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The Moderating Effect of Income on the Predictors of Cassava Farmers' Adoption of Agricultural Technology in Nigeria: A Conceptual Framework

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ABSTRACT: *This study endeavors to construct a comprehensive conceptual framework elucidating the moderating influence of income on factors influencing the adoption of agricultural technology among cassava farmers in Nigeria. Agricultural technology, herein, refers to the innovative utilization of emerging Information and Communication Technologies tailored for agricultural applications within remote environments. The agricultural sector holds paramount significance within the Nigerian economy, engaging nearly 70% of the labor force and contributing over 40% to the gross domestic product. The adoption of technology in agriculture signifies potential enhancements in income, poverty alleviation, improved national nutrition and health, reduced food prices, and employment opportunities. However, the income of cassava farmers plays a pivotal role in ensuring their sustainability. Regrettably, their income streams are often unstable due to fluctuations in market prices, adversely impacting their ability to finance the adoption of technology to bolster productivity. Therefore, this research aims to develop a robust conceptual framework delineating the moderating role of income on the determinants of agricultural technology adoption behavior, particularly pertinent within the Nigerian context. It is imperative to tailor conceptual frameworks specifically for Nigeria, given that frameworks derived from other regions may not be directly applicable to the unique challenges and dynamics of the Nigerian agricultural landscape.*

KEYWORDS: Agricultural technology adoption, Cassava Farmers, Nigeria, Moderation Effect, Income, Conceptual Framework.

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INTRODUCTION

Internet advent has transformed how businesses are done, leading to terms like e-learning, e-government, e-banking, and e-commerce more recently e-agriculture (Oni et al., 2017). Agricultural technology is defined as the design, development, conceptualization, application and evaluation of innovative ways to apply emerging Information and Communication Technologies in the remote environment, focused on agriculture (Adeyemo, 2013). Agriculture may be one of the most critical sectors in the Nigerian economy, as it is estimated to engage nearly 70% of Nigerian's labor force and contribute more than 40% of the gross domestic product (Koyenikan, 2008; FMARD, 2015). It is also projected to be the main or primary source of income to almost 2.5 billion people in the developing world (Koyenikan, 2008). Agriculture has gone through several revolutions under different governments in Nigeria; ranging from operation feed the nation, structural adjustment programme agriculture, to green revolution. The most recent is the Agricultural Transformation Agenda (ATA) (FMARD, 2015) in which grassroots farmers got mobile phones free of charge to encourage e-agriculture. This gesture was never enjoyed by farmers until around 2015. Although, the term e-agriculture was alien to the farmers; but for its convenience, it is being embraced because fertilizers and implements are delivered via e-agriculture. To support the farmers, the National Information Technology Development Agency (NITDA) has an e-portal that handles e-agriculture but most farmers are unaware, let alone taking advantage of it for national economic advancement (NITDA, 2015).

In sub-Sahara Africa, it is estimated that those who live below one US dollar ($1) per day are more than half of the population, indicating some 115 million people (Adeyemo, 2013). Also, 12 out of 15-member countries ranked among the world's least developed countries. Such desperate circumstances inevitably set limits on the citizens. The adoption of agricultural technology can change the story for the better, particularly in Nigeria. A huge volume of uneducated and peasant farming population is being orientated to embrace technology in order to expanded regional market or the opportunities that might result from scientific knowledge or a freer flow of goods and capital globally. But these same difficulties of economic isolation and constrained opportunity have driven many nations like India, Nigeria, Brazil to adopt technology (e-agriculture inclusive). The countries do use weather, breeding, market forecasts and strategies as ways to overcome domestic weaknesses such as infrastructure deficit, pest troubles, ignorance, limited communication and transportation links with the outside world.

Adoption of technology in agriculture is a pointer to enhanced income, poverty reduction, better national nutrition and health, reduced food price, and employment generation. Furthermore, the

ability of a farmer to obtain relevant and current information, process and use such to adoption of a new technology depends on the farmers' educational level (Lavison, 2013; Mwangi and Kariuki, 2015). The productive green revolution of the Asian Tigers was made possible due to adoption of improved technologies. Refusal to adopt agricultural technology is a pointer to social-economic troubles, deprivation, and degradation (Mwangi and Kariuki, 2015; Jain et al., 2009). Grassroots farmers experience rainfall that was never expected or planned for, due to ignorance of weather forecasts, infertile land, poor or lack of infrastructure. Commonly, information about issues such as irrigation, agricultural input sourcing and products marketing, credit facility availability, and extension services are barely readily accessible to many farmers (Muzari et al., 2012).

For many decades before year 2000, e-agriculture was being adopted at a low pace and the required aspects of adoption were barely known to many farmers (Simtowe et al., 2011; Mwangi and Kariuki, 2015). Social networks and learning are key factors that determine the adoption of any new technology (Uaiene, 2009; Oni et al., 2017). These factors have been categorized through studies into other several classifications. Armstrong and Diepeveen (2008) divided the major factors that determine the level of adoption of agricultural technology into institutional, economic and social factors. Their work revealed a Farmer Decision Support Framework (FDSF) developed to aid growers in decision making. The e-agriculture platform galvanizes cropping information from experts (research papers, websites, advisers, private consultants, and government) in western Australian agriculture sector. It was challenging to evenly distribute farming materials (implements, chemicals, and fertilizers) to all farmers and this has been complemented by information websites of breeding, seed companies, government extension websites, agriculture marketing websites and others.

Using the Internet and other technologies, the Department of Agriculture and Food of Western Australia (DAFWA), provides a website giving downloadable reports and can compare varieties of crops. The FDSF uses information collected from many sources, captured, integrated, processed, and validated through the data mining tools and put in an organized useable way to the farmers. There was a proposal of an Agricultural Information Dissemination System (AgrIDS) in Australia aimed at providing grassroots farmers expert information to boost crop productivity. It was meant to deliver a timely and effective agricultural counsel on crops via internet in form of texts and images to convey experts' knowledge. The stakeholders of the system are the farmers, Agricultural Information System (AIS), coordinators and agriculture experts. The experts are scientists giving scientific knowledge from training and experience into the system, the coordinator is a mediator between end users (farmers), the AIS, and experts. They visits the farms to get research data (soil, crop, animals, sales, weather) information and make recommendations. The farmers are registered into the system by the coordinators for subsequent e-agriculture platform benefits and feedback (Adeyemo, 2013).

According to National Communications Commission (NCC) as reported in Newswatch (2015); there are 146 million telecom subscribers in Nigeria. This can only make acceptance and adoption of e-agriculture better. This is a good platform to take advantage of e-agriculture, as a high percentage of farmers have mobile phones. The Ministry of Agriculture, under the transformation agenda of agriculture uses short message service (SMS) on mobile phones to distribute fertilizers and seedlings to farmers across Nigeria. This helps to curtail (if not totally prevents) corruption in the distribution chain, kicks out adulterated content, and enhances accessibility, transparency and accountability (Newswatch, 2015). The use of e-agriculture to distribute seedlings and fertilizers in Nigeria affords a timely planting and an appreciable increase in output, boosting the GDP. It is noteworthy that Nigerian farmers are tapping into e-agriculture by marketing their farm produce on websites, although mostly corporate farmers, for example universities and big farms, as at present (NITDA, 2015). Many blogs are also available attracting buyers of plantain suckers, fingerlings, eggs, and other fisheries and poultry products, thereby attracting unemployed graduates to agriculture as e-agriculture makes access to initial needs easier.

Furthermore, income of the cassava farmers plays a vital role in his sustainability. But their income is not always steady as harvest is grossly affected by vagaries of market prices. This has meant that the farmers of cassava can rarely finance their use of technology to improve productivity. According to Carr, Susan and Tait (2017), this has led to persistent poverty and kept cassava farming at subsistent level . Developing a robust and comprehensive conceptual framework for agricultural technology adoption behaviour among the Cassava farmers in Nigeria is very germane. This will enable food and agricultural products marketers have deeper insights about the predicting factors that influences the adoption behaviour. Also, a robust conceptual framework that focuses on farmers' income as a moderator will enable agricultural marketing scholars understand better how income of Cassava farmers can modulate their adoption behaviour regarding agricultural technologies.

AIhough there are plethoral of extant literature on adoption behaviour, studies on farmers' adoption of agricultural technology in a typical developing economy like Nigeria is scarcely reported and especially in the North Central Nigeria which is the food basket of the nation hence, it is expedient to conduct a context-specific study in this area. Furthermore, the application of unified theory of technology adoption in the food and agricultural marketing domain is under-research, this study seeks to fill this literature gap. Moreover, extant literature on agricultural technology adoption behaviour that focuses on cassava farmers are still lacking {to the best knowledge of the researcher). Therefore, this study deems it necessary to explore cassava farmers since cassava is one of the most consumed farm produce in Nigeria. Moreover, there is need to develop a robust conceptual framework on the moderating role of income on the predictors of agricultural technology adoption behaviour in a typical developing country like Nigeria since, conceptual frameworks on agricultural technology adoption behaviour from other climes may not

be suitable to a typical Nigerian context. Lastly, studies that employed income as a moderating variable in the domain of agricultural technology adoption behaviour is grossly deficient. To this end, this study include income as a moderator of the predictors of cassava farmers' adoption of agricultural technology and develop a robust and comprehensive conceptual framework suitable for a typical developing country-context like Nigeria.

REVIEW OF RELATED LITERATURE

Agriculture: An Overview

Agriculture can immensely support to reduce poverty while increasing income. At the same time, enhancement in agriculture will lead to uplift the food security. These improvements might have a tremendous effect on about 80% of the poor people living all around the world. These poor people are mostly residing in rural areas and many of them are working in the agriculture sector (The World Bank, 2019). The World Bank (2019) mentions that according to their studies, around 65% of the poor working adults are earning their income through agriculture and related activities. Thus development in agriculture will have an immense effect in ending poverty. At the same time, it will promote the spread of wealth and will provide food required for the increasing population. In 2019, agriculture contributed 3.5% to the global gross-domestic product (GDP) according to the statistics given by the World Bank Group (2021). The same report mentions that the highest contribution from agriculture to the GDP is reported from low income countries (23.9%) while the least is reported in high income earning countries (1.3%) in 2019. Therefore, agricultural development is considered as an apex and an essential strategy to boost the economy of a country (Eklund, 1983; Devi et al. 2014; Diiro and Sam 2015). Each day, research generates novel technologies in the agricultural sector. These technical advancements are taking place around the world. Novel or improved technologies are considered as key role players in many sectors including agriculture (Ugochukwu and Phillips, 2018). The most important fact about these novel and improved technologies is that, how efficient they are in improving food production thus leading to ensuring food security. In the recent past, new technologies were emerging worldwide. Yet, the adoption of these new technologies is not guaranteed. But the real impact expected from introducing the novel technology will be visible only when adoption of the technology has taken place. Even if people get similarly aware on a particular technology, they will behave differently toward different technologies. Therefore, the time duration taken for adoption might vary depending on many factors, such as characteristics of the technology and of the adopter. But the rate of adoption and its diffusion will determine the extent of adoption that has taken place over time. Many researches have been conducted using different models considering different factors to detect the adoption and the influence of each and every factor taken for the study. Similarly, many studies have been conducted in medicine, information and communication technology, and education too, again using different models as well as factors to decide on technology acceptance and/or rejection (Ugochukwu and Phillips, 2018; Walisinghe et al. 2017). With all these research

and discussions, novel technologies are to be used as a remarkable tool to alleviate poverty and the economic development of a nation. Identifying the factors affecting the process and discussing different theories and models to describe the adoption will facilitate the proper execution of the required activities to achieve such goals. But the low rate of adoption is still considered a major limitation in all these sectors especially in developing countries (Silva and Broekel, 2016; Mwangi and Kariuki, 2015; Bandiera and Rasul, 2002). However, adoption of novel technologies still lies as a pivotal requirement in the development of the agriculture sector. Therefore, much emphasis is given to facilitate and ensure adoption of technologies.

Adoption of Technology

Many authors define adoption in different ways. In 2012, Loevinsohn et al., had defined the adoption to be as "the integration of a new technology into existing practice and is usually proceeded by a period of 'trying' and some degree of adaptation". On the other hand, Bonabana-Wabbi (2002) had mentioned that Feder et al., (1985) had defined adoption as "a mental process an individual passes from first hearing about an innovation to final utilization of it". Feder et al., (1985) had given another definition for adoption, which is "the integration of an innovation into farmers' normal farming activities over an extended period". In all these definitions the actual practice and time factor are mentioned. Although adoption is taken as a behavioural change, it might not be permanent. Discontinuation of adoption might also take place due to many reasons. Some of them are personal, institutional, and social. Another remarkable reason is that, a person might discontinue the adoption of a specific technology due to the availability of a superior technology that will be able to satisfy the consumer expectations at an elevated level (Dasgupta, 1989). Feder et al., (1985) classified adoption into two categories, namely, "individual adoption" and "aggregate adoption". Feder et al., (1985) were referring to the individual adoption to be an adoption taking place at the farmers' level. The definition for this individual adoption is "the degree of use of a new technology in the long-run equilibrium when the farmer has full information about the new technology and its potentials". In aggregate adoption, diffusion and time factor are taken into consideration. Diffusion is thus defined as "the spread of a new technology within a region". Therefore, the aggregate adoption is analyzed by the aggregation of usage of particular novel technology, within a certain community, a specific geographical area or a specific population. Rogers (1983) describes the diffusion of technology where he says, "Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system". Here in this definition too, the time factor is raised. Furthermore, this definition discusses a special communication process where the message is on the novel technology. In the collection of all these definitions and comments from various scientists, the summary of it is that the adoption of technology is a process that leads to the usage of new technology and it might spread to other people through the diffusion process. Sometimes the people might discontinue using this technology due to various reasons as well. Furthermore, the adoption process has many factors affecting it. In a holistic manner, Melesse (2018) had

summarized some paradigms introduced by many authors as below. The innovation diffusion model, the adopters' perception, and the economic constraints models. The innovation diffusion model was based on one assumption. This assumption was defined as, "the technology is technically and culturally appropriate, but the problem of adoption is one of asymmetric information and with very high search cost". The adopters' perception paradigm describes features related to adopters. It suggests that the attributes of the technology perceived by the adopter will determine the adoption of the novel technology. This implies that even with all the required information that the first paradigm discusses is available, each person who receives the information will evaluate the technology in a different manner than the scientists (Kivlin and Fliegel, 1967). Therefore, it is very important to understand the technical information, process of dissemination of it as well as the comprehensive abilities of the end-user in generating new technologies. It is equally important in determining the information dissemination procedures as well. The economic constraint model, which is the third paradigm, discusses that the availability of required inputs in the short run will determine the adoption process. Such crucial inputs could be access to credit, land and labor (Aikens et al. 1975). This implies that even with all the information in hand and a complete understanding of it, lack of required resources will limit the adoption of the technology. But the use of these three paradigms together in modelling the technology adoption process is much explanatory and appropriate than using a single model (Melesse, 2018). The author also agrees with all these paradigms however, which are more effective in a collective approach. That will lead to all the factors mentioned in all three paradigms; i.e. the level of information reaching the farmer, perceived effectiveness of the technology to the individual farmer and all the infrastructure and other capital resources required for the usage of the technology that are altogether affecting the adoption process. Many authors have cited as well as described a number of theories in adopting the technologies.

Income of Farmers

According to Nangayo, Omanya, Bokanga, Odera, Mnshiri, Ali, and Werehire (2005), an increase in the demand for cassava and the resultant rise in income from cassava production serve as significant motivators for farmers to embrace productivity-enhancing technologies. This adoption facilitates yield enhancement and the expansion of cassava cultivation. In Sierra Leone, as highlighted by Sesay, Lebbie, and Wadsworth (2021), the cultivation and trade of cassava rank second only to rice in terms of their contributions to sustenance and economic livelihoods for farmers, processors, and traders. Abdoulaye, Abass, Maziya-Dixon, Tarawali, Okechukwu, Rusike, Alene, Manyong, and Ayedun (2014) underscore the pivotal role of cassava in providing sustenance and income to over 30 million farmers, as well as a significant number of processors and traders in Nigeria. Additionally, Mvodo and Liang (2012a) assert that cassava offers growers higher income compared to its major competitors, rice and maize, in Cameroon.

Moreover, the adoption of new agricultural technology, as noted by Challa (2013), leads to improved input/output relationships, resulting in increased output and reduced average production costs, thereby yielding substantial gains in farm income. Nweke (2003) observes the ubiquitous cultivation of cassava among households, serving both as a dietary staple and a primary source of income. Furthermore, Nweke and Manyong's (2000) study delineates the transformation of cassava farming from subsistence to income-generating activities, with cassava cultivation contributing approximately 20% to household income among cassava-growing households.

Agricultural Technology

Farming methods have evolved massively over the years, from basic, hand-held tools to the modern, sophisticated machinery. Most farmers are now embracing modernity, which has enabled them to achieve the highest potential in whichever farming activity they choose to undertake. By agriculture technology , farming methods are increasingly becoming more refined, less manual, yields are increasing. Technological advancements have permeated every industry across the world and agriculture is no exception. Nowadays, technology is significantly helping growers and farmers in several ways, including precise forecasting, data-driven decision making, and more. The changes have also resulted in a positive impact on the bottom line of most farmers and ultimately led to improved accesses to food products, at reasonable prices.

Performance Expectancy and Agricultural Technology Adoption

Performance expectancy (PE) can be defined as "the degree to which the user expects that using a system will help him or her to attain gains in job performance" (Venkatesh et al., 2003). More concrete this means that people are more likely to adopt new technologies when they believe this will help them to perform their job.

Venkatesh et al. (2003) integrated five concepts from various models into the construct of performance expectancy, namely perceived usefulness, extrinsic motivation, job-fit, relative advantage and outcome expectations. The concept of perceived usefulness was introduced by Davis (1986) in the Technology Acceptance Model and adapted by Taylor and Todd (1995) in their C-TAM-TPB. The definition of this concept is similar to the one of performance expectancy and refers to an individual's perception about the likelihood that the use of a system will enhance his or her performance on the job (Davis, 1986; Taylor and Todd, 1995). When the encouragement to perform an activity is achieving external outcomes, the motivation to do this is called extrinsic. Examples of extrinsic motivation are rewards and punishments such as salary, grades or promotions (Davis et al., 1992). Job-fit as a third concept can again be explained by the belief of an individual that accepting the technique or technology will lead to gains in job performance (Thompson et al., 1991). The extent to which an individual perceives a new technology as being more useful than the previous one, simply explains the concept of

relative advantage (Rogers, 1995). Bandura (1986) introduced outcome expectations in his Social Cognitive Theory. This concept is divided into performance-related (or job-related) and personal-related outcome expectations (e.g. sense of accomplishment and self-esteem). The similarities between these concepts are acknowledged by several researchers (Davis, Bagozzi, & Warshaw, 1989; Plouffe, Hulland, & Vandenbosch, 2001).

The relationship between performance expectancy and the intention to use or the actual use of new technologies in healthcare settings has been the subject of many research questions. In studies executed around the world the techniques or technologies are diverse, ranging from electronic medical records to robotic-assisted surgery (Arman & Hartati, 2015; BenMessaoud, Kharrazi, & MacDorman, 2011). All hypothesized that performance expectancy predicts the acceptance of IT in healthcare organizations and most of them found evidence for this assumption (Phichitchaisopa & Naenna, 2013; Van der Vaart, Atema, & Evers, 2016). Although these results indicate a clear answer to the hypothesis, other researchers did not find a statistically significant effect of performance expectancy on behavioural intention or actual use (Schaper en Pervan, 2007; Vanneste, Vermeulen, & Declercq, 2013). Devolder, Pynoo, Sijnave, Voet and Duyck (2012) found that the UTAUT predictors had different weights dependent on the subgroup studied and thus suggest that every type of people should be treated separately. We therefore proposed as follows:

Proposition 1: Performance expectancy has a positive and significant effect on the agricultural Technology Adoption Behaviour

Effort expectancy and Agricultural technology adoption Behaviour

The second concept, effort expectancy, can be defined as "the degree of ease associated with the use of the system" (Venkatesh et al., 2003). Similar to performance expectancy, Venkatesh et al. (2003) captured three constructs from other models into this concept, that is, perceived ease of use, complexity and ease of use. The first one, perceived ease of use, is a concept from the Technology Acceptance Model (Davis, 1986) which refers to the idea of someone that using the new technology will be effortless. The second concept integrated in effort expectancy, is complexity of the MPCU (Thompson et al., 1991). Complexity in this model, to be understood as the difficulty to use a system, as perceived by the users. Ease of use as a last concept, is a core construct of the IDT (Rogers, 1995) and its definition is apart from one difference equal to the one of complexity. The definition of complexity concerns a general system whereas ease of use is about an innovation (Venkatesh et al., 2003).

The hypothesis that effort expectancy positively affects the behavioural intention to use, as well as the actual use of a technique or a technology, has regularly been formulated in previous studies (Arman & Hartati, 2015; Chang, Hwang, Hung, & Li, 2007; Phichitchaisopa & Naenna, 2013).

Most researchers found support for this relationship (Chang et al. 2007; Phichitchaisopa & Naenna, 2013), but others concluded that effort expectancy had no significant influence (Arman & Hartati, 2015; Bennani & Oumlil, 2013). Arman and Hartati (2015) argue that the characteristic of the sample could have been the possible explanation. Almost 70% of the participants had a maximum age of 50 years and 67% were specialists with a lot of experience, and as previously mentioned age and experience both moderate the effect of effort expectancy (Arman & Hartati, 2015; Venkatesh et al., 2003). Based on the forgoing, we proposed as follows:

Proposition 2: Effort expectancy has a positive and significant effect on the adoption of agricultural technology among cassava farmers.

Social influence and Agricultural Technology Adoption Behaviour

According to the UTAUT social influence of "the degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh et al., 2003) is the third and last direct determinant of the behavioural intention to use a technique or technology (Venkatesh et al., 2003). The three concepts included in social influence are: subjective norm, social factors and image. Each of these concepts refer to the notion that the social environment has a substantial influence on the way people act (Venkatesh et al., 2003). Subjective norm was introduced in the TRA by Ajzen and Fishbein (1977), then used by Ajzen (1985) in his TPB and by Taylor and Todd (1995) in their C-TAM-TPB. Venkatesh and Davis (2000) extended the Technology Acceptance Model by including subjective norm as an extra concept for the prediction of behavioural intention. Their new model was called TAM2. The concept can be explained by one's perception about how important others think he or she should act. Social factors as a second concept integrated in social influence refers to the internalisation of the culture and social agreements the individual shares with others (Venkatesh et al., 2003). Social factor is a core construct of the Model of PC Utilization by Thompson et al. (1991). The third concept, image, is introduced in the IDT by Rogers (1995) and can be understood as the perception that the use of a new technique or technology will upgrade a person's image or social status.

Based on the UTAUT, researchers often want to investigate the hypothesis that social influence has a positive effect on the behavioural intention to use, and the actual use of a technique or technology (Arman & Hartati, 2015; Chang et al., 2007; Phichitchaisopa & Naenna, 2013). Although some researchers found social influence was the most salient predictor (Alaiad & Zhou, 2014), others found that the effect was only marginally significant (Chang et al., 2007). Indeed, some studies even had to reject the hypothesis, because the effect of social influence did not achieve significance (Bennani & Oumlil, 2013; Phichitchaisopa & Naenna, 2013).

Proposition 3: Social Influence has a positive and significant effect on the Agricultural Technology Adoption Behaviour

Facilitating Condition and Agricultural Technology Adoption Behaviour

Facilitating conditions refers to consumers' perception that technical infrastructure exists to support the use of technology (Vankatesh, 2012; Yeoh & Chang 2011, Brown, 2005). In UTAUT, facilitating conditions were theorized to determine the technology use. Based on the forgoing, we proposed as follows:

Proposition 4: Facilitating condition has a positive and significant effect on the Agricultural Technology Adoption Behaviour.

Intrinsic Motivation and Agricultural Technology Adoption Behaviour

Intrinsic Motivation is defined as "the fun or pleasure derived from using a technology (Vankatesh & Thong, Xu Brown 2012). In previous technology acceptance studies, it has been shown to be an importance factor in determining the acceptance of technology (Brown & Vankatesh, 2005). Sequel to this assertion, we proposed as follows:

Proposition 5: Intrinsic motivation has a positive and significant effect on the Agricultural Technology Adoption Behaviour

Nexus Between Price Value and Agricultural Technology Adoption Behaviour

In marketing research, the monetary cost is usually conceptualized together with the quality of products or services (Zeithaml, 1988), we follow these ideas and define price value as consumers' cognitive tradeoff between the perceived benefits of the applications and the monetary cost for using them (Dodds, 1991). Unlike organizational technologies, individuals pay for the cost of adopting and using a technology or product on their own (Zhou, 2013). On the basis of the foregoing, we proposed as follows:

Proposition 6: Price value has a positive and significant effect on the Agricultural Technology Adoption Behaviour

Prior Experience and Agricultural Technology Adoption Behaviour

When the farmers are already having experience on cultivations in their lands for a longer time, they might have a better understanding of the impact of the problem that the technology is addressing to. Furthermore, the long-term experience will facilitate the farmers in making the best option. Therefore, it might have a positive relationship with positive factors of the technology. But negative experiences with similar technologies will affect negatively on the adoption of the introduced technology. Thus, the level of and proper awareness with regard to the technology introduced is a prominent issue in influencing the adoption of the technology. It is closely associated with the prior experience that the farmer has (Senanayake & Rathnayaka, 2015). Based on the foregoing, we therefore proposed as follows:

Proposition 7: Prior Experience has a positive and significant effect on the Agricultural Technology Adoption Behaviour.

Moderating Effects of Income

Many authors had cited income status as one of the influencing factors in adoption. Accordingly, Udimal et al., (2017) and Kinyangi (2014) had mentioned that the respondents with higher annual income were adopting more of the novel technologies recommended for agriculture, revealing a significant positive correlation with adoption. Melesse (2018) also reports that when introducing a technology package for teff, barley, wheat and maize, a positive and strong relationship was observed with the annual income of the participant. This was also confirmed by Silva and Broekel (2016) in relevance to rubber cultivations in Sri Lanka. We therefore proposed as follow:

Proposition 8: Income will moderate the relationship between performance expectancy, effort expectancy, social influence, facilitating condition, intrinsic motivation, price value, prior experience and agricultural technology adoption among cassava farmers.

Empirical Review

Ahmad, Tahar, Cheng and Yao (2017) carried out a study with the purpose to examine the extent of solar photovoltaic technology acceptance by Malaysian energy consumers. In order to achieve this objective, their study used Technology Acceptance Model (TAM) has the theoretical framework. A survey research design was adopted and 663 out of 780 copies of questionnaire were returned and validated for the study. Collected data were analysed using descriptive analysis while the formulated hypotheses were tested using inferential statistics. It was found that perceived ease of use, attitude to use and perceived usefulness have significant influence on behavioural intentions to use solar photovoltaic technology.

Sardianou and Genoudi (2013) conducted a study aimed at determining the consumers' willingness to adapt renewable energies in the residential sector of Anthens Greece. A cross sectional data between December 2009 to January 2010 were collected from 200 respondents using stratified random sampling. The data were analysed using Probit regression analysis. The findings revealed that marital status and gender are statistically insignificant factors in the willingness to adopt renewable energy. Financial incentives were statistically significant factor so as tax deductions, energy subsidy and the price of energy.

Similarly, a study was done in Nikaia, Greece by Ntanos, Kyriakopoulos, Chalikias, Arabatzis and Skordoulis (2018) which focused on the discovery of factors that shape public opinion about renewable energy sources and empirically investigate the willingness to pay for expansion of renewable energy sources in the electricity mix. Data were collected from 398 respondents statistically drawn from 89,380 residents in the study area. Data collected were tested using

principal component analysis, one-way ANOVA and hypotheses were tested using binary logit regression with aid of Stata/MP 13.0 and SPSS 17. It was revealed statistically that there exist a relationship between renewable energy sources perceived advantages and willingness to pay was positively related to education, energy subsidies and state support.

More so, Kotilainen and Saari (2018) conducted a study to explore consumers' attitudes towards using renewable energy technology and how policies could influence consumers' interests by turning them to prosumers. The survey design was conducted in 5 European countries and the partial least square Structural Equation Modeling (PLS-SEM) method was employed to analyse the data collected. It was shown that both economic and non-economic policies affect consumer attitudes towards renewable energy technologies adoption.

Furthermore, a study conducted in Iran by Komendantova, Yazdanpanah and Shafiei (2018) was aimed at studying the deployment of renewable energy sources among young people using social cognitive theory as a reference framework. A cross-sectional survey was conducted among the students of University of Esfanhan, Iran. A sample of 260 students was randomly selected using random sampling. Hypothesized relationships were tested using structural equation modeling (SEM) with the aid of AMOS 20. It was revealed that there exists a positive influence of self-rewarding to encourage young people to participate in energy transition and social outcome expectation is a major driver.

In similar vein, Feng (2012) carried out a study with the purpose of analyzing the major factors influencing users' intentions to adopt renewable energy technologies in Taiwan. In order to achieve this, 273 respondents formed the survey and the research was anchored on the theory of reasoned action, technology acceptance model and Roger's diffusion of innovation model. Structural equation modeling was adopted to test the hypothesized relationship between the variables of study. It was found out that innovation acceptance and subjective norm positively influence renewable energy technology intentions to adopt while external variable of the users and attitude towards the renewable energy technology usage partly influenced its adoption.

Moreover, Leijten, Bolderdijk, Keizer, Gorsira, Weff and Steg (2014) did an empirical study among 139 Dutch citizens (aged 18-85). The aim of the study is to find out the factors influencing consumers' acceptance of future energy systems. Experimental design and questionnaire were adopted as the research design and instrument respectively. Conjoint analyses were done to test the data collected. It was revealed that respondents preferred making adjustments rather than reliance on technology to do so for them. Also, consumers failed to exhibit a clear preference for any of the displayed production level.

Also, Zahari and Esa (2016) carried out a study on the drivers of renewable energy adoption behavior among the residents of Klang valley in Malaysia. A total of 501 respondents were used for the study. A self-administered questionnaire was employed via convenience sampling. Data

collected were analysed using SEM partial least square while a bootstrap resampling procedure was conducted to estimate the coefficients. It was revealed that the intentions to adopt renewable energy are influenced by perceived utility of new technology, perceived benefit of new technology and perceived utility of a new service.

Ing, Keong, Hong, Yan, Wei, and Ching (2019) in their study conducted among Malaysian consumers which was aimed at determining the factors affecting consumers' perception towards renewable energy among adults in Kuala Lumpur. The study data were collected using survey questions on respondents between age 21-50 years. Correlation and multiple regression were used to test the data. It was found that global and local economic factors contribute most to consumers' perception towards renewable energy while perceived product benefit has no significant relationship.

Ejekela (2021), conducted a secondary research on what informs farmers' attitudinal changes in accepting improved seedlings of agriculture in Benue State. To under take this research , he selected farmers of cassava and yam in ldomaland , and collated data between 1980-2020 from the State Ministry of Agriculture. After the regression, it was discovered that peer group influences and religious belief played the most role in determining the behavior of farmers towards the acceptability of improved products.

Kachalla (2020), conducted a secondary research on farmers'attitude towards advertized and government –approved farming seedlings in Kogi State between 1985 -2019. He selected 100 farmers from Okene and 100 farmers from Igalla. After the regression , it was discovered that what informs change of attitude of farmers to wards accepting seedlings introduced by government is chiefly clannish beliefs.

Uduak (2020), conducted a primary research on farmers' attitude on the acceptability of improved seedlings by farmers in Niger State by selecting 50 farmers each from Suleija , Madalla, Zungeru and Kotangora. They were asked to what extent religion played vital role in influencing farmers' attitude towards improved seedlings of agricultural products as introduced by government. 40 (80%) from Kotagura and Madalla and 30 (60%) from the rest of Suleija and Zungeru agreed that religion played the most role in shaping farmers' attitude towards accepting improved agricultural products. So, we conclude that religion is a vital force as far as acceptability of improved seedling by farmers in Niger State is concerned.

Omeje (2021) , conducted a primary research on the extent social group affects farmers attitude towards accepting improved agricultural seedlings by interviewing 80 farmers from the Forest Zone of Southern Kaduna State. 60 (75%) said that social group played vital roles in accepting any seedling by farmers, while the rest disagreed. So, we conclude that social groups play vital roles in shaping farmers attitude towards accepting improved seedlings.

Unongo (2020) , conducted a primary research on what informs farmers attitude towards accepting improved seedlings by interviewing 100 farmers in Keffi , Abuja 95 (95%) agreed that social groups influenced their choice of improved seedlings , while the rest disagreed , So, we conclude that social groups play vital roles towards making farmers accept introduced improved agricultural seedlings .

Isa (2018), conducted a primary research on the influence of peer group on the acceptability of improved seedling by farmers in Niger State by asking 50 farmers from Shiroro in Niger State . 40 (80%) agreed that they have been influenced by peer group to accept or reject improved seedlings, while the rest disagreed, So, we conclude that peer group really influences acceptability of agricultural seedlings.

Timorthy (2021) , conducted a primary research on the extent social groups influence choice of agricultural seedlings by interviewing 100 farmers in Lokoja, Kogi State. 65 (65%) noted that social group really influences acceptability of improved seedlings , while 35(35%) disagreed. So , we conclude that social groups influence acceptability of improved seedlings.

Danjuma (2021), conducted a primary research on the extent of peer group influence on accepting improved seedlings by farmers in Benue State. He interviewed 100 farmers in Katsina Ala, by asking them to the extent peer group influenced them to accept improved seedlings from government. 68(68%) said yes , while 32 (32%) said no. So, we conclude that peer group really influences acceptability of improved seedlings by government to farmers.

Biu (2020) , conducted a primary research on the effect of psychological thought on the farmers attitude towards accepting improved seedlings by interviewing 50 farmers each from each senatorial zone of Kwara State. 40(80%) , 30(60%) and 45 (90%) all agreed that farmers are influenced by their respective psychological perceptions in their respective evaluations to the improved seedlings introduced by government, the rest said the acceptability is a function of the extent of awareness created by government. So, we conclude that awareness has to be seriously mounted by the government to dissuade farmers from anti –psychological rating of improved seedlings.

Oken (2019) conducted a research on the way farmers feel on the introduction of improved seedlings as evaluated by government by selecting 20 farmers in Igalla land of Kogi State. 17 (85%) said that they use improved seedlings so far they come to know of it , while 3(15%) were indifferent. So, we conclude that accepting improved seedlings by farmers has to do with government action to market the idea to farmers. Bichi (2017) , conducted a secondary research on the way farmers in Benue had accepted improved seedlings between 1970 and 2016 by the data generated from the ministry of Agriculture. The result shows

that farmers attitude towards accepting improved seedlings is greatly influenced by their psychological perceptions.

Edugbanya (2021), conducted a secondary research on the extent farmers develop interest on using the improved seedlings from government in Kogi State by leaning information state ministry of Agriculture between 1980 - 2020. In the analysis that ensued , it was discovered that farmers attitude towards improved seedling varied as to their psychological perceptions. Tallen (2021) , conducted a secondary research on the way agricultural policy by government influence the extent farmer regard government introduced seedlings. Data from the state ministry of agriculture of Plateau were collated for the study between 1990 -2020. In the analysis that followed , it was discovered that government policy was a great factor in shaping farmers attitude towards accepting improved seedlings.

Ochei (2020), conducted a research on the impact of government policy on farmers choice of seedling by regressive data collated from the ministry of agriculture of Kogi State between 1981 – 2019. After the regression , it was discovered farmers choice of seedlings depends on government policy of agriculture and how it is implemented. Lalong (2021) , conducted a research on the extent of the impact of government policy on the choice of seedlings by interviewing 100 farmers in Southern Plateau State. In the interview analysis , it was discovered that farmers attitude towards a particular agricultural product depended very much o the way it was marketed by the same government .

Orthom (2021) , conducted a secondary data research on the extent family influences affected acceptability of government improved seedlings in Benue State by generating data from the state ministry of Agriculture between 1975-2020. The regression was done by the use of SPSS soft ware . In the analysis that followed , it was discovered that family upbringing played vital role in shaping farmers attitude towards accepting government improved seedlings. Unongo (2019) , conducted research on the way family influence affected farmers choice of agricultural seedlings in Benue State by interviewing 100 farmers in Zaki Ibiam. 74 (74%) said that family played important role in the way famer accept improved seedling. 16(16%) said that both family influence and the way government packaged the program of introduction determined it , while 10 (10%) had no opinion. So, we conclude that family influence and policy packaging played important role in shaping farmers choice of improved seedlings.

Wakawa (2018), conducted a secondary research on the way farmers assess improved seedling in Borno State, by interviewing farmers in Biu , Southern Borno State. It was discovered that farmers depend so much government what the flow of family thoughts are to accept or reject any product that come from the government. Goje (2019) , conducted a

research on education help shape people's opinion on governance by interviewing 100 farmers in Gombe state. 65(65%) stated that education is a potent force in better assessment of government policy, while the rest had no opinion . So, we conclude that education is helpful to accepting improved seedlings.

Melaye (2020) , carried a secondary data analysis on the extent income affects farmers acceptability of improved seedling in Kogi State between 2000-2019, using SPSS software. After the regression, it was discovered that farmers knew very little about technology and so, were not influenced by it in their choices. Amale (2020) , carried out a primary research on the how income played a role in changing farmers' attitude towards accepting particular agricultural seedlings in Benue state by interviewing 50 farmers from Kogi West Senatorial zone. 72 (72%) said that information technology played little role in shaping farmers attitude towards accepting any product, while the rest 28 (28%) disagreed. So, we conclude that income has not been familiar with workers to the extent of greatly changing their choices.

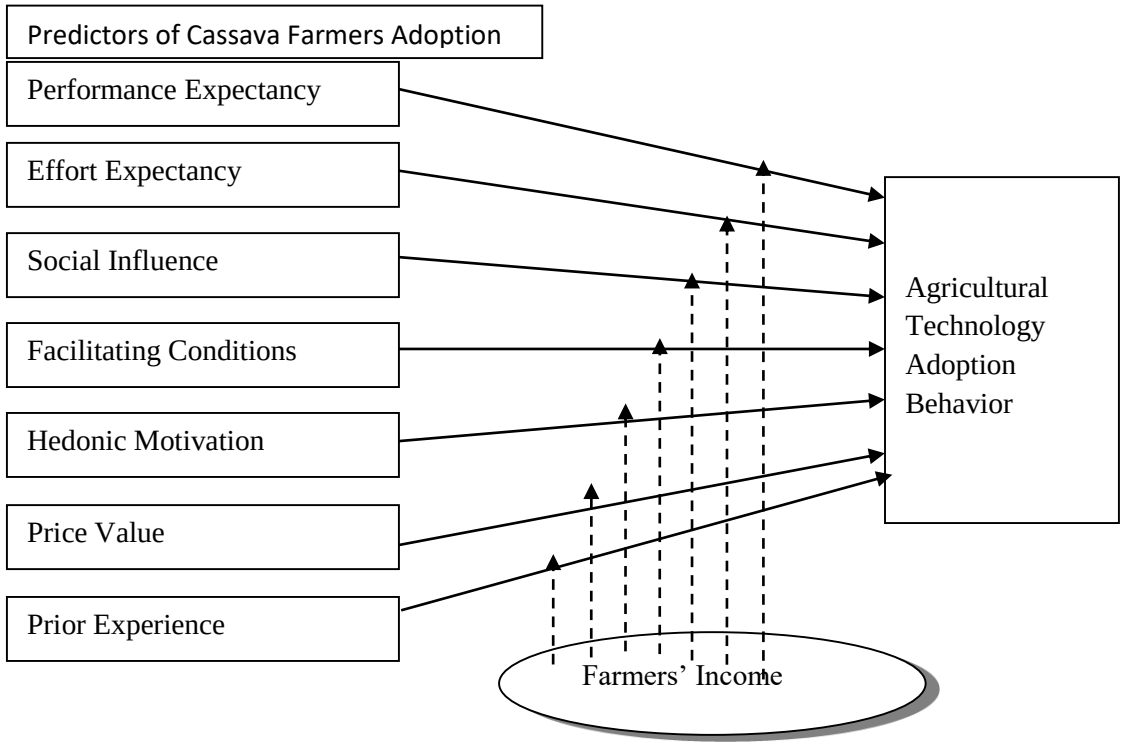
Ishiaku (2021) , conducted a primary data analysis on the way income shapes people view on national issue in Taraba State by interviewing 100 people , including farmers in Gembu Plateau of the state. 50 (50%) said that income played very important role in shaping people's role in accepting any government product, 50 (50%) had no clear opinion . So ,we conclude that much work need be done by way of awareness creation by government to encourage people to accept any government product, and that farmers should be at the fore front of such sensitizations for them to really see sufficient reason to accept improved seedlings by government.

Unongo (2020) in his work did not state how social groups has particularly influenced farmers attitude towards awareness creation by government official. Isa (2018) , did not explain the way peer group influence particularly affects farmers choice of any introduces seedling. Danjuma (2021) in his expressed view did not bring out the fact that government can manipulate some social views. Tallen (2021) , did not state how skewed government policies negate good efforts of people including farmers. Ochei (2020) , did not bring out the fact that formulation of government policies is done by privileged few who may not know very well the situations affecting the generality of the people.

Orthom (2021), in his work failed to bring out the fact family influences are products of cultural permutations. Wakawa (2018), failed to appreciate the fact that religion plays vital role in shaping families' opinions. Goje (2019) , failed to state inexact terms, the way education shapes farmers choices in accepting improved seedlings. Ujege (2019) did not state clearly how education helps in marketing government policies to the people. Melaye (2020) , failed to state that income of farmers played important role in making them accept government

policies. Amale (2020), did not show how farmers income affects their patronage of government policies. Ishiaku (2021), did not show how income generally affect acceptance of government programmes at the lowest level.

Proposed Conceptual Framework



Source: *Researcher's own Conceptualizations.*

CONCLUSION

In conclusion, the advent of the internet has catalyzed a significant transformation in various sectors, including agriculture, leading to the emergence of terms such as e-learning, e-government, e-banking, and more recently, e-agriculture. Agriculture stands as a cornerstone of the Nigerian economy, engaging a substantial portion of the labor force and contributing significantly to the gross domestic product. However, despite its pivotal role, the sector faces challenges such as low productivity, inadequate access to information and resources, and fluctuating income levels among farmers.

The adoption of agricultural technology presents a promising avenue for addressing these challenges and unlocking the sector's potential for enhanced income, poverty reduction, improved

nutrition and health, reduced food prices, and employment generation. However, the adoption of technology in agriculture is not without its barriers, including limited access to relevant information, inadequate infrastructure, and low levels of education among farmers.

This study underscores the critical need for a comprehensive conceptual framework to elucidate the predictors of agricultural technology adoption behavior among cassava farmers in Nigeria, with a specific focus on the moderating role of income. By developing such a framework, stakeholders in the agricultural sector can gain deeper insights into the factors influencing adoption behavior and devise targeted interventions to promote the uptake of technology among farmers.

Moreover, this study highlights the dearth of literature on agricultural technology adoption behavior in typical developing economies like Nigeria, particularly in the North Central region, which serves as the nation's food basket. By filling this literature gap and applying theories such as the Unified Theory of Technology Adoption, this research aims to contribute to the scholarly discourse on technology adoption in the agricultural marketing domain.

Furthermore, given the significance of cassava as one of Nigeria's staple crops, there is a pressing need to focus on cassava farmers and develop context-specific frameworks tailored to their needs and challenges. By incorporating income as a moderator variable, this study seeks to provide a nuanced understanding of how income levels influence technology adoption behavior among cassava farmers.

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