EXTENSION SUPPORT FOR CASSAVA *(Manihot esculenta)* PRODUCTION AND PROCESSING IN NIGERIA: IMPACTS ON FARM PRACTICE ADOPTION

by

Oluchi Linda Otubo

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Approved by

Joseph J. Molnar, Chair, Professor of Agricultural Economics and Rural Sociology
Ryan Thomson, Assistant Professor of Agricultural Economics and Rural Sociology
Dennis A. Shannon, Professor of Crop, Soil and Environmental Science

ABSTRACT

Many factors have been found to affect farmers' adoption of new technologies by different authors, which include farmers' interaction with extension services and socio-economic characteristics of farmers. This study therefore, analyzed the impact of cassava farmers' exposure to extension on the adoption of technology and the influence of some of their individual and farm characteristics on adoption. The data used was drawn from a survey carried out in 4 geopolitical zones in Nigeria known for cassava production which was conducted by International Institute of Tropical Agriculture (IITA) in 2010. A total of 952 respondents were selected for the study and data was analyzed using descriptive and inferential statistics. Findings show that most of the farmers are in their productive age (49years) and men constitute a greater percentage (76.8%) of those who are engaged in cassava production in the study areas. Also, the respondents had an average of 10 years of formal education and have been growing cassava for about 11-20 years while majority were small scale farmers having farm sizes ranging from 1-5 hectares with 11-20 years of farming experience. The most significant factors influencing adoption appear to be technology awareness, extension exposure, and age, which were positive and statistically significant at $P<0.01$ while household size, years of farming experience, and farm size were negative and statistically significant at $P<0.01$. Results indicate that farmers to farmers' technological diffusion played the greatest role in dissemination of the technologies whereas interaction with extension agents were low. However, factors that hinder the interaction between extension agents and cassava farmers need to be considered for a future research.

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LIST OF ABBREVIATIONS

ADP	Agricultural Development Program
EA	Enumeration Area
FAO	Food and Agriculture Organization
FC	Frequency Count
FCT	Federal Capital Territory
IITA	International Institute for Tropical Agriculture
LGA	Local Government Area
NBS	Nigerian Bureau of Statistics
NC	North Central
NGO	Non-Governmental Organization
NHIS	National Integrated Survey of Households
SE	South East
SPSS	Statistical Package for Social Sciences
SS	South South
SW	South West

CHAPTER 1: INTRODUCTION

1.1 Background Statement

Agriculture occupies a key position in the Nigerian economy judging by its critical role of providing food security, provision of employment, revenue generation and provision of raw materials for industrial development (Ajala, Ogunjimi, and Farinde 2013). It continues to remain a major driver of economic growth in Nigeria especially from cassava production. Cassava is a crop with enormous potentials. It provides a stable food base for the food need of the populace, components in livestock feeds and raw materials for industries. Cassava also seems to be recording resounding success in sub-Saharan Africa out of the numerous stories of crop intervention failures in the region. As a result of this, many African countries have embraced its cultivation with renewed vigor. Nigeria is one of such African countries. Almost every household in rural Nigeria grows cassava on small farms as one of the staple food crops to feed families and supply the local markets (Aderinto, Agbelemoge, and Dada 2017).

Cassava (*Manihot esculenta)* is an important regional food source for about 200 million people (nearly one-third of the population) of sub- Saharan Africa (Abdoulaye et al. 2014). Cassava provides food and income to over 30 million farmers and large numbers of processors and traders in Nigeria (Abdoulaye et al. 2014). The high tendency to serve as a relief crop to food insecurity because of its copious consumption in various forms by people and its ability to subsist and give appreciable yields on soils where many other crops fail to perform, has endeared its cultivation by many smallholder farmers (Anaglo et al. 2020). This was further supported by the assertion of Anyeagbunam, et al. (2015), that cassava has become a very popular crop in Nigeria and is fast replacing other traditional local staples in the country (Zie, Manu, and Wouapi 2019).

FAOSTAT (2010) maintained that cassava has moved from minor crop to major crop in Nigeria and has gained industrial recognition and relevance (Saani et al. 2007). This then presupposed that traditional use or utilization of cassava is changing from primarily human consumption to processing into industrial products as well as for exportation.

The role of agricultural extension services is very crucial in improving agricultural development in Nigeria. It does this by facilitating the education of farmers to improve their skills, knowledge and attitude as related to agricultural development. It builds the capacity of farmers through the use of a variety of communication methods and help farmers make informed decisions. It transmits the result of research on how to solve the problems of agriculture to farmers and encourages the application of these and other improved technical knowledge on agriculture by farmers. It takes the problem of farmers to research institutions for solution.

Ekele (2015) asserts that the information obtained from transfer of technology could improve farmer’s livelihood and for extension services to be functional, the extension agent acts as a catalyst in the dissemination of information to rural farmers. The extension agent according to Davies (as cited in Amonjenu 2016) support people engaged in agricultural production and facilitates their effort to solve problems, adopt new innovation approaches that could provide for local farmers, and discuss issues that affects crop production.

1.2 Problem Statement

Strong criticism of public agricultural extension services has circulated in recent years. According to (Qamar 2002), this criticism is due to its top-down approach, which has been supply-driven, technically weak, catering only for large farmers (progressive farmers) and providing insufficient coverage of the small-scale farmers, who are the producers of the bulk of food crops in Nigeria. This implied that proven agricultural technologies which are needed to ensure higher productivity and food security, do not reach the millions of small-scale farmers scattered all of the country. Consequently, these farmers have managed to obtain information from sources such as other farmers, inputs dealers, produce buyers and NGOs (Agbelemoge 2009).

A number of studies have been carried out on the adoption of improved technologies singly and independently; (Abdoulaye et al. 2014; Alene, Poonyth, and Hassan 2000; Oluoch-Kosura, Marenya, and Nzuma 2004; Abdoulaye and Sanders 2002; (Bamire, Fabiyi, and Manyong 2002;). According to Von Braun (1988), agricultural growth via technological transformation leads to an expanded food supply which presupposes relationship between production and processing operations in agriculture. Greene (2003) posited that most studies on adoption have reflected farmers-, farm-, institutional and technology-specific factors based on analysis that identified and estimated separately in a single equation model. Inadequate adoption of contemporary innovations and technology have constrained cassava productive efficiency to less than 60% in most countries in sub-Saharan Africa including Nigeria (Ajibefun 2015). The call to address this seemingly difficult challenge has again come to the fore as the demand for cassava is increasingly gaining momentum among various consumers.

Even though considerable work has been done on the impact of extension service delivery among cassava farmers in Nigeria, it is not well documented how, specifically, cassava farmers exposure to extension services affects the adoption of improved technologies in Nigeria, and the extent of their role in enhancing production, thus, the study seeks to fill that gap. The aim of the study is to analyze the impacts of farmers exposure to extension on the adoption and awareness of improved cassava technologies and also its influence on some individual and farm characteristics of the cassava farmers by answering the following research questions:

1.3 Research Questions:

- What are the individual and farm characteristics of the cassava farmers as mediating variables for the impact of extension exposure?
- What are the famers sources of extension messages and other forms of assistance?
- What are the impacts of cassava farmers' exposure to extension with their individual and farm characteristics on the adoption of improved technologies?

1.4 Research Objectives:

The general objective is to assess the influence of extension exposure and some individual and farm characteristics of cassava farmers on awareness and adoption of technologies.

The specific objectives of this research are to;

- Develop a conceptual framework elucidating how extension exposure affects the adoption of improved farm practices;
- Determine the individual and farm characteristics of the cassava farmers in the study area as mediating variables for the impact of extension exposure;
- Measure the exposure of cassava farmers to extension messages and other forms of assistance;
- Analyze the impact of cassava farmers' exposure to extension, with their individual and farm characteristics on the adoption of improved technologies.

1.5 Justification:

Adoption of extension recommendations by farmers leads to improved yields of crops. Studies have shown positive correlation between adoption of extension recommendations by farmers and crop yields, which translate into increased income and improved quality of life of farmers (Nwaobiala 2017). Similarly, Abdoulaye et al. (2014) reported significant difference between cassava yield of farmers adopting improved cassava production and processing technologies and those not adopting the recommendations.

Technological improvement is also the most important factor in increasing agricultural productivity and reduction of poverty in the long-term (Solomon 2010; Asfaw et al. 2011). To increase productivity, technology must be adopted in the production process and the rate of adoption of a new technology is subject to its profitability, degree of risk associated with it, capital requirements, agricultural policies and socioeconomic characteristics of farmers (Shideed and El Mourid 2005).

CHAPTER 2: CONCEPTUAL FRAMEWORK

This chapter provide an overview of previous research and conceptualizations of Extension exposure and technology adoption with their relationships to individual characteristics and farm characteristics. It also draws closer attention to Roger's model on the processes of diffusion of innovation in relation to technology adoption.

2.1 Adoption of Technology

The definition of adoption varies across studies, and the appropriateness of each approach depends on the particular context it is been used. Technology can be seen as the process by which humans modify nature to meet their needs and want. This position approximate Hornby (2000) view that Technology can be defined as the scientific study and use of mechanical arts and applied science and application of these two-practical task in industries. Olayide (1980) also defined technology as the systematic application and collective human rationality to the solution of the problems through the assertion of control over nature and all kinds of human processes. Atala (2002) defined technology as an organized capacity for some purposive activity. The definitions above suggest that agricultural technology include both components and processes of agricultural production. These processes may include; production of plant and animal breeding (including biotechnology), the introduction of new crops, livestock and fisheries, mechanization, infrastructural development and inputs.

Rogers (1995), stated that the adoption of innovation is related to innovation decision process through which an individual passes from first knowledge of an innovation, to forming an attitude towards the innovation, deciding to adopt or reject the innovation, implementing the new ideas, and confirming the innovation decision. This implies that new technologies can only be accepted by rural farmers when they have passed through the innovation to decision process and these farmers have picked interest concerning this because, when a farmer picks interest, he tends to seek for more information on his own and when this happens adoption can take place. A more meaningful definition may be that a technology is a set of new ideas. New ideas are associated with some degree of uncertainty and hence a lack of predictability on their outcome.

For Rogers (2003:177), adoption is a decision of "full use of an innovation as the best course of action available" and rejection is a decision "not to adopt an innovation". Rogers defines diffusion as "the process in which an innovation is communicated thorough certain channels over time among the members of a social system" (Rogers 2003:5). As expressed in this definition, innovation, communication channels, time, and social system are the four key components of the diffusion of innovations. The second element of the diffusion of innovations process is communication channels. For Rogers (2003:5), communication is "a process in which participants create and share information with one another in order to reach a mutual understanding". This communication occurs through channels between sources. Rogers states that "a *source* is an individual or an institution that originates a message and a channel is the means by which a message gets from the source to the receiver" (2003:204). Abdoulaye et al. 2014 in their study identified the various sources of information that was harnessed by cassava farmers for the adoption of technologies.

According to Hillmer (2009), Rogers states that diffusion is a specific kind of communication and includes these communication elements: an innovation, two individuals or other units of adoption, and a communication channel. Communication is an indispensable factor in agricultural practices and it is one of the basis of extension service delivery. *Mass media* and *interpersonal communication* are two communication channels (Rogers, 2003). Mass media channels include a mass medium such as TV, radio, or newspaper, interpersonal channels consist of a two-way communication between two or more individuals. On the other hand, “diffusion is a very social process that involves interpersonal communication relationships” (Rogers 2003:19). Thus, interpersonal channels are more powerful to create or change strong attitudes held by an individual.

In interpersonal channels, the communication may have a characteristic of *homophily*, that is, “the degree to which two or more individuals who interact are similar in certain attributes, such as beliefs, education, socioeconomic status, and the like,” but the diffusion of innovations requires at least some degree of heterophily, which is “the degree to which two or more individuals who interact are different in certain attributes.” In fact, “one of the most distinctive problems in the diffusion of innovations is that the participants are usually quite heterophilous” (Rogers 2003:19).

Rogers (2003), reviews that diffusion theory provides a model for the diffusion innovation process, which extension professionals as change agents can use as a media which will attract innovators and early adopters. According to Rogers (2003), the five important attributes of innovation related to an individual’s attitude toward an innovation and whose stage in the innovation decision process summarized by Rogers are relative advantage, compatibility, complexity, observable and trial. The speed of diffusion of an innovation depends primarily on the attributes of the technology, a good diffusion network that starts by word-of-mouth, and continues by imitation, supported by change agents and stakeholders Hillmer (2009).

For a technology to impact on the economic system, blending into the normal routine of the intended economic system without upsetting the system’s state of affairs is required. This entails overcoming the uncertainty associated with the new technologies. It therefore comes as no surprise that several studies set out to establish what these factors are, and how they can be eliminated (if constraints) or promoted (if enhancers) to achieve technology adoption. Adoption models are generally based on the theory that farmers make decisions in order to maximize hand, farmers utility depends on optimizing the productivity and minimizing the cost of cultivation to attain maximum profits (Adesope et al. 2012). (Feder, Just, and Zilberman (1985), stated that farmers adopt or practice new technologies when they expect a more profitable outcome that is gained from the existing technology.

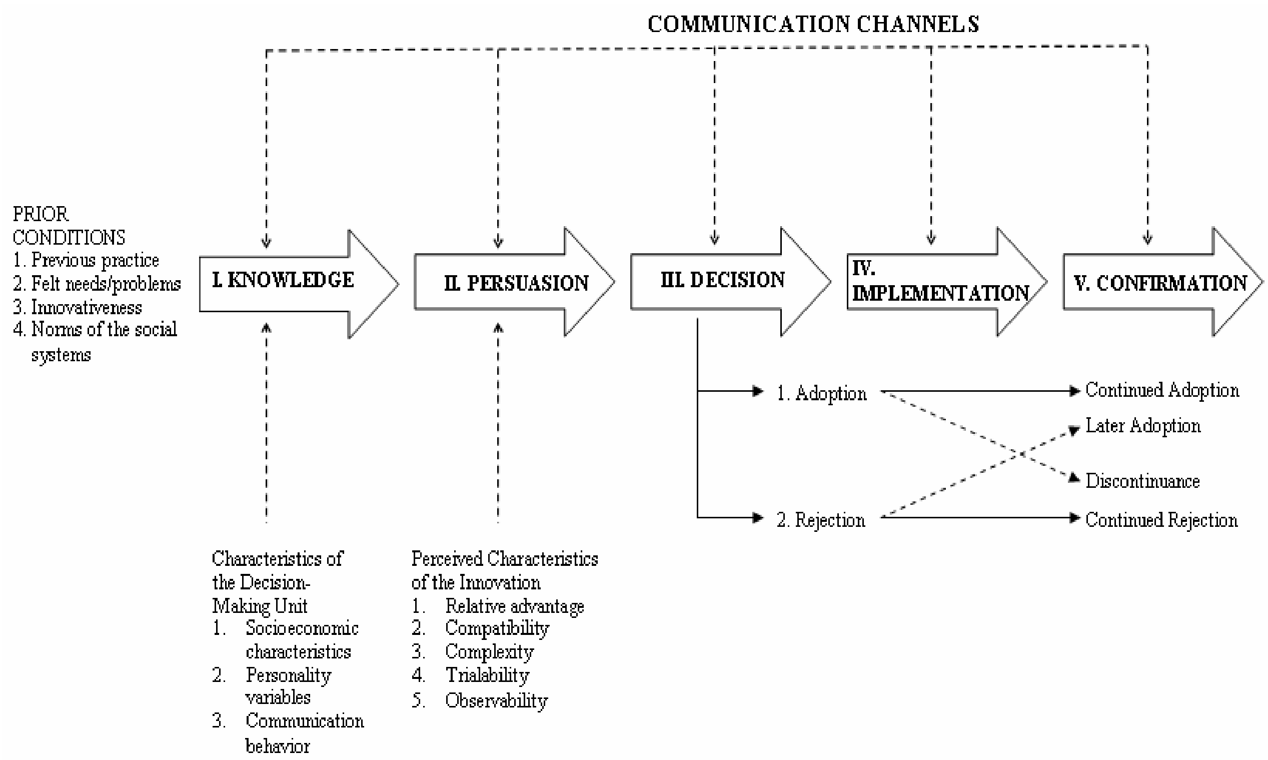

Figure 1. A Model of Five Stages in the Innovation-Decision Process (Rogers 2003)

Improvement in agricultural productivity has a powerful knock–on effect to the rest of the economy. Food processing, input supply and the consequent increase in affordable food stimulates economic growth and development. Technology change in agriculture began at least 10,000 years ago when the first cultivation selected wild plants which were experimented with different growing environments (Egwu 2003).

2.2 Barriers to the Adoption of Agricultural Technologies

Obstacles are widely present in developing countries and are often pointed out to justify public intervention in extension services. Jack (2009) groups these barriers in two categories: (i) barriers that make a technology that is beneficial for society not beneficial for the individual farmer, and (ii) barriers that discourage the adoption even when a technology is potentially profitable for the individual farmer. In the former case, extension services can be considered as an instrument to help farmers to adopt technologies while, in the latter, they can be seen as an additional agricultural input, whose supply and demand could be constrained by specific barriers. The generation and spread of information, economic limits, social factors, farmers' characteristics, attributes of sustainable practices and infrastructure conditions are identified barriers to adoption (Rodriguez et al. 2009). Also, limited use of some improved cassava varieties previously developed by research institutions in Nigeria has been noted (Nweke, Spencer, and Lynam 2002).

2.3 Extension as a Source of Technology Adoption

Extension service delivery agency is a critical stakeholder in the agricultural development of Nigeria. Agricultural extension refers to a set of organizations that support people engaged in agricultural production and facilitate their efforts to solve problems; link to markets and other players in the agricultural value chain; and obtain information, skills, and technologies to improve their livelihoods (Davis 2009). Government, through Agricultural Development Program (ADP), private agencies through agro-input dealers, associations and non-governmental agencies provide extension related services to Nigerian farmers including cassava farmers.

The role of extension service in getting improved technologies to the farmers cannot be overemphasized. Extension agents play the role of disseminating these technologies to farmers (Agumagu and Nwaogwugwu 2006). Almost all countries in the world deliver some type of extension service to help rural people advance their agricultural production and improve their living standard; extension is responsible for serving about one billion small scale farmers in the world (Mwamakimbula 2014). The improvement of agricultural sciences and technology has brought about dramatic changes in the agricultural sector. This has led to the increased need and opportunity for investigating the impact of agricultural extension services in various parts of the world (Davis et al. 2012). Similarly, Asiabaka, Morse, and Kenyon (2001) expressed the view that, 'for farmers of different agricultural zones to adopt a new agricultural technology, they must be aware of the technology, have valid and up-to-date information on the technology, the applicability of the technology to their farming system and receive the technical assistance necessary to the technology.' This points to the importance of farmers' exposure to extension in the adoption of improved technologies. Determining the influence of these factor on a root crop like cassava will be useful in formulating adequate policies that will assist cassava farmers to solve imminent problems.

2.4 Cassava Technology

Cassava (Manihot esculanta) has become one of the most popular and widely grown plant amongst arable crops, particularly in Nigeria in the recent time. The high tendency to serve as a relief crop to food insecurity because of its copious consumption in various forms by people and its ability to subsist and give appreciable yields on soils where many other crops fail to perform, has endeared its cultivation by many smallholder farmers (Anaglo et al. 2020). This was further supported by the assertion of Anyeagbunam et al. (2015) that cassava has become a very popular crop in Nigeria and is fast replacing other traditional local staples in the country (Zie, Manu, and Wouapi 2019) while FAOSTAT (2010) maintained that cassava has moved from minor crop to major crop in Nigeria and has gained industrial recognition and relevance (Sanni et al. 2007).

According to IITA, cultivating cassava comes with a lot of convenience. Some of which include: its ability to do well in poor soils, its labor requirements are low, it can be inter-cropped with other crops, and it matures within a period of 6 months–3 years after planting.

Cassava production has increased significantly, particularly in the last decade, partly through the adoption of higher yielding varieties, but mostly through an increase in the area under cassava production and processing. The trend has increased from 38 million metric tons in 2014 to 51million metric tons in the year 2017 (Nwaobiala 2018). Different production technologies (improved varieties, management technology) and processing technologies (like grating technology, peeling technology, frying technology, etc.) have been adopted and used by the cassava farmers till recent times.

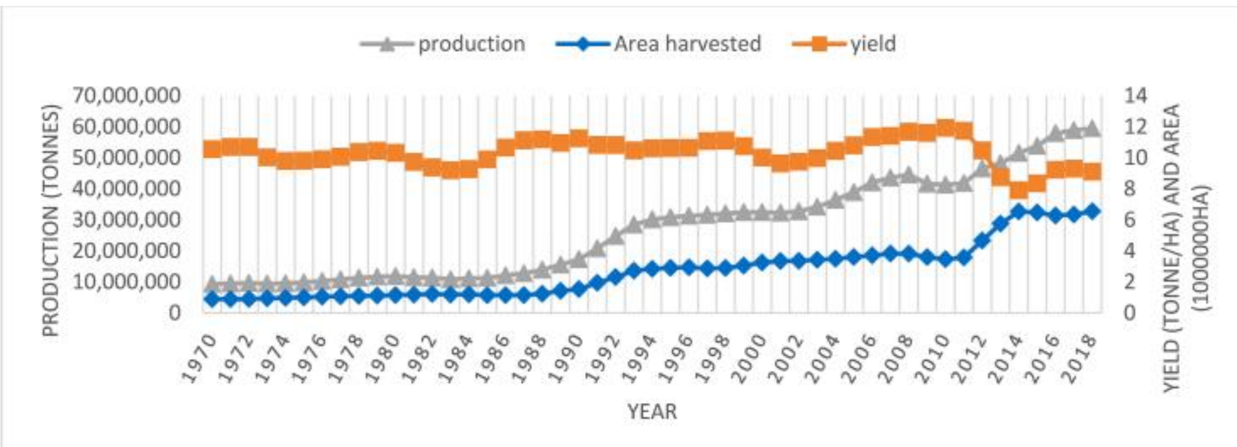

Figure 2: Trend in area, production and yield of cassava in Nigeria. Source: FAOSTAT 2019.

For cassava transformation program to achieve its objectives in Nigeria, recommended production technologies are to be adopted by farmers. The program targets to achieve food security and poverty reduction through enhanced adoption and utilization of agricultural knowledge and information (FAO 2010). Experts have argued that the cassava production is one of the well-developed agricultural crops in Nigeria because of its relatively well established and processing techniques.

Cassava serves different purposes as it can be consumed raw upon maturity and can be processed into varieties of products using various processing technologies– e.g., cassava flour, fufu, garri, and starch for industrial use. These processed products are very popular with the growing urban population because they are easier to prepare and can be kept longer than the other staple crops. For instance, garri is made from cassava storage roots, *grated, fermented, and fried* with or without palm oil (Christine et al. 2010).

In Nigeria, modern agricultural technology has contributed significantly to agricultural development and the gap between developed and developing countries in the area of agricultural production can be attributed largely to differences in the level of technological development, adaptation and transfer process (Odebode 2008). 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 as well as in industry. This is not so in Nigeria where these technologies are not often available to farmers. Where they are made available, few farmers, usually excluding the users, which are usually women, have access to them (Adekanye 1983)

The major constraint of cassava processing is rapid deterioration of the roots. Cassava roots have a shelf-life of 24–48 hours after harvest (Nyerhovwo 2004; Stephen and Eric 2009). Once harvested, it has to be either consumed immediately or processed into more stable product forms. Fresh roots must be processed within 2 to 3 days from harvest. To reduce this level of losses, it is very necessary that they are processed as early as possible (Adekanye, Ogunjimi, and Ajala 2013).

Cassava processing using traditional methods is tasking, time- consuming, ineffective, and inefficient. Such difficulties arise in the grating and draining of the starchy fluid from the cassava dough since the conventional methods available involve processes that require a lot of labor and man hours (Adekanye et al. 2013). The problem is worsened when the quantities to be produced are very large (Stephen and Eric 2009). Cassava farmers are often unable to process harvested roots and have to sell their crops at a very low price to middlemen who are willing and able to reach them (Nweke 1994). Mechanization is necessary for production, harvesting and processing to reduce cost and to minimize waste.

Traditional tools used in Gari processing includes: Millstone, grinding stone, pestle and mortar. These methods have low productivities and low hygienic. These problems led to the designing and construction of machines that can grate the cassava of high quality in a short period of time and reduce human drudgery. Some of the machines include: roller crushing mill, hammer mill, bar mill, grater etc. (Adekanye et al. 2013). New technology and different types of equipment have been designed and manufactured to improve the processing of cassava into gari and other products. These processing machines include: cassava harvesters, cassava graters, cassava pressing machines, mill, sifter and fryers. The quality of product differs from one operator to another and sometimes from one batch to another (Igbeka, Jory, and Griffon 1992).

2.5 A Model of Cassava Technology Adoption

Farm Characteristics

<u>Farm Size:</u> Land is perhaps the single most important resource, as it is a base for any economic activity especially in rural and agricultural sector. It is frequently argued that farmers cultivating larger farm land are more likely to adopt an improved technology (especially modern varieties) compared with those with small farmland (Obisesan 2014).

Just and Zilberman (1983) reported that in an extensive survey of the developing country, technology adoption literature, Schutjer and Van der Veen (1977) concluded that, there appears to be no consistent pattern of land size acting as a constraint to technology adoption. But Tahirou et al. (2019) in their study reported that farm size is a strong determinant of adoption.

Therefore, I hypothesize that;

H_1: Farm size is positively related to adoption of technology i.e., the more the number of farmlands owned by the farmers, the more they are able to adopt a new technology.

Extension Exposure

Studies have shown positive correlation between adoption of extension recommendations by farmers and crop yields which translate to increased income and improved quality of life of farmers (Nwaobiala 2017). Also, Akobundu et al. (2004) used the distance from the extension office, whether an individual was rejected a loan, total farm debt and the previous visit of an extension agent as instruments for participation and found a positive impact on farm income only for individuals with a high number of extension visits. Iwueke (1989) found contact with extension service to be positively and significantly associated with adoption.

According to Ejechi (2015), adoption of improved technologies increases with increase in the number of extension contacts. This is because the farmers are likely to receive more valuable information about technologies from the extension agents during such visit. The farmer with access to extension services is also likely to have more accurate expectations of the distribution of the profitability of the innovation. This will in turn reduce the number of years required before full adoption takes place (Ghadim and Pannell 1999).

Based on these studies, I hypothesize that;

H_2: Extension exposure has a positive impact on adoption of technology i.e., increase in extension exposure will lead to increase in the adoption of technology.

Individual Characteristics

Ejembi et al (2002) reported that socio-economic characteristics of farmers affect adoption of technologies. Rodriguez et al. (2009) also identified age, attitudes and beliefs as factors that affect adoption.

Age: The effect of age on technological adoption decisions may be negative or positive (Abdoulaye et al. 2014). Younger farmers have been found to be more knowledgeable about new practices and may be more willing to bear risk and adopt new technology because of their longer planning horizons. The older the farmers, the less likely they are to adopt new practices as they place confidence in their old ways and methods. Age may also influence risk aversion, with the traditional view being that older farmers are more risk averse (Ghadim, and Pannell 1999). On the other hand, older farmers may have more experience, resources, or authority that may give them more possibilities for trying a new technology. Thus, for this study, there is no agreement on the sign of this variable as the direction of the effect is location-or technology-specific (Feder et al. 1985; Nkonya, Schroeder, and Norman 1997; Oluoch-Kosura et al. 2004; Bekele and Drake 2003). Thus, I hypothesize that:

H_3: Age has a positive effect on technology adoption. As the technology gets more sophisticated, the younger farmers will be willing to bear risk and adopt new technology.

Education: Education was hypothesized to influence the adoption of decisions positively since, as farmers acquire more, their ability to obtain, process, and use new information improves and they are likely to adopt. Education increases the ability of farmers to use their resources efficiently and that will enhance their ability to obtain, analyze and interpret information. Several studies indicated positive relationship between education and technology adoption (Nkonya, Schroeder, and Norman 1997; Alene, Poonyth, and Hassan 2000; Oluoch-Kosura, Marenya, and

Nzuma 2004). Iwueke (1989) also found education to be positively and significantly associated with adoption. According to Akinbile (2003), the more literate farmers are, the more they comprehend technologies more than others. Furthermore, farmers with better education, more skills and more wealth are more likely to adopt certain kinds of innovations that are more dependent on knowledge (Maffioli et al. 2013). I therefore, hypothesize that:

H_4: Education has a positive influence on technology adoption i.e., farmers that have formal education will adopt technology more.

Household size: According to Abdoulaye et al. (2014), in their work on awareness and adoption of improved varieties and processing technologies in Nigeria, household size, which includes all people living under the same roof and who eats from the same pot as the household head, has been identified to have either a positive or a negative influence on adoption. Larger family size is generally associated with greater labor force availability for the timely operation of farm activities. Therefore, a farm with larger number of workers per hectare is more likely to be in a position to trial and continue using a potentially profitable innovation (Abdoulaye et al. 2014) Thus, I hypothesize that:

H_5: Increase in family size will lead to increase in technology adoption.

Farming experience: Experience of the farmer, as indicated by the number of years that the farmer has been farming in the region, is likely to have a range of influences on adoption (Abdoulaye et al. 2014). The farmer's previous experience with other innovations may have been either positive or negative and this will likely influence his or her perception to adopt a new technology (Ghadim and Pannell 1999). Experience will improve the farmer's skill at production. Again, this has positive and negative possibilities. Higher skill increases the opportunity cost of not growing the traditional enterprise. On the other hand, it may enhance the profitability of the innovation. Finally, a more experienced grower may have a lower level of uncertainty about the innovation's performance. In this case, the value of information due to reductions in uncertainty would be lower (Ghadim and Pannell 1999). Therefore, I hypothesize that;

H_6: Increase in number of years of experience will lead to increase in adoption of technology.

CHAPTER 3: METHODS

3.1 Description of the Study Area

Nigeria is a country in West Africa that shares land borders with the Republic of Benin in the west, Chad and Cameroon in the east, and Niger in the north. Its coast lies on the Gulf of Guinea in the south and it borders Lake Chad to the northeast. Notable geographical features in Nigeria include the Adamawa Highlands, Mambilla Plateau, Jos Plateau, Obudu Plateau, the Niger River, River Benue, and Niger Delta. Nigeria is the most populous country in Africa and has 36 States and a Federal Capital Territory (FCT) located in Abuja. The States are also sub-divided into smaller administrative units known as Local Government Areas (LGAs). The country is disaggregated into six geopolitical zones: north-east, north-west, north-central, south-east, south-west, and south-south.

Found in the tropics, where the climate is seasonally damp and very humid, Nigeria is affected by four climate types; these climate types are distinguishable, as one moves from the southern part of Nigeria to the northern part of Nigeria through Nigeria's middle belt. With a population of over 206 million, Nigeria has over 250 ethnic groups of which the three largest are: Hausa, Igbo, and Yoruba, and these ethnic groups speak over 500 distinct languages and are identified with a wide variety of cultures. Agriculture remains an important sector of the economy, as of 2010, even though it used to be the principal foreign exchange earner of Nigeria. The major crops include cowpea, rice, corn, cassava, millet, guinea corn, yam, soybean, sorghum, and melon while the cash crops are cocoa, rubber, cashew, kola nut, and oil palm.

3.2 Sampling:

Data was drawn from a survey carried out in 4 geopolitical zones in Nigeria known for cassava production which was conducted by International Institute of Tropical Agriculture (IITA) in 2010. A total of 952 respondents were selected comprising of 38% who participated in project R4D interventions (participants) and 62% who did not (non-participants). The participants were selected based on their initial participation in the project. These included 160 respondents from the SW, 96 respondents from the SS, 70 respondents from the SE and 35 respondents from the NC. The non-participants were selected randomly from non-participating communities in the regions. They included 262 from SW, 157 from SS, 114 from SE and 58 from NC.

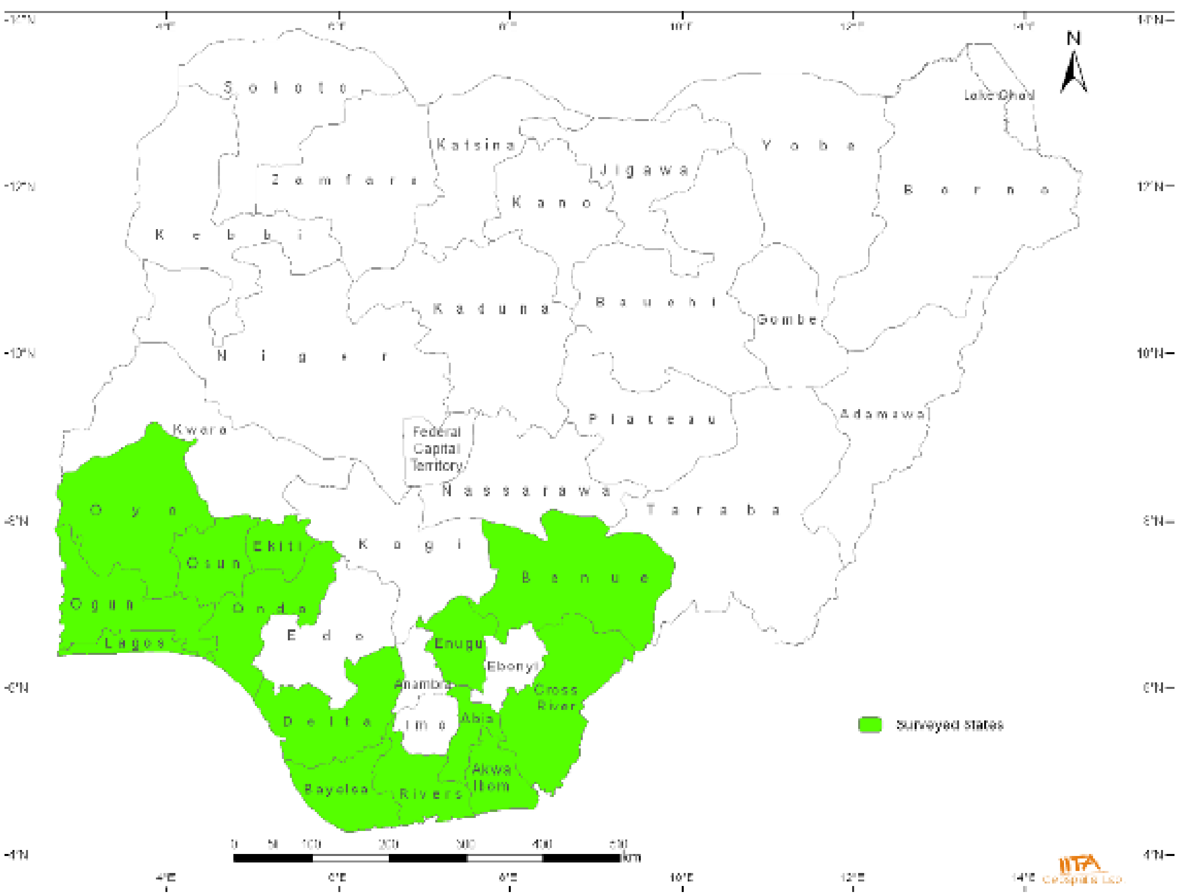

Figure 3: Map of the study area.

To ensure a sub-nationally representative sample of communities and households, a three-stage stratified random sampling procedure was adopted, whereby states were used as strata to improve sampling efficiency. LGAs that are rural were used as primary sampling units (PSUs).

Enumeration areas (EAs), defined as a cluster of housing units, were used as secondary sampling units (SSUs). The rural smallholder farming households were used as the final sampling units. LGAs were selected from each State based on probability proportional to size, where size is measured in terms of the number of EAs. The EAs that formed the sampling frame were obtained from the Nigerian Bureau of Statistics (NBS), which uses the 2003/2004 master sample frame of the National Integrated Survey of Households (NISH).

The advantage of using EAs as sampling units is that each is approximately equal in size. This ensured that all farmers had an equal probability of being selected, unlike when sampling units are towns or villages of unequal size. Within each LGA, four EAs were selected at random from a sampling frame of EAs classified as rural or semi-urban, giving a total of 80 EAs or villages. Finally, a list of households was developed for the selected EAs, and a sample of at least ten farming households was selected randomly in each of the sampled EAs. Trained enumerators administered community and household questionnaires under the field supervision of a senior agricultural economist and the direction of IITA's economist. The data was collected using a well-structured questionnaire.

3.4 Data Analysis

Data collected was analyzed in SPSS using descriptive and inferential statistics in order to achieve the specific objectives. Descriptive statistics such as mean, frequency tables and percentages and inferential statistics such as multiple regression models with Pearson correlation matrix were used for the analysis. However, the preliminary descriptive analysis was conducted in order to acquire some basic understandings and distribution of different independent and the dependent variables. A Pearson’s correlation matrix was constructed to examine the correlation between different variables under study while multiple regression analysis was used to investigate the functional relationships among the variables. The relationship is expressed in the form of an equation or model connecting the dependent variables and the independent variables.

3.5 Measures

Technology Adoption Index:

The indicators are both the production and processing cassava technology variables. It indicates the response to the adoption question, "Have you ever used this technology" for the seventeen technologies analyzed in this study. A variable count was conducted which shows the occurrences of the same value(s) in a list of variables for each case. However, a list of technologies with ***yes*/*no*** check boxes indicates which technologies each of the respondents adopted. The number of ***yes*** responses for each respondent were counted in order to create a new variable that contains the total number of technologies adopted.

Farm Characteristics Index

The farm size and cassava areas cultivated were measured by the total number of lands owned by the farmers and the total size of lands dedicated to cassava production. These were measured because increase or decrease in the size of land, can determine if a famer will be able to adopt a new technology or not.

Extension Exposure Index

These were measured to explain the number of times a farmer was able to interact with either an extension agent, agricultural extension worker or was able to attend training on production and processing of cassava.

Measure 1: How many times did you interact with extension agent on cassava processing last?

Measure 2: How many times did you interact with agricultural extension workers on cassava production?

Measure 3: How many times did you interact with agricultural extension workers on cassava processing?

Measure 4: How many times did you attend cassava processing training last session?

Individual Characteristics Index

The individual characteristics indices are age, education, household size, gender, marital status, farming experience, years of growing cassava and years of processing. The rationale for inclusion of these factors was based on a priori expectation of agricultural technology adoption literature.

Table 1: Description of variables used in the study

Variables	Description of variables
Dependent	
Extension exposure	Number of interactions with any extension services
Technology awareness	Number of farmers aware of cassava technologies
Technology adoption	Number of farmers that have ever used cassava technology
Independent	
Gender	Gender of respondents (0=female, 1=male)
Age	Age of respondent in years
Marital status	Indicates a person who is married, single or otherwise
Education	A measure of ability to read and write.
Household size	Number of people living under the same roof and taking joint decision about their welfare

Farming experience	Total number of years engaged in farming
Years of growing cassava	Total number of years engaged in cassava farming
Years processing cassava	The number of years a farmer has been into cassava processing
Farm size	Total size of lands owned by cassava farmers
Cassava area (ha)	Total size of lands dedicated to cassava farming

3.6 Model Specification

Frequency/percentage model

This model will be used to analyze the individual and farm characteristics of respondents and measure of cassava farmers to extension messages. Descriptive analysis was conducted to acquire some basic understandings and distribution of different independent variables and the dependent variables. The formula is presented thus;

$$\text{Percentage} = \frac{\text{Frequency count (FC)}}{\text{Total number of respondents (n)}} \times 100$$

FC represents the number of people that ticked a particular item as presented in the questionnaire.

Multiple Regression Model

This model was used to analyze the impact of cassava farmers exposure to extension on the adoption of improved technologies. Multiple regression model was used to determine the relationship between the dependent and independent variables which estimates the extent to which extension exposure, technology awareness and technology adoption were correlated with the individual and farm characteristics of the respondents. Pearson correlation matrix was also constructed to examine the correlation between different variables under study.

The model is implicitly represented below as;

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, \ldots X_n)$

The explicit form of the model is represented thus;

$Y_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \ldots + \beta_nX_n + et$

Where;

$\beta_1 - \beta_n$ = estimated parameters

β_0 = autonomous level of adoption known as the constant.

et = error term

Thus, the regression model is given as;

Extension exposure (Y_1) = β0 + β_1Gender + β_2Age + β_3Marital status + β_4Education + β_5Household size + β_6Farming experience + β_7Years of growing cassava + β_8Years of processing + β_9Farm size + β_{10}Cassava area ……………………………………….(i)

Technology awareness (Y_2) = β0 + β_1Extension exposure + β_2Gender + β_3Age + β_4Marital status + β_5Education + β_6Household size + β_7Farming experience + β_8Years of growing cassava + β_9Years of processing + β_{10}Farm size + β_{11}Cassava area ……………………………………….(ii)

Technology adoption (Y_3) = β0 + β_1Technology awareness + β_2Extension exposure + β_3Gender + β_4Age + β_5Marital status + β_6Education + β_7Household size + β_8Farming experience + β_9Years of growing cassava + β_{10}Years of processing + β_{11}Farm size + β_{12}Cassava area ……………………………………….(iii)

Hypothesis test

A null hypothesis was tested at a 95% confidence level ($P \leq 0.05$) which states that:

H_{01}: There is no significant effect of cassava farmers' individual and farm characteristics on extension exposure.

H_{02}: There is no significant effect of farmers' individual characteristics, farm characteristics and extension exposure on the awareness of technology.

H_{03}: There is no significant effect of farmers' individual characteristics, farm characteristics, extension exposure and technology awareness on the adoption of technology.

This further state that all regression coefficients are equal to zero.

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = 0$

CHAPTER 4: RESULTS

In this chapter hypotheses are tested and results are discussed. First, descriptive analyses are used to provide a general understanding of all the variables of interest. Second, sources of cassava technology information are summarized based on the percentages reported as sources of information that were accessed by the farmers. The Pearson correlation matrix summarizes the linear association, and the strength of association between two variables of the dependent and independent variable. In the last section, the regression analysis explained the variables that were significant based on the hypothesis that were tested. The first section deals with presentation of results of the analysis based on the specific objectives of the study.

4.1 Descriptive Analysis

Table 2 provides the summary statistics of the dependent and independent variables. The variables considered in this study are indices of extension exposure, technology awareness, technology adoption, and farm and individual characteristics of participants. The indices of extension exposure consist of questions that indicate respondents' interaction with extension agents or their engagement in field trainings. Farm characteristics indices considered were farm size and cassava area (size of land dedicated to cassava farming), while the individual characteristics were gender, age, education, marital status, household size, years of farming experience, years of growing cassava, and years of processing cassava. These characteristics play important role in understanding the differences among households and hence explaining their behavior regarding technological change.

From the sampled households, result shows that the average age of the respondents was 49.08 and the oldest among them was 100 years which means that most of the farmers are in their productive age. Age is also considered to be a primary latent characteristic in adoption decisions.

Majority of the respondents were men showing a mean of 0.77 (76.8%) which means that men constitute a greater percentage of those who are engaged in cassava production in the sampled states. 86.6% of the respondents were married having family responsibility. Family responsibility presupposes their willingness to get involved in productive activities to meet family demands. The average number of households reported were between 6-10 (57.5%) persons which suggests availability of family labor. Education level of the respondents was high with an average of 10 years of formal education which indicates that the respondents are literate and are expected to be more receptive to improved farming techniques and improved technologies.

Majority of the respondents (31.7% with a mean of 2.44) reported that they have been growing cassava for about 11-20 years. Likewise, majority of the respondents (31.6% with a mean of 2.66) had between 11-20 years' experience in farming while experience in processing was between 1-10 years. This finding indicates that the respondents were experienced farmers. Majority of the respondents owned farms less than 5hectares, likewise same is dedicated to cassava farming which means that most of them were small scale farmers.

Table 2: Descriptive statistics of variables used in analysis, Nigeria cassava farmers, 2010

Variables	Valid	Missing	Mean	Mode	Range	Minimum	Maximum	Response
Dependent								
Extension exposure	952	0	0.24	0	4	0	4	
Technology awareness	952	0	4.66	2	17	0	17	
Technology adoption	952	0	2.69	0	17	0	17	
Independent								
Gender	952	0	0.77	1	1	0	1	0 = female, 1 = male
Age	938	14	49.08	50	82	18	100	
Marital status	952	0	0.13	0	1	0	1	0 = married, 1 = others
Education	952	0	10.11	10	20	1	21	
Household size	946	6	2.00	2	4	1	5	1=1-5, 2=6-10, 3=11-15, 4=16-20, 5=21 and above
Farming experience	925	27	2.66	2	4	1	5	1=1-10, 2=11-20, 3=21-30, 4=31-40, 5=41 and above
Years of growing cassava	926	26	2.44	2	4	1	5	1=1-10, 2=11-20, 3=21-30, 4=31-40, 5=41 and above
Years of processing cassava	952	0	2.20	1	4	1	5	1=1-10, 2=11-20, 3=21-30, 4=31-40, 5=41 and above
Farm size	952	0	1.40	1	3	1	4	1=under 5, 2=6-10, 3=11-15, 4 = 16 and above
Cassava area (ha)	952	0	1.09	1	3	1	4	1=under 5, 2=6-10, 3=11-15, 4 = 16 and above

4.2 Sources of Cassava Information

Table 3 shows that the spread of information about the technologies were a collective effort by many stakeholders. Results indicate that farmers to farmers' technological diffusion played the greatest role in dissemination of the technologies. Also, majority of the farmers sourced their information from extension agents and IITA. It is expected that farmers' interaction with extension agents for a better use of the production and processing technologies would have positive impact on their farm output and productivity. Farmer-to-farmer contact is very important in technology dissemination especially in small-scale farming system (Grisley 1994). This is similar to the findings of Sanginga et al. (1999) who stated that friends/neighbors contact and extension contact from the principal sources of information seemed to be more effective.

Table 3: Sources of cassava technology information, Nigeria 2010

	Percent reported as source of cassava technology information							
Topic	**IITA**	**Government**	**NGO**	**Farmer**	**Media**	**Extension Agent**	**Agro Dealer**	**Others**
Improved varieties	15.6	3.7	0.8	28.0	2.9	46.3	2.5	0.3
Management	7.5	2.0	0.7	47.1	1.8	39.7	1.1	0.2
Peeling	7.8	-	3.3	44.4	6.5	28.1	9.2	0.7
Washing	6.6	-	2.5	45.5	2.5	33.1	9.1	0.8
Grating	9.7	1.1	1.4	59.2	1.7	22.2	4.7	-
Chipping	11.9	-	2.4	16.7	11.9	42.9	11.9	2.4
Extracting	5.1	2.6	2.6	43.6	12.8	28.2	2.6	2.6
Pressing	8.7	1.0	1.4	60.9	4.5	19.0	3.8	0.7
Sifting	12.7	-	2.8	56.3	4.2	19.7	4.2	-
Drying	5.7	2.9	1.4	42.9	8.6	22.9	12.9	2.9
Boiling	8.3	-	-	30.6	11.1	33.3	13.9	2.8
Distilling	25.0	-	-	25.0	-	37.5	-	12.5
Fermentation	6.7	-	-	31.1	8.9	42.2	8.9	2.2
Frying	14.6	-	1.8	50.6	1.8	22.6	7.3	1.2
Pelleting	20.0	-	-	10.0	-	50.0	10.0	10.0
Grinding	6.5	1.6	2.4	52.8	3.3	24.4	5.7	3.3
Milling	10.3	1.3	2.6	37.2	15.4	23.1	5.1	5.1
Number	*952*							

Source: Data analysis (2021)

4.3 Correlation Matrix

Pearson correlation (*r)* was conducted to measures the strength and direction of the linear relationship between two variables. The strength of the relationship varies in degree based on the value of the coefficient.

Table 4 presents the correlation between the dependent variables and the independent variables. Overall correlation between extension exposure, technology awareness, technology adoption and the independent variables were low. The highest degree of correlation (0.577) was observed between technology awareness and technology adoption. This correlation was significant at 0.01 (1%) level. In other words, there is moderate positive relationship between technology awareness and technology adoption. Also, a correlation was identified among two independent variables (technology adoption and technology awareness) indicating a multicollinearity. In this case, a multicollinearity will not be considered a problem since it does not influence the predictions, precision of the predictions, and the goodness-of-fit statistics and the overall R^2 quantifies how well the model predicts the Y values.

Table 4: Pearson correlation matrix of study variables, Nigeria cassava farmers 2010

	Variables	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1.	**Extension exposure**	1											
2.	**Technology awareness**	.125**	1										
3.	**Technology adoption**	.187**	**.577****	1									
4.	Gender	-0.050	0.010	-.085**									
5.	Age	0.020	0.057	0.054	.125**	1							
6.	Marital status	0.036	-0.014	0.059	-.308**	0.011	1						
7.	Education	0.010	0.029	0.014	0.062	-.076*	-.077*	1					
8.	Household size	.134**	0.042	-0.062	.125**	.200**	-.097**	0.049	1				
9.	Years of farming	.070*	-0.053	-.129**	.196**	.474**	-0.007	-.123**	.302**				
10.	Years growing cassava	0.053	-.093**	-.104**	.161**	.453**	0.006	-.130**	.256**	.891**	1		
11.	Years of processing	0.010	-.134**	-.103**	.123**	.363**	0.026	-.135**	.148**	.763**	.851**	1	
12.	Farm size	-.102**	-0.008	-.155**	.114**	.087**	-.084**	-0.033	.249**	.157**	.111**	0.019	1
13.	Cassava area	-0.004	-0.021	-.077*	-0.001	.066*	-0.020	-.082*	.090**	.094**	.098**	.073*	.295**
	Number	*902*											

**, * means Correlation is significant at 0.01 (1%) and 0.05 (5%) level respectively. Source: Data analysis (2021)

4.4 Regression Analysis

Table 5 presents the standardized beta coefficients for the regression analysis between the individual characteristics, farm characteristics, extension exposure, technology awareness and technology adoption. A standardized beta coefficient compares the strength of the effect of each individual independent variable to the dependent variable. The higher the absolute value of the beta coefficient, the stronger the effect. It is reported in order to identify independent variables that have more impact on the dependent variable. Indeed, an independent variable with a larger standardized coefficient will have a greater effect on the dependent variable.

The regression analysis showed that different variables had an effect on technology adoption, technology awareness and extension exposure. A positive sign on a parameter indicates that a standard deviation increase in independent variable will result to a standard deviation increase on the dependent variable. The table shows that age, household size, years of farming experience, years of processing cassava and farm size had a significant relationship with extension exposure, technology awareness and technology adoption.

Impact on Extension Exposure

The results show an R^2 value of 0.051 which implies that 5.1% of the variation of the response variable (Extension Exposure) around its mean is explained by the regression model, and F-value of 4.801**. The results of the regression analysis show a positive coefficient for household size which is statistically significant at 1%, while years of processing cassava, and farm size are negative and statistically significant at 5% and 1% respectively.

Interpreting the standardized beta coefficients, a one standard deviation increase in household size results in a 0.151 standard deviation increase in exposure to extension, a one standard deviation increase in farm size results in a 0.164 standard deviation decrease in exposure to extension, and a one standard deviation increase in years of processing results in a 0.136 standard deviation decrease in exposure to extension. This is not consistent with the a priori expectation because one would think that the larger the farm size, the more likely a farmer is to have more exposure to extension. For years of processing cassava, this implies that the more time spent in processing cassava, the less the interaction with extension agents. The result also contradicts a priori expectation because the longer a farmer is engaged in processing, the more it is expected that he would make extension contact as well as gain more knowledge and information of different techniques in processing.

Impact on Technology Awareness

The results show an R^2 value of 0.050 which implies that 5% of the variation of the response variable (Technology awareness) around its mean is explained by the regression model, and F-value of 3.199**. The results of the regression analysis show a positive coefficient for extension exposure and age which are both statistically significant at 1%, while years of processing cassava is negative and statistically significant at 1%.

Interpreting the standardized beta coefficients, we get that one standard deviation increase in extension exposure and age results in a 0.126 and 0.116 standard deviation increase in technology awareness respectively. Also, one standard deviation increase in years of processing results in a 0.175 standard deviation decrease in technology awareness. For years of processing cassava, this implies that the more time spent in processing cassava, the less the farmers awareness of new technologies. The result is not in line with a priori expectation because it is expected that the more a farmer is engaged in processing, the more he would be aware of new technologies.

Impact on Technology Adoption

The results showed an R^2 value of 0.388 which implies that 38.8% of the variation of the response variable (Technology adoption) around its mean is explained by the regression model, and F-value of 46.936**. The results of the regression analysis show a positive coefficient for technology awareness, extension exposure, and age, which are all statistically significant at 1%, while household size, years of farming experience, and farm size were negative and statistically significant at 1%.

Interpreting the standardized beta coefficients, we get that one standard deviation increase in technology awareness, extension exposure and age results in a 0.551, 0.126 and 0.099 standard deviation increase in technology adoption respectively. Also, one standard deviation increase in household size, years of farming and farm size results in a 0.058, 0.237, and 0.099 standard deviation decrease in technology adoption respectively.

The result of respondents' exposure to extension and adoption shows a positive impact and this is due to the fact that for adoption to take place there must be adequate information about the technology, which the extension agents have to do frequently with the farmers. For age, it implies that any increase in age is expected to lead to increase in adoption of cassava technologies in the study areas. This also means that the older the farmers get, the more they are willing to adopt new technologies. This result follows Ejechi (2015), that age has direct relationship with adoption of cassava production technologies.

The negative significance of household size implies that a standard deviation increase in household size results to a 0.058 standard deviation decrease in adoption of cassava technologies. This is not in line with the *a priori expectation* because larger households are more likely to have access to more information on new technologies which can lead to adoption. Also, the negative relationship of the variable with adoption has been linked to the increased consumption pressure associable with a large family (Abdoulaye et al. 2014).

The significant influence of farming experience on adoption may be due to the risk involved in adoption. Farming experience having a negative relationship with adoption implies that, farmers who are new to cassava production are expected to be reluctant to take risk by adopting new technologies than farmers who are more experienced. The result does not corroborate with the findings of Tahirou et. al. (2019) in their study that farm size is a strong determinant of adoption.

Table 5: Regression of Extension Exposure, Awareness Index, and Technology Adoption Index on selected farm and individual characteristics, Nigeria cassava farmers 2010

	Standardized beta coefficients					
Variables	**Extension exposure**	**Technology awareness**		**Technology adoption**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Technology awareness	--	--	--	--	--	**0.551****
Extension exposure	--	--	**0.126****	--	**0.196****	**0.126****
Gender of respondent	-0.068	0.011	0.020	-0.052	-0.039	-0.050
Age of respondent	-0.019	**0.114****	**0.116****	**0.160****	**0.164****	**0.099****
Marital status	0.023	0.001	-0.002	0.031	0.026	0.027
Education	-0.006	0.009	0.010	-0.006	-0.005	-0.010
Household size	**0.151****	0.042	0.023	-0.016	-0.046	**-0.058****
Years of farming	0.135	0.063	0.046	**-0.185***	**-0.211****	**-0.237****
Years growing cassava	0.035	-0.043	-0.047	0.110	0.104	0.130
Years of processing cassava	**-0.136***	**-0.192****	**-0.175****	-0.104	-0.077	0.019
Farm size	**-0.164****	-0.025	-0.004	**-0.133***	**-0.101****	**-0.099****
Cassava area	0.037	-0.005	-0.010	-0.017	-0.024	-0.019
R^2	0.051	0.035	0.050	0.063	0.099	0.388
Adjusted R^2	0.040	0.024	0.038	0.052	0.088	0.380
N	902	902	902	902	902	902
F-value	**4.801****	**3.199****	**4.242****	**5.970****	**8.899****	**46.936****

**, * means significant at 0.01 (1%) and 0.05 (5%) level respectively. Source: Data analysis (2021)

CHAPTER 5: CONCLUSION

This chapter summarizes the findings from the study the impact of extension exposure on technology adoption and also to understand the influence of some of the individual and farm characteristics of the respondents on adoption of technology.

5.1 Main Findings

The findings shows that all the F-values were significant which means to reject the null hypothesis. This indicates that some of the variables had impact on adoption of technologies. Variables like extension exposure, technology awareness, age, household size, years of farming experience, years of processing and farm size all had significant effect on technology adoption. Gender, marital status, education, and cassava area had no significant influence on extension exposure, technology awareness and technology adoption. The highest degree of correlation (0.577) was observed between technology awareness and technology adoption. This implies that the farmers must be aware of a technology before adoption can take place.

The study shows that most of the farmers are in their productive age and men constitute a greater percentage of those who are engaged in cassava production in the study areas. It was also indicated that average mean of the respondents had 10 years of formal education which shows that they are literate and are expected to be more receptive to improved farming techniques and technologies. Majority of the respondents had experience in farming and have been growing cassava for about 11-20 years. Majority of the respondents owned farms less than 5hectares, likewise same is dedicated to cassava farming which means that most of the farmers were small scale farmers.

5.2 Empirical Implications

This explains the empirical findings of the study based on the proposed regression model.

Firstly, in the model investigating the effect of individual and farm characteristics of the respondents on extension exposure, we found that household size shows a positive coefficient value which is statistically significant at $P<0.01$, while years of processing cassava, and farm size are both negative and statistically significant at $P<0.05$and $P<0.01$ respectively. This implies that the larger the household size the more their extension exposure and the more the years of processing the less the extension exposure, the more the farm size the less the extension exposure. Therefore, fitting the regression model gives;

$$Y_1 = 0.151X_5 - 0.136X_8 - 0.164X_9$$

Secondly, the model investigating the effect of individual characteristics, farm characteristics, and extension exposure, on technology awareness, we found that extension exposure and age shows a positive coefficient which are both statistically significant at $P<0.01$, while years of processing cassava is negative and statistically significant at $P<0.01$. Therefore, fitting the regression model gives;

$$Y2 = 0.126X_1 + 0.116X_3 - 0.175X_9$$

The model investigating the effect of individual characteristics, farm characteristics, extension exposure, technology awareness, on technology adoption, we found that technology awareness, extension exposure, and age, which are all statistically significant at $P<0.01$, while household size, years of farming experience, and farm size were negative and statistically significant at $P<0.01$. Therefore, fitting the regression model gives;

$$Y_3 = 0.551X_1 + 0.126X_2 + 0.099X_4 - 0.058X_7 - 0.237X_8 - 0.099X_{11}$$

5.3 Theoretical Implications

Some of the findings in this study are more in line with Rogers's theory and model of diffusion of innovation as it is a very important theory that can serve change agents (extension services and research institutes) well. The theory also benefits the targets of change, since the farmers' exposure to extension has a positive impact on technology adoption. In line with Rogers's proposed theory that communication is an indispensable factor in agricultural practices and it is one of the basis of extension service delivery (Rogers 2003), the findings suggests that farmers to farmers' technological diffusion played the greatest role in dissemination of the technologies, along with extension agents, IITA, and media.

5.4 Practical Implications

Some of the findings would appear to contradict with some previous findings while some are consistent. For instance, the negative influence of farm size and years of processing on adoption contradicts with the findings of Ayayi and Solomon (2010) that farm size and years of farming experience had positive influence on adoption at $p < 0.05$.

However, based on personal having lived most of my life Nigerian participated in extension services, large hectares of land that would be available for farming are mostly be located in deep rural places, and extension agents are usually not able to access many such locations due to reason such as transportation and general lack of funds. As a result, farmers in such areas have minimal and often times zero access to extension activities and technologies.

Also, it is consistent with the Nigerian reality that it is usually residents of places located far away from cities that would be engaged in farming for an extended period of time. Hence, for the same reason as in the previous paragraph, they have minimal access and interaction with extension agents.

5.5 Future Research

This research's main focus is on the impact of extension exposure on the adoption of cassava technology. The primary purpose is to provide a general understanding about the relationship between extension exposure, and farm & individual characteristics of cassava farmers on technology adoption. However, factors that hinder the interaction between extension agents and cassava farmers need to be considered for a future research. This is due to my findings which indicate that farmers to farmers' technological diffusion played the greatest role in dissemination of the technologies whereas interaction with extension agents were low.

To take this study further, a study to examine the effect of distance of farmers from the focal points (extension services, research institutes) on adoption is necessary. It is anticipated that close proximity of farmers to extension services may increase the likelihood of adoption of technologies. Therefore, examining the level and intensity of adoption of farmers in various locations relative to the focal points may be important in highlighting the importance of distance in adoption studies

Factors like distance to the nearest adopter of the technology and the frequency of contact that the farmer maintains with them is likely to influence adoption and therefore, should also be considered. This is because the closer the farmers are to the nearest adopter and the higher the frequency of contact with them, the more likely it is that the farmer will receive valuable information about using the technology, improving their skill and reducing their uncertainty.

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