwankwo, C. A., Onyeneke, R. U., & Amaefula, C. (2020). Socio-economic determinants of adoption of improved cassava varieties among farmers in Nigeria. *Journal of Agriculture and Rural Development*, 22(1), 45-59.

Nweke, F.I., D.S.C. Spencer, and J.K. Lynam (2002), The Cassava Transformation:

Obisesan, A. (2014). *Gender differences in technology adoption and welfare impact among Nigerian farming households*. University of Ibadan.

Odebode, Stella O. (2008). Appropriate Technology for Cassava Processing in Nigeria: User's Point of View. Journal of International Women's Studies, 9(3), 269-286. Available at: https://vc.bridgew.edu/jiws/vol9/iss3/15

Odoemenem, I. U., & Otanwa, L. B. (2011). Cassava production in Nigeria: A review of trends, constraints, and prospects. *African Journal of Agricultural Research*, 6(20), 4362-4370.

Ogunkoya O.,Hassan B., Shobayo, P., (2014). Dynamic Capabilities and Competitive Advantage: An Analysis of The Nigerian Banking Sector. *Journal of Accounting and Management.* Vol. 4. No. 2(2014).

Ojo, S. O., & Ogunyemi, A. I. (2014). Analysis of factors influencing the adoption of improved cassava production technology in Ekiti State, Nigeria. *International Journal of Agricultural Sciences and Natural Resources*, 1(3), 40-44.

Okpeke, M. T., & Oyeagocha, S. U. G. (2010). Analysis of processing Cassava tubers to gari in Isoko North Local Government Area of Delta State Nigeria. *E.A. Journal*, 6(11), 20-24.

Omonona, B., Oni, O., & Uwagboe, O. (2006). Adoption of improved Cassava varieties and its impact on rural farming households in Edo State, Nigeria. *Journal of Agriculture and Food Information*, 7(1), 40-45.

Osagie, E., (1992). West African regional Economic Integration: Nigerian Policy Perspectives for the 1990s.pp 35-100.

Owombo, P. T., Akinola, A. A., Ayodele, O. O., & Koledoye, G. F. (2012). Economic impact of agricultural mechanization adoption: Evidence from maize farmers in Ondo State, Nigeria. *Journal of Agriculture and Biodiversity Research*, 1(2), 25-32.

Oyewole, O. B., & Odunfa, S. A. (2014). Effect of processing variables on cassava product quality. *African Journal of Food Science*, 8(4), 250-257.

Perz S.G. (2003) Social determinants and land use correlates of agricultural technology adoption in a forest frontier_ A case study in the Brazilian Amazon. Journal of Human Ecology. Volume 31, Issue 1, PP133 – 165. DOI:10.1023/A:1022838325166

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

Root and Tuber Expansion Programme (RTEP). (2001). Program framework for enhancing root and tuber production and processing. International Fund for Agricultural Development (IFAD). https://www.semanticscholar.org/paper/The-Impact-of-RTEP-Technology-Adoption-on-Food-of-Obisesan-Omonona/cd0d5e70fd236769ff71f3694b0666a136ebd172?p2df

Sadeghi, A., (2018). Success factors of high-tech SMEs in Iran: A fuzzy MCDM approach. *Journal of High Technology Management Research* https://doi.org/10.1016/j.hitech.2018.04.007

Samiee, A., Rezvanfar, A., & Faham, E. (2009). Factors affecting adoption of integrated pest management by wheat growers in Varamin County, Iran. *African Journal of Agricultural Research*, 4(5), 491-497.

Simtowe, F., & Zeller, M. (2006). *The impact of access to credit on the adoption of hybrid maize in Malawi: An empirical test of an agricultural household model under credit market failure*. University Library of Munich.

Sserunkuuma, D. (2005). The adoption and impact of improved maize and land management technologies in Uganda. *The Electronic Journal of Agricultural and Development Economics*, 2, 67-84.

Tesfaye, A., Negatu, W., Brouwer, R. & Van Der Zaag, P. (2014), Understanding Soil Conservation Decision of Farmers in The Gedeb Watershed, Ethiopia. Land Degrad. Develop., 25: 71-79. https://Doi.org/10.1002/Ldr.2187

Uaiene, R. (2011). Determinants of agricultural technology adoption in Mozambique. *African Crop Science Conference Proceedings*, 10, 375-380.

Uematsu, H., & Mishra, A. (2010). *Can education be a barrier to technology adoption?* [Paper]. Paper prepared for presentation at the Joint Annual Meeting, Denver, Colorado, July 2010.

World Food Program (2022). climate Adaptation Innovation Accelerator Programme,

Yamane, T. (1967). *Statistics: An introductory analysis*. Harper & Row.

Yaron, D., Dinar, .A., & Voet, H. (1992). Innovations on family farms: The Nazareth region in Israel. *American Journal of Agricultural Economics*, 74(2), 361-370.