EFFECTS OF VITAMIN A FORTIFIED CASSAVA TECHNOLOGY ADOPTION ON FOOD SECURITY OF RURAL FARMERS IN BENUE STATE, NIGERIA

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MTech/SAAT/2018/8104

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ABSTRACT

This study assessed the effects of Vitamin A fortified Cassava technology adoption on food security status of cassava farmers in Benue State, Nigeria. The study determined the adoption level of vitamin A fortified cassava technologies and the factors affecting adoption of vitamin A fortified cassava by farmers in Benue state, Nigeria. It also examined the food security status of the farmers and the constraints associated with the adoption of vitamin A fortified cassava technology with the aim of finding ways to increase vitamin A fortified cassava production and productivity in the study area. The study revealed that the mean age was 43 years and (84.7%) were married males with 83.1% at high level of formal education. The means household size of the farmers was 9 persons and most of them had been producing cassava for an average of 20 years. The study also revealed that (78.%) of the respondents had contact with extension agents, 60.2% joined cooperatives organization and 28.4% had access to credit. The technologies such as plough before planting (44.1%), planting by June–July (86.4%), spacing of 25cm by 50cm (60.2%), seed/ stem cuttings of 35–50kg (62.7%), systemic herbicide (58.5%), organic fertilizer (61.0%) and harvesting period of 9–10 months (63.6%) after planting were the most adopted by the respondents. Ordinary Least Square (OLS) regression estimates revealed that farming experience (0.2627), household size (0.3094), farm size (5.7025), extension contact (0.4804), income (0.0001), training received (4.7686) and distance to market (7.1218) were the factors found to influence adoption of vitamin A fortified cassava. On the food security status, 69.0% of the adopters' households were found to be food secured, while 31.0% were not food secured. However, factors such as Loamy soil of (2.78), plough before planting (3.62), plough after planting (2.15), planting by June–July (3.64), planting in September (1.79), spacing of 25cm by 25cm (2.18), spacing of 25cm by 50cm (2.31), stem cuttings of 50kg per hectare (1.71), systemic herbicide application (2.51), contact herbicide application (3.40) and harvesting 9–10 months (1.90) at 1%, 5% and 10% probability level respectively, were found to have significant effects on food security status of the adopters of vitamin A cassava technologies. The major constraints associated with adoption of vitamin A fortified cassava in the study area were high cost of vitamin A fortified cassava stem ($\bar{X}$ = 2.50), inadequate input for cultivation (X= 2.40) and poor credit facilities to cassava farmers ($\bar{X}$ = 2.40) ranked 1st and 2nd, respectively. Based on the findings, the study concluded that the adoption of vitamin A fortified cassava technologies had significant effects on food security status of the respondents. It was therefore recommended that vitamin A fortified cassava farmers should be assisted with farm inputs, credit and other incentives to enhance their production. Also, farmers should organized themselves into groups for easy participation in seminars, workshops and tour that will expose them to better knowledge. Government at all levels and Non-Governmental Organizations (NGOs) should implement policies that support farming of vitamin A fortified cassava because of its effect on food security status of the rural farmers.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Agricultural sector plays a key role in the development of most developing Nations (Ajayi *et al*, 2017). It is a major tool used to describe the most powerful nations of the world, because the country that is self-sufficiency in food production would curb food insecurity and reduce poverty of its citizenry. Agriculture is the main stay of Nigeria's economy. As at 2017, agriculture contribution to the Nation's Gross Domestic Products (GDP) is 24% (National Bureau of Statistics (NBS), 2018). Agriculture encompasses crop production such as maize, yam, rice, cassava etc. There are different varieties of cassava in which vitamin A fortified is one of them. Vitamin A fortified cassava technology could be a useful means to overcome problem of food insecurity and poverty of the developing nation like Nigeria.

One of the goals in Nigeria agriculture development programmes and policies is to increase agricultural production especially in area of food crop such as cassava. Adoption of improve cassava varieties with technologies can accelerate production and economic growth (Ekwe, 2013). Productivity increase in Agriculture can reduce food insecurity and poverty by increasing farmer's income, reduce food prices and enhance increment in consumption (Diagne *et al.*, 2007). Cassava play key role in alleviating poverty in Nigeria, as virtually an average household consume cassava products daily throughout the year (Ayinde *et al.*, 2017).

Therefore, vitamin A Fortified cassava is an important factor in food security, poverty alleviation, rural-urban drift, and unemployment reduction among others (Stain *et al.*, 2015). Based on that, Nigeria released two improved cassava varieties of Vitamin A bio-fortified in an effort to maintain its lead as the world's largest producer of the root crop and improve incomes of farmer thereby realizing vitamin A fortified cassava for adoption . (International Institute of Tropical Agriculture (IITA), 2013). The two varieties of Vitamin A fortified cassava that were released are UMUCASS42 and UMUCASS43. They perform well in different cassava production regions of Nigeria, Benue State inclusive with a high yield, high dry matter and good disease resistance (Oparinde *et al.*, 2016). The roots of these varieties are yellow and contain moderate levels of pro-vitamin A that can take good care of ever increasing population Vitamin A deficiencies.

Oparinde *et al.* (2016) reported that Vitamin A and mineral deficiencies affect more than two billion people worldwide, causing illness, disability and mortality. According to Ekwe (2013) and Micronutrient Initiative (2014), the problem of vitamin A deficiency is most severe in developing countries like Nigeria where one third of the children under the age of five suffer from Vitamin A deficiency and one fifth maternal deaths are attributed to iron deficiency anemia during pregnancy. It was reported that 25% of children under the ages of six years in Nigeria suffer from Vitamin A deficiency, while 69% of children under five years have iron deficiency anemia (Rice *et al*., 201 4). However, 47% of Nigerian women aged 15 to 49 suffers from iron deficiency anemia which have several negative health and economic consequences including mortality and reduced productivity (Egesi, 2013).

The vitamin A fortified cassava varieties have the potential of providing up to 25% of daily Vitamin A requirements of children and w omen since the presence of pro-Vitamin A (Beta-carotene) in the new cassava could improve the nutritional status of the consumers (Micronutrient Initiative, 2019). Therefore, there is need to evaluate the adoption of Vitamin A fortified cassava on the food security status of the farmers. Formulation of different food products from this cassava technology will help to enhance its consumption (Sagar *et al.*, 2009; Bai *et al.,* 2010; Omodamiro *et al.,* 2011). Vitamin A fortified cassava technology adoption is essential for economic prosperity in Nigeria.

Ayinde (2016) reported that in the past, producer cooperative and State farms were the main users of the improved agricultural technology, but, in recent years, individual farmers have started to adopt and use the improved technologies including that of vitamin A fortified cassava. World Health Organization (WHO) (2011) reported that, deficiency of vitamin A had led to impaired vision and reduced immunity thereby compromising growth and development leading to death in most severe cases. It was therefore believed that, adoption of Vitamin A fortified cassava varieties and its consumption would reduce the negative consequences of death and improve health status of the rural farmer generally.

The Food and Agriculture Organization (FAO) (2013) has made production of Vitamin A fortified cassava global focal point of their programme. The Federal Government of Nigeria (FGN) (2015) in her effort at increasing food production, raising farmers' income and improving the standard of living of people in the rural community via increase productivity of farm products has keyed into FAO programme on Vitamin A fortified cassava production in Nigeria. The improved varieties has the advantages of disease and pest resistance, high yield and early maturing coupled with better agronomic practices. This makes it now a growing commercial market that brings income to the farmers and revenue to the government thereby, reducing poverty and enhancing economy of the Nation.

1.2 Statement of the Research Problem

Nigeria has substantial economic potentials in its cassava sector, but its contribution to national economy growth is still far from being fully exploited (Ayinde, 2016). The performance of vitamin A fortified variety of cassava is superior to the traditional cassava varieties cropped by most farmers (Ekwe, 2013). Food production could be increased, through the adoption of Vitamin A fortified cassava technology by farmers thereby enhancing food security and alleviating the poverty status. Vitamin A Fortified cassava technologies adoption has important role to play in food security, health benefits, income generation and employment opportunities which could boost the economy of the nation and that of the study area in particular, but the effect of adoption has not been felt. Poor level of awareness among the rural farmers, inadequate farm land for vitamin A fortified cassava, inadequate stem/planting materials, high incidence of pests and diseases, inadequate input for cultivation and poor handling among others could be the problems associated with the adoption of Vitamin A fortified cassava varieties in the study area.

It is against the backdrop of aforementioned that, this study was conducted to assess the effect of Vitamin A fortified cassava technologies adoption on food security status of rural farmers in Benue State Nigeria. Thus, the study seeks to provide answers to the following research questions.

i. What are the socio – economic characteristics of the respondents in the study area?

ii. What is the adoption level of Vitamin A fortified cassava technology in the study area?

iii. What are the factors affecting adoption of Vitamin A fortified cassava technology in the study area?

iv. What is the food security status of the respondents in the study area?

v. What are the effects of Vitamin A fortified cassava technology on food security status of cassava farmers in the in the study area?

vi. What are the constraints associated with adoption of Vitamin A fortified cassava technology in the study area?

1.3 Aim and Objectives of the Study

The aim of this study is to assess the effects of Vitamin A fortified cassava technology adoption on food security status of cassava farmers in Benue state, Nigeria.

The specific objectives are to:

i. describe the socio-economic characteristics of the respondents in the study area;

ii. examine the adoption level of Vitamin A fortified cassava technology in the study area;

iii. determine the factors affecting adoption of Vitamin A fortified cassava technology in the study area;

iv. examine the food security status of the farmers in the study area;

v. determine the effect of Vitamin A fortified cassava technology adoption on food security status of respondents in the study area, and

vi examine the constraints associated with the adoption of Vitamin A fortified cassava technology in the study area.

1.4 Hypotheses of the Study

The null hypotheses tested in the study are:

HO_1: There is no significant relationship between selected socio-economic (age, marital status, gender, household size, education, farm size and experience) characteristics of the rural farmers and adoption level of Vitamin A fortified cassava technologies in the study area

HO_2: There is no significant difference in the food security status of farmers' with regards to adoption of Vitamin A fortified cassava technologies in the study area.

1.5 Justification of the Study

The justification of this study stem from the needs to provide useful information that would be of benefits and serve as guides to Government with regards to undertaking measures that have a clear direction towards technology development and transfer in Agriculture especially that of Vitamin A fortified cassava technology, this will bring out the economics potentials in cassava sector, that will contributes to national economy growth. It will also help policy makers to formulate realistic policies that are relevant to farmers in terms of utilization of technology on improved cassava varieties, that will be superior to the traditional cassava varieties resulting to high yield and increase in food production to the cassava farmers.

Researchers will find the outcome of this study relevant as it will in increase their knowledge about innovations that are relevant and timely for increase agricultural production and productivity. The finding will also guide extension organizations in distributing the technology of Vitamin A fortified cassava to the farmers through increase level of awareness, adequate farm land for vitamin cassava production, availability of stems/planting materials, adequate input for cultivation, good handling among other problems associated with the adoption of new varieties thereby encouraging high productivity through technology adoption. It will provide insight to farmers for obtaining relevant information techniques on Vitamin A fortified cassava technology awareness, availability of planting materials and general cultural practices for enhance production and increase output, thereby reducing poverty, increasing food security and standard of living of the farmers in the study area and Nigeria in general.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Empirical Review of Past Studies

2.1.1 Socio-economic characteristics of the rural farmers

2.1.1.1 *Age of the farmers*

A study conducted by Ojeleye (2018) on “Socio-Economic determinants of the adoption of TME 419 and UMUCASS 38 improved cassava varieties in Ajaokuta Local Government Area of Kogi State, Nigeria” shows that a good proportion (70%) of the respondents fell within the age of 31-50 years with the mean age of 48.7 years. The author reported that the respondents were middle aged persons who are very active, dynamic and pioneer to innovation, hence could have a likelihood of having positive attitude towards using the improved varieties. Furthermore, the study conducted by Bonabana-Wabbi (2002), on “Assessing factors affecting Adoption of Agricultural Technologies in Virginia Polytechnic Institute and state University, USA” shows that many (50.0%) of the respondents were between the age range of 45-54 while 16.67% and 5.0% were between the ages of 35-44 and 55-64yers respectively. However, only 8.33% were between the age range of 5-34yers.Which Implies that the rural women who were engaged in water yam value addition were still strong and active indicating that age is the primary latent characteristic in adoption decisions.

2.1.1.2 *Gender*

Gender is used as a yardstick for differentiating human being into males and females, which in turn explain the activity in the society. FAO (2013) reported that in the Northern Nigeria males participate fully in farming activities whereas females engage actively in processing and selling of farm produce, but in the southern parts of Nigeria both males and females do the same nature of energy demanding job like clearing of land and making of ridges. Furthermore a study by Ume *et al.* (2016) on socio economic determinant factor to adoption of cocoyam production technologies by small holder farmers in south east Nigeria revealed that majority 89.6% of the respondents were male, while only 10.4% of them were female. Implies that male respondents were more involved in farming activities than female respondents which could be due to the tedious nature of agriculture.

2.1.1.3 *Marital status*

A result of a research findings of Afolami and Falusi (2012) on Effect of Technology change and equity; and Odoemekun and Anyim, (2019) on “Determinants of adoption of pro-vitamin A cassava varieties among farmers in Abia state, Nigeria showed that (75%) of the respondents was married. This implies the likelihood such household having children who could help in the farming business and reducing cost of hired labour by the rural farmers. In addition, study by Bonabana-Wabbi (2002) on assessing factors affecting adoption of agricultural technologies in Virginia polytechnic Institute and state University, USA shows majority (75%) of the respondents were married. Which he said must be, and not only to boost food production but also to augment their family income, as mothers and home makers. In addition study by Ume *et al* (2017) on Technical efficiency of yam based intercropping system among farmers in Abia state revealed that majority 98.4% of the respondents were married, while few 1.6% were single. This implies that majority of the rural farming households were married with the main purpose of pro-creation of young ones that could assist in future farming activities.

2.1.1.4 *Household size*

The household is the main source of labour for production activities in the rural farming communities among family members, individual provide family labour under reciprocate arrangements during land preparation, making of ridges, weeding and harvesting. Labour is also provided to non-family members for a fee and is a good source of income for the households (Amaka, 2007). The studies of Odoemekun and Anyim (2019) also indicated that 60% of their respondents had household size of 5-8 person with mean of 6 persons. This implies that household with such size has more mouth to feed and could likely participate in any food production programme in order to improve the food security status of the family. Furthermore, study by Bonabana-Wabbi (2002), indicated that many (50.83%) of the respondents had large household size of 9-12 persons, while 12.50% and 36.67% had household sizes of 1-4 and 5-8 persons respectively was in-line with the findings of Birol *et al*. (2015) who noted large family size necessitates respondents to adopt new technologies for increased returns to sustain their families.

2.1.1.5 *Level of education*

Assefa and Vanden Berg (2010) on their study on “Genetically modified maize; Adoption practice of small-scale farmers in South Africa showed that 94.2% of the respondents had formal education, only 5.8% had no formal education. Similarly, Birol *et al.* (2015) on their research findings on Effect of processing on Retention of Carotenoids Crantz roots also has positive outcome of his results opined that high educational attainment is a desirable condition for agricultural development, since it augured well for extension services in transferring research results for sustainable food production. The basic objective of any form of education is to impart knowledge which would influence a change in attitude, skills, or knowledge. It therefore implies that Vitamin A fortified cassava farmers in the study area will not have much problems making use of improved technology in order to enhance agricultural productivity in the study area (Mittal and Mehar, 2016).

FAO (2010) studies has shown that Nigerian farmers are highly literate in the language of their areas of origin. 40% have had formal education (i.e. schooling) but most do understand a display of instruction by line diagrams. The studies except Ayinde (2016) have also shown a positive association between literacy and adoption of innovation and formal schooling, and the level of social participation shown that Nigerian farmer belong to a member of formal and informal organizations. They also identified a positive correlation between the Nigerian farmers' level of participation in community life and adoption of agricultural innovations.

2.1.1.6 *Extension contact*

Ayinde (2016) on Risk analysis in innovation system: a case study of vitamin A cassava variety among farmers in Nigeria said 75% of the respondents had access to extension services, while only 25% had innovations and technical assistance to the farmers, productivities, thereby making the farmers have a positive attitude towards the enterprise (Ayinde, 2016). Ayinde (2017a) on Determinants of adoption of vitamin A bio-fortified cassava variety among farmers in Oyo state, Nigeria found that with Nigerian farmers the importance of Extension agent cuts across various stages of the adoption processes. More study by Ume *et al.* (2016) on socio-economic determinant factor to adoption of cocoyam production technologies by smallholder farmers in south east Nigeria indicated that more than half 52.0% of the respondents had contact with extension agents with a mean contact of once annually, while 48.0% of the respondents had no contact with extension agents. That implies that some of the rural farming households had contact with extension agents which could influence their perception about adoption of cocoyam production in the study area. Agricultural extension service constitutes a driving force for every agricultural development as extension agents are responsible for extension service delivery to rural farmers. Further study by Uwandu *et al* (2019) on his study on determinant of the degree of adoption of pro-vitamin A cassava varieties among farmers in Delta state, Nigeria. Posited that one of the objectives of extension programme is to increase agricultural production by encouraging people to be actively involved in farming.

2.1.1.7 ***Membership of cooperative society***

Also, 88.4% of the respondents belonged to different Co-operatives and organizations, while 8.4% do not belonged to any association by Ojeleye, (2018) a study Members of organization could have access to information through interaction with other members which could boost their attitude towards technology use. Study by Bonabana-Wabbi, (2002), shows that majority (84.00%) belong to cooperatives while 16.00% do not. Acquisition of information about a new technology through cooperatives demystifies it and makes it more available to farmers. Information reduces the uncertainty about a technology's performance hence, may change individual's assessment from purely subjective to objective over time (Zanu *et al*., 2012). Exposure to information about new technologies as such significantly affects farmers' choices about it.

Some other studies have been done in Nigeria by Odoemekun, (2019) to characterize our peasant or present farmers involvement on cooperatives indicated that majority 78.0% of the respondents in the study area were member of cooperative societies with a mean of 12 years as a member, while 22.0% of the were not member of the cooperative societies. This implies that most of the rural farming households were into cooperative due to benefits they could derived from it. Particularly, information sharing with respect to agricultural innovations and better production output. Cooperatives allows group of people with common interest comes together to meet certain needs that could not be achieve through individual efforts. Its helps in identify economic opportunities for the poor, empowering the disadvantaged to defend their interests and providing security to the poor. Cooperatives, therefore, represent one of the few options that farmers have for surviving and plays vital role in influencing perception of members.

2.1.1.8 *Level of income*

Level of income is generally a difficult variable to measure among respondents who do not keep records. However, the Nigerian farmer's income varies depending upon the type of cash or export crop he deals with. "Vitamin A fortified cassava (*Manihot esculanta*) being the highest export crop income earner and soybean the lowest" the size of farm; the type of farming; (i.e. whether mixed, livestock or crop farmer) and whether it is a part-time or a full time farming. When other things are held constants, there is obviously a positive relationship between level of income and adoption of innovations. Furthermore, study by Bonabana-Wabbi (2002) on assessing factors affecting adoption of agricultural Technologies in kumi district, eastern Uganda. MSc. Thesis, Department of agricultural and applied economics, Virginia polytechnic Institute and University, USA. Showed that many 50% of the respondents had income ranging from #700,000.00 - #899,999.00 programs that produce significant gains can motivate people to participate more fully in them. In fact, people do not participate unless they believe it in their best interest to do so. Farmers must see an advantage or expect to obtain greater utility in adopting a technology (UNDP, 2018).

2.1.1.9 *Level of farming experience*

The study conducted by Olatade *et al.* (2016) on how farmers' characteristics affect their willingness to adopt agricultural innovation posited that, majority of the respondents in their study area had long years of farming experience which enabled them to make sound decisions as regards right resource allocation and proper management of their farms for greater benefits. Study by Bonabana-Wabbi (2002). Majority (58.33%) of the respondents had farming experience ranging from 21- 30 years indicating that they have long years of experience in processing. Laria, (2013) indicated that experience is a major factors in adoption of technologies and should serve as an advantage for increased investment and technology utilization. In addition, a study by Paul et al (2009) on challenges in household food security and poverty status indicated that more than half 56.7% of the respondents had farming experience between 11- 30years, while 32.1% of the respondents had farming experience of more than 30 years and 11.2% of the respondents had farming experience of less than 11 years with mean farming experience of 25.4 years. This implies that most of the natives or rural farmers had been into farming for long period of time which could help them to have favourable perception.

2.1.1.10 *Source of credit*

Central Bank of Nigeria, (2016) on Annual Report and statement of Accounts, Eastern Nigeria on credit source to farmers in Nigeria, although family members, friends, neighbours, and local formal organizations play very important parts in Nigerian farmer's awareness of an innovation, these studies have identified various mass media-radio, re-diffusion, agricultural newsletters, newspapers and television as important sources of information about how and where to source agricultural loans. These has also been identified a positive relationship between some farmers, mass media and adoption of agricultural innovations by Nigerian farmers (Central Bank of Nigeria (CBN), 2016). Furthermore, source or access to credit by Sahel (2014) on the study of the role of women in Nigeria agriculture revealed that more than half 51.0% of the respondents had access to credit with a mean credit of #65,608.33 accessed, while only few 49.0% of the respondents had no access to credit. This implies that some of the rural farming households had access to credit in the study area which could positively influences their perception about women participation in agricultural activities. Access to agricultural credit has the propensity to break the vicious cycle of poverty and raise the production capacity of farming households. Credit is an important variable needed to acquire or develop farm enterprise (Sahel, 2014).

2.2 Adoption Level of Vitamin A Fortified Cassava Varieties Technology

Before determining the adoption level of vitamin A fortified cassava technology adoption on food security status of the rural farmers, there is need to look at the recommended vitamin A fortified cassava Improved Technological practices adopted by the farmers, Soil selection, Land preparation, planting Date, Spacing, Seed Rate, Herbicide application, Fertilizer application, Harvesting period of vitamin A fortified cassava.

The result by Onunka *et al*. (2011) on a research carried out " Attitude of farmers towards pro-vitamin A cassava production technologies in Abia state, Nigeria revealed the respondents attitude towards improved cassava varieties production technologies such as soil with good Ph through site selection, ploughing before planting through land preparation, planting date was September/October. The result showed that mean average (67.4%) farmers could be considered as positively inclined towards farming of Improved varieties because the respondents has favourable (25.83%) and moderate (60.0%) attitudes. However, the result different from some earlier research findings elsewhere (Nyaupane and Gillespie, 2009). On a similar study, "The influence of land tenancy Rotation selection for crawfish farmer's adoption of Best management practices" Atlanta, Georgia. This implies a different scenario prevails in the study area and the trend is not surprising in view of the respondents' dynamic socio-economic characteristics which were likely to have effects on their attitude towards "bio-fortified vitamin A cassava varieties production".

Alake *et al*. (2016) noted that the input expansion policy of government in the cassava industry through the provision of Bio-fortified cassava varieties and improved processing technology will lead to efficient use of resources in Bio-fortified vitamin A cassava production Nigeria. Hence, the only way to increase the production of bio-fortified vitamin A cassava is through the adoption and efficient utilization of improved Herbicide application systemic (1 litre / hectare), fertilizer application; Inorganic (Urea) fertilizer used as technologies by rural farmers, which could lead to increased productivity and income (Laria, 2013). On the account of these, the federal government in making efforts to increase the production of cassava, a staple crop for many farmers, to make it an export product under the Agricultural Transformation Agenda (ATA). The central aim of any improved technology is to bring an improved technologies such as stem with Early maturing(9 – 10) months, good stem cutting (20 – 35kg/ha), good spacing (50cm by 50cm) that are effective and have gained mass adoption by rural farmers (Ajala, 2011).

Effectiveness is the measure of the extent to which the improved technologies such as good Land preparation, good Soil selection, planting date, good spacing, good seeds rate, Herbicide and fertilizer applications, above all importantly, harvesting period have produced the expected results or met the objective of disseminating them. Available statistic proved that despite introduction of this technology, increase in the yield of bio-fortified cassava has not been significant over the years (Central Bank of Nigeria, (CBN), 2016; National Bureau of Statistics, (NBS), 2018). Most studies have focused majorly on the distribution of cassava income between adopters and non-adopters of improved cassava varieties, and between labourer and land owners (Afolami and Falusi, 2012). But, this study among other stated objectives focused on food security of rural farmers by adoption and non-adoption of the Vitamin A fortified cassava farmers in the study area. The rapid population growth rate without corresponding increase in food production has resulted to food supply deficit, hunger and poverty (Eyinla *et al.*, 2019).

Eyinla further noted that, successful agricultural development cannot take place in Nigeria until the problems which militated against effective extension and adoption of improved technologies are identified and solved. Ime (2003) revealed that in Nigeria, a series of extension strategies have been used to promote the transfer of new technologies and farming practices, but have been hindered mostly by poor monitoring system; poor research communication system and poor financial allocation to various extension agencies. All these have created a wide gap in technology development and transfer in all aspects of agriculture to rural farmers.

Olaosebikan *et al.* (2019) revealed that there is a wide gap between what research findings have shown to be possible and feasible on the one hand and what actually obtains on the other. The author further stated that, irrespective of the potential and promise of any agricultural research findings, the full potential cannot be realized until it has been brought to the knowledge of the intended beneficiaries (farmers). The author also noted that, many factors affect communication of agricultural innovations to rural farmers. These include inappropriate communication strategies which are used by extension agents to reach farmers and many research institutes have not fashioned out effective means of disseminating their improved research results to farmers.

However, with a clear understanding of agricultural extension variable or factors affecting farmers in vitamin A fortified cassava production and appropriate remedial action taken, it is hoped that, the performance of vitamin A fortified cassava technologies by rural farmers would improve and this will result in increased food production. Socio-economic surveys of Vitamin A fortified cassava technology adoption in Benue State Nigeria by Alene *et al.* (2012), and Mittal and Mehar (2016) and Ayinde (2016) confirmed that, adoption levels depend on many factors, such as: (a) vegetation characteristic of area with regard to its suitability for growing other crops; (b) population density (which influences the number of cassava farmers that could adopt new improved varieties); (c) tribal preferences which restrict cultivation of cassava to poorer rural farmers who lack land and cash to expand bio-fortified vitamin A cassava hectare upon adoption of the varieties (d) relative competition with cassava in each locality by other carbohydrate crops, examples maize, yam, rice, plantain; (e) proximity of high density population that does not farm but, consumes cassava as garri, fufu; (f) local presence and capacity of the propagate distribution agency as source of planting materials for small farmers; and (g) farmers own perception of overall benefits from this improved cassava varieties relative to local varieties. This farmers' perception of the benefits is not only based on superior yields of fresh tubers, but also on harvest duration (9 – 10 months), high yielding, high moisture contents, quality of processed product for food and health benefits of vitamin A fortified cassava consumers, labour needs on handling to retained it vitamin elements and general economics of vitamin A fortified cassava varieties within the local situations

2.3 Food Security Status of Rural Farming Household

Food security have been linked in many previous studies, the reason is that the poorer a rural household is, the lower their access to food both in terms of quality and quantity. The level of food security is therefore, one of the indications of the level of economic development. Food insecurity is synonymous with not knowing where your next meal is going to come from.

According to Olatade (2016), there is often a strong interrelationship between food security and poverty. This is supported by Adewuyi and Hayatu (2011), who stated that the incidence of poverty is closely related to malnutrition as majority of the poor are rural farmers who engage largely in subsistence farming which therefore, generate very low income.

In many rural Agraian communities, it has been observed that there is a strong relationship between the contributions of house wives from proceeds of their small farm business to the household food security. Therefore, the poor rural households lack access to rich and nourishing food as a result of poverty. According to the Asian Development Bank (ADB) (2012), food security and poverty reduction are inseparable. Although, food security alone does not eradicate poverty, any strategies to fight poverty must be integrated with policies to ensure food security and to offer the best chance of reducing mass poverty and hunger. On the other hand, food insecurity is often predominant in underdeveloped countries as most of the households and communities are poor and unable to afford the basic necessities of life, thereby, impeding their growth and development. As such, food security has been high on the development agenda of all countries and poor countries that have many food insecure people often call urgently for action on the issue owing to the steady rise in food prices as found in Nigeria. This is supported by Kakwani and Son (2008), who found that although rising food prices affect everyone, the impact is disproportionately large among the poor, who spend a greater proportion of their budgets between 60% and 70% on food. These therefore, show the strong relationship between poverty and food security.

Study by Ekwe and Onunke (2006) showed that the coefficient of the farmers years of technology use had negative relationship with their attitude towards use of the technology and significant at 1% level. This finding is at variance with Rao and Annadana (2017) who stipulated that both farmers who are using a technology and those not using technology may have had similar beliefs in common. However, if the strength of the beliefs that individuals linked to positive outcomes were greater than the strength of the beliefs associated with negative outcomes, those individuals are likely to have favorable attitude towards technology use. If the reverse holds true, they will have negative attitudes. The expected financial returns coefficient had direct relationship with the dependent variable at 95% confidence interval. It was generally belief that the expected financial support is a motivating factor to technology usage. Tafida (2007) reported same as the author linked the non-financial negative interactions between technologies and farming system as the most common reasons given by his respondents for not using the new technology/ varieties.

The coefficient of education was positive to farmers attitude to adopt bio-fortified vitamin A cassava varieties in the study area of Bauchi state. Education according to Abdullahi, *et al* (2010), helps individuals to invest in change in management and obtain new skills, make extra planning and prudent in resources hence creating positive attitude towards use of technologies. The coefficient of access to extension services was positive and significant at 1% level. Abdullahi *et al*. (2010) finding is synonymous with the above assertion. Ume *et al*. (2016) reported that farmers who get adequate extension contacts are able to access modern agricultural technology for input mobilization, input use and disease control, which enable them to reduce technical inefficiency, hence making their attitude to technology use to be positive. Their statistical test of the coefficient of membership of organization had positive relationship with the dependent variable and significant at 5% risk level. Co-operative enable member to have access to information on improved innovations, material input of the technology (fertilizer and chemical), credit for payment of labour, capacity building and training to boost farmers' attitude toward use of technology (Ekwe and Onunka, 2006; Ekwe *et al*., 2008).

2.4 Effect of Vitamin A fortified Cassava Technology Adoption on Food Security Status of Farming Households

Udensi *et al*. (2012) in his study on effect of adoption on improved vitamin A fortified cassava variety on Households' income distribution in South-Eastern, Nigeria" says technology can be seen as the process by which humans modify nature to meet their needs and wants. Hornby (2002) noted that technology can be defined as the scientific study and use of mechanical arts and applied science and application of these to practical task in industries. Zeller (2006) also defined technology as the systematic application of collective human rationality to the solution of the problems through the assertion of control over nature and all kinds of human processes. Ayinde, *et al* (2017a) 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 improved plant varieties and animal breeds (including biotechnology), the introduction of new crops, livestock, fisheries, mechanization, infrastructural development and inputs. Therefore, a good technology is defined as one that is profitable in an ideal world without market inefficiencies or other adoption constraints.

Ayinde *et al* (2017b) discovered the following improved technologies available for practice for cassava; ploughing and ridging before planting, planting on flat after ploughing, use of improved varieties, supply or replacement of un-germinated seedlings, weeding at least twice a year, fertilizer application, use of herbicides to control weeds and application of insecticides. These results in quality yield and high productivity. Cassava is the most grown crop in Benue state in the north central of Nigeria especially by the small-holder farmers. It plays a vital role in the food security of the rural economy because of its capacity to yield under marginal soil conditions and its tolerance of drought. Both rural and urban communities use cassava mainly as food in both fresh and processed form (FAO, 2019). Cassava based meal are the most frequently eaten meals in the rural areas in Nigeria. Data from the collaborative study of cassava in Africa (COSCA) showed that 80% of Nigerians in the rural areas eat cassava meal at least once in a week. In 2007, cassava production in Nigeria was 46million tons making it the world's largest producer (IITA, 2013). Total area harvested of crop in 2001 was 3.1 million hectare with an average yield of about 1t/ha. In order to boost the yield which affects the level of production in cassava, the use of improved varieties in cassava production arose.

Nweke *et al.* (2004) on "Vitamin A fortified cassava production in Nigeria" maintained that cassava performs five main roles; famine reserve crop, rural food staple, cash crop urban consumption, industrial raw materials and foreign exchange earner. The author further posited that Nigeria is the most advanced of the African countries poised to diversify the use of cassava as a primary industrial raw materials and livestock feed. Two factors provide Nigeria with this comparative advantage in Africa, the rapid adoption of Bio-fortified cassava varieties and the development of small-scale processing technologies.

The research on the "current pandemic on cassava Mosaic Virus in East Africa and its control Chatham, UK by Otim 2000 undertaken in Nigeria in 1970 was fundamentally for the development of cassava resistance to mosasic virus. Furthermore, Nigeria has released two Bio-fortified cassava varieties in an effort to maintain its lead as the world's largest producer of the crop and improve incomes of rural farmers. The varieties were developed through a collaborative effort between the International Institute of Tropical Agriculture (IITA) and the

Nigeria Roots and Crops Research Institute (NRCRI), Umudike. The two varieties are originally recognized as IITA-developed genotypes. IITA-tms-19822132 and IITA-tms-1011206. But, with the official release, they now known as Umucass 42 and Umucass 43, respectively. Both varieties performed well in different cassava production regions of Nigeria included Benue State with high yield, high dry matter and good disease resistance. The roots of these varieties are yellow contain moderate levels of pro-vitamin A (IITA, 2013).

The potential maximum yield of the two varieties is between 49 and 53 tons per hectare, according to pre-varietal release trials that were conducted between 2008 and 2010. Local varieties produce less than 10 tons per hectare. The varieties are also resistant to major pest and diseases that affects cassava in the country including cassava mosaic disease, cassava bacteria blight, cassava anthrannose, cassava mealy bug and cassava green mite. NRCRI cassava breeder, who presented the varieties before the Nigeria varietal release committee (the body in charge of officially releasing varieties) said varieties have the following distinct qualities. (a) Good for high quality cassava flow-a sought-after trait by researchers transformation agenda in Nigeria, (b) High dry matter which is positively related to starch and crucial cassava value chain development, (c) High leaf retention which is positively related to drought tolerance and is crucial for cassava production in the drier regions and in mitigating the impact of climate change, and (d) Moderate level of beta carotene for enhancing nutrition.

Over the years, cassava has been transformed from being a “poor man’s” crop to cash and industrial crop, as it is now processed to products such as starch, flour, glucose and ethanol. This transition has increased the demand for this root crop. Researchers say developing new improved varieties is one way of boosting the steady supply of cassava roots for value chain development and for industry. A continuous breading of such improved new varieties will help in stabilizing production, processing, proper handling and marketing of cassava products. “the impact of these efforts will be felt in areas such as rural employment and vibrant cassava industrial sector,” he added (IITA,2013).

2.4.1 Overview of Vitamin A fortified Cassava (*Manihot esculanta*)

Cassava is a most popular food crop grown in West Africa. It is an Asian origin, a native of South America refereed to it as *manihot*, and it commonly grown throughout the tropics. It importance is known for its starchy, tuberous roots, it is a shrubby crop that grows to the height of 6-8 feet. It has rough erect stem and resembles the cannabis plant in appearance. The large compound dark green, reddish veined leaves are divided into seven leaflets in the form of a palmate. The stems contain soft white pith and have nodes from which new plants are obtained. It is relatively easy to cultivate, needing very little cultural practice. It occupies a unique position in the world’s food economy especially due to the fact that it survives where other crops fail (William, 2000).

Vitamin A fortified cassava advantage and importance over other crops is its drought tolerance and ability to give satisfactory yield on a wide range of soil types including acid soils (Adinyan, 2001). Through providing food continuously under conditions that cause other crops to fail, cassava has often played a critical role in alleviating famine and poverty. Eventually, it becomes the most important root crop in tropical Africa, providing over 50% of the calorie intake of more than 200million people (almost one third of the population) of the sub-Saharan Africa (World Bank, 1996).

In recognition for food security among poor and underdeveloped nations, the Food and Agriculture Organization (FAO) has made its production a global focal point of their programme. The Federal Government of Nigeria (FGN) in her effort at increasing food production, raising farmers income and improving the standard of living of people in the rural community via increasing productivity of farm products, has keyed into FAO programme through their commitment to cassava production in Benue State and Nigeria in general. In pursuit of this commitment, the FGN also sought technical assistance from International Fund for Agricultural Development (IFAD) for a programme to increase productivity of bio-fortified cassava through increased use of improved varieties which enjoy the advantages of disease and pest resistance, high yielding and early maturing coupled with better agronomic practices and introduction of improved processing method (Kogi State Agricultural Development Project, 2015).

2.4.2 Importance of Vitamin A fortified Cassava

In terms of global production, vitamin A fortified cassava is grown on about 16.2million hectares of land in 99 countries and produces about 162.7million tons of fresh tubers per year (FAO, 2016). The five largest world producsers are; Nigeria, Brazil, Angola, Indonesia and Thailand that together account for 65.5% of world production. FAO. (2016) reported that cassava in Africa is a subsistence crop often produced on marginal lands in shifting cultivation system by small-scale farmers. They grow cassava especially to feed their families but, there is now a growing commercial market for cassava. Most of cassava products used food are derived from the starchy roots but the leaves are also consumed as preferred green vegetables in some cassava growing communities especially central Africa. The stems are used to feed pigs and as firewood.

Table 2.1: Vitamin A Fortified Cassava Producing Countries in the World

No	Countries	Units of tonnes
1.	Nigeria	47,406,770
2.	Thailand	30,227,542

3.	Indonesia	23,227,542
4.	Brazil	21,484,218
5.	Angola	16,411,674
6	Ghana	15,989,940
7.	Democratic Republic of the Congo	14,611,911
8.	Viet Nam	9,757,681
9.	Cambodia	7,572,344
10.	India	7,236,600
11.	Malawi	4,813,696
12.	United Republic of Tanzania	4,755,160
13.	Cameroon	4,596,383
14.	China mainland	4,585,000
15.	Mozambique	4,303,000

Source: Oishimaya, 2017

Table 2.2: Vitamin A Fortified Cassava Producing States in Nigeria

No.	State	Tonnes
1.	Benue	3,548.0
2.	Cross River	2,290.0
3.	Enugu	2,189.0
4.	Imo	2,332.0
5.	Kogi	2,962.0
6.	Taraba	2,952.0
7.	Rivers	1,745.0
8.	Ondo	1,738.0
9.	Delta	1,710.0
10.	Edo	1,678.0

Source: Akinpelu, 2011

Cassava production in Nigeria was on the rise until the period between 1970 to 1976 when many farmers migrated to the cities as a result of oil boom (Davies, 2009). This therefore, led to great decline in the area cultivated. The southern and north-central areas of the country are the major cassava producing states in Nigeria due to the crops adaptation to soil in these areas. It has ability to thrive on less fertile soil over other crops. Yields on farm trials range between 9.9 to 17.3t/ha and capable of producing up to 50tons/ha. Foreign Agricultural Service (FAS) (2014) posited that the roots can be kept in the ground and harvested when needed. It is easily propagated by stem cuttings, which are however, not edible. It provides about 45% of daily intake in sub-saharan Africa (FAO, 2013) and about 70% of the daily calorie intake of over 50million Nigerians. In comparison to other food crops (such as yam, rice, maize and shorgume), cassava demands less of farmers' resource. It is propagated by stems, tolerates moisture stress, makes limited soil fertility demand, and has no specific planting and harvesting periods. It can be processed into a variety of food items or forms and does not require elaborate storage facilities because harvested cassava in any form deteriorates in quality after two days. Therefore, farmers leave their cassava in the field until the need arises for harvest.

However, with population pressure and agricultural land use intensification, storage in the field is at a high opportunity cost since farmers require more land for cultivation. In terms of nutritive value, cassava roots contain about 60% of water and fleshy, rich in carbohydrate. The roots are low in protein and lipids but, reasonably rich up to 25% of daily vitamin A requirement of children and women, since the presence of pro-vitamin A (Beta-carotene) in the improved varieties (*Bai et al*, 2010)., it is also rich in calcium and vitamin C, which when consumed with some energy dense protein and nutrient rich supplementary food such as beans and oil seeds pulses and fishes provide energy in adequate diet (FAO, 2010).

The Vitamin A Fortified cassava varieties out yielded the local at farm level but, farmers have been slow to adopt them based on factors such as unfamiliarity. Most farmers have never had opportunity to try them and therefore, do not know whether they will like them or not, unavailability of planting materials, their high moisture content, the relatively unknown processing qualities(product chain) of the improved cassava varieties compared with the known qualities of the local varieties (World Bank, 2010). It noted that improved cassava varieties express their greater yield potential under both low and high inputs than the local cassava varieties.

2.4.3 Cassava varieties in Nigeria

It had been suggested that before modern research on cassava started in Nigeria in 1954 at the Federal Department of Agricultural Research (FDAR), Ibadan, there were numerous local ecotypes of traditional clones. These varied in their tuber yields general tolerance of prevailing pests and diseases. "*Oloronto*" (531101), a local cultivar from the Ibadan area, was then recommended for the farmers in Nigeria. It was later used in crosses in 1967 which led to the release of improved varieties such as 60444, 60447 and 60506 for the whole country. In 1972, when Cassava Bacterial Blight (CBB) became a scourge for cassava in the country, only 60306 and few local types tolerated the disease. Breeding work at international institute for tropical agriculture (IITA) later identified improved clones which were released after 1976. Release of the first two IITA clones, namely TMS 30211 and TMS 30395, were rapidly followed by TMS 30572, TMS30001, TMS300017, TMS 30110, TMS 30555, TMS 30337, TMS 4(2) 1425 and other (IITA, 2013).

These vitamin A fortified cassava varieties differed in their resistance to cassava diseases and pests such as CBB, cassava mosaic virus (CMV), cassava anthracnose disease (CAD), cassava mealy bug (CMB) and cassava green spider mite (CGM). They also produced tubers with varying quality of roots at differing maturity duration and storage in the ground. Farmers preferred improved varieties because of their higher yields, earlier maturity, high suppression to weeds, higher nutritional contents and greater resistance to diverse diseases and pest (Operinde *et al.*, 2013).

A wide varieties of cassava cultivars can be observed in farmers' fields but, one or two cultivars may occur more frequently in a given zone. Thus, the most commonly observed local cultivars in middle-belt Nigeria are: (a) "*odongbodudu*" with its reddish petiole, cream-coloured stem, moderate branching, and clear white flesh; (b) "*oyarugbadudu*" with indeterminate growth habit, dark stem, and cream-coloured petiole; (c) "*eye dud*" which is similar to tms 305752 and whose origin is suspected to be from IITA's stock dispersed by some extension staff in the early 1970's (d) " *isunikankiyan*," a high-branching, erect cassava variety with reddish petiole, stem and periderm, usually early-maturing, mealy and sweet. Normally, a field of cassava in middle-belt Nigeria may contain different combination of all four varieties including some other minor cultivars. However, the most commonly grown local variety in middle-belt, Benue state in particular is *odongbo*, which bears different names in different parts Nigeria.

2.4.4 Concept of Food security

The term food security is a complex terminology; it has no exclusive definitions but can only be defined based on the view and the context for which an author wishes to research upon. Food security has been defined by United State Agency for International Development (USAID) (2011) as when all people at all times have both physical and economic access sufficient food to meet their dietary needs for productive and healthy life". This definition encompasses availability, access and utilization. Food availability is achieved when sufficient quantities of food available to all individuals. Such food can be supplied through household production, other domestic output and commercial imports or food assistance (USAID, 2011).

The World Bank (2016) defined food security as, "year round access to amount and variety of food required by all household members in order to lead active and healthy lives, without undue risk of losing such access". This definition also encompasses availability, access and utilization to meet an active and healthy life. On the other hand, household food security is the application of this concept at family level, with individuals in the household as the focus of concern. This suggests that, an analysis of household food insecurity should also focus on individual household members, i.e. individual level of security within a household or the vulnerability of certain groups of a population due to their social status, labour availability and special nutritional needs such as rural women, malnourished children and the elderly. In some societies for instance, traditional or cultural practices prevent women and children to share the available food with men. Women may have less control of resources than men. Hence, women and children may be more vulnerable (Umar, 2015).

The World Food summit 1996, also defines food security as: “Food security exits when all people at all times, have physical and economic access to sufficient, safe and nutritious food to meet the dietary needs and food preferences for an active, healthy life” (FAO, 1996). FAO has defined food security not in terms of access to, and availability of food, but also in terms of resource distribution to produce food and purchasing power to buy food, where it is produced. Ogwumike (2012) similarly, defines food security as a state that exits when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active life. Food insecurity, when people lack this, is seen as due to unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate utilization at individual levels. An understanding of food security also includes the time dimension, which explicitly describes the intensity and characteristics of the household’s food insecurity.

Food insecurity can be “chronic” or “transitory”. A constant failure to” access” food is distinguished as chronic, while a temporary decline is considered as transitory food insecurity. Chronic food insecurity is a sign of poverty and shows a long- term structural deficit in food production and lack of purchasing power. Transitory food insecurity, on the other hand, implies a short –term variability in food prices, production and income (Oladunni, 2010). Transitory food insecurity is a temporal or seasonal shortage of food because of the unexpected factors for only a limited period and it is often triggered by seasonal inability in food supply or availability and fluctuation in prices income (Hornby, 2002).

Chronic food insecurity can translate into a higher degree of vulnerability famine or hunger. Repeated seasonal food insecurity also depletes the assets of the households and exposes them to higher level of vulnerability. Food security in general is a concept that integrates a number of important issues the magnitude of which ranges from micro to macro- economics. Its attainment requires an overall consideration in terms of policy and program development in all aspect of the food system. Hence, the success in production and distribution plays an important role in influencing the food security status of an individual, a household or a society at large (Hornby, 2002).

Other similar word for food insecurity includes, but is not limited to beggary, bankruptcy, debt, destitution, hardship, indigence and insolvency. In addition, food insecurity is a situation or an experience of being unable to eat well at right time, unable to afford a good food that is safe. Food insecurity has been viewed from different aspects, ranging from insufficiency in income for securing the basic necessities of life such as food, portable water, clothing and shelter (Oladunni, 2010).

The definition of food insecurity varies and relate to the kind of lifestyle being defined. Food insecurity has remained a hydra-headed or a lingering problem in sub-saharan Africa and has been described as one of the unattained millennium development goals (MDG), was the eradication of extreme food insecured and hunger. According to Oladeji and Folorunsho (2007), a more operational definition of food security is usually helpful for clear understanding of issue of this kind and to keep track of the status and trends of the phenomenon.

According to the National Planning Commission through the Data gotten from National Bureau of Statistics (2019), available statistical fact on food insecurity in Nigeria indicates the following, inter alia; 25% of population lives in extreme food insecured while 44% are food insecured in relative terms. It was also found that almost 31% of the respondents live on less than a dollar a day and that food insecurity incidence is highest in North- East (23%), North-West (22.9%), North- Central (20.3%), South-South (16.1%), South- West (10.2%) and South-

East (7.5%), with about 63% of poor people living in the rural areas as compared with 37% in urban areas.

According to the United Nations (2013), the Copenhagen declaration on social development states that food security entails lack of income and productive resources, sufficient to ensure sustainable livelihoods, hunger malnutrition with associated ill health, limited or lack of access to education and other basic services, homelessness and inadequate housing, lack of participation and exclusion in decision-making in both social and cultural life. One of the basic manifestations of poverty as indicated earlier is hunger and malnutrition. Although food insecurity is a worldwide phenomenon, it has been observed that Nigeria is one of the most food insecured countries in the world. The situation has reached an alarming stage, as more than 45% of the population lives below the food security line while 65% are extremely food insecured (Oladunni, 2010).

Food insecurity is responsible for the many challenges be it social, economic, psychological and political problems faced in most third world countries Nigeria inclusive. Many youths due to idleness have resulted to social vices which have not only affected the economic potentials of the continents but have further created political division among member countries. This is confirmed by the World Bank (2016), which categorized Nigeria, Kenya, Nepal, Haiti and Cameroon among others as countries with low Human Development Index (HDI) as against the very high and high Human Development Index countries like Norway, Australia, Hong Kong, USA, UK, Russia and Romania, with less number of poor people. In Nigeria for instance, the minimum wage of eighteen thousand naira (₦18,000.00) is used as the minimum requirement or food security line for which one could say that once disposable income is less than this amount, the farm family or individual is said to be poor, but for disposable income greater than or equal to eighteen thousand naira, the farm family or individual is said to be non-food secured and yet many farm families live below the food security line.

2.4.5 Food Security Components

Food security is multi-dimensional having interrelationships with vulnerability indicators; it cannot be captured by any single or specific indicator. It would therefore be important to understand the essential dimensions of food security – Access to food, Availability of food, and Utilization of food. The interactions and combinations of these dimensions represent food security together. Currently stability is also considered as the fourth component of food security (Ogwumike 2012):

i. Access is referred to access by individuals to adequate resources (entitlement) to acquire `appropriate foods for a nutritious diet. Entitlements are defined as the set of all those commodity bundles over which a person can establish command given the legal, political, economic `and social arrangements of the community in which he/she lives (including traditional rights e.g. access to common resources). Securing access to enough food at all times for an active and healthy life is a prime objective of all modern society because of the role played by food economy, culture and politics. Food access is largely determined by the ability of households and individuals to obtain food from own production, purchases and other sources, such as gifts, government transfers and food aid.

ii. Availability refers to the availability of sufficient quantities of food of appropriate qualities, supplied through domestic production or imports (including food aid). On the supply side, cereal output is the key indicator, as cereals provide about 60% of dietary energy in developing countries. At micro or household level, availability is taken as the capacity of the households to produce the food need.

iii. Utilization is related to utilization of food through adequate diet, clean water, sanitation and healthcare, to reach a state of nutritional well-being for which all physiological needs are met. This bring out the importance of non-food inputs in food security. It is not enough that someone is getting what appears to be an adequate quantity of food if that person is unable to make use of the food because he or she is often falling sick. The dimension of food utilization underlines the importance of such processes including marketing, storage, processing, cooking practices, feeding practices and nutrition to the attainment of food security.

iv. Stability is a very important component of the food security indicator. To be food secure a population, household, or individual must have access to adequate food at all times. They should not be at risk of losing access to food as a consequence of a shock (e.g. an economic or climatic crisis), or cyclically (e.g. during a particular period of the year – seasonal food insecurity). The concept of stability can therefore refer to both the availability and access dimensions of food security.

2.4.6 Origin of Food security

The roots of concern about food security can be traced back to the Universal declaration of Human Rights which recognized that "everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including" (UN 1948). Food security as a concept originated in 1979's and since then it has been a topic of considerable attention. However, the concept has become more complex to a shift in the level of analysis from global and national to household and individual levels. In the mid-1970s food security was conceived as adequacy of food supply at global and national levels. This view focused merely on food production variables and overlooked the multiple forces that in many ways affected food access and the definitions of food security focused on aggregate food supplies at national and global levels, and analysts advocated production self-sufficiency as a strategy for nations to achieve food security.

2.4.7 Measurement of Food security

There are various tools used in the measurement of food security, given its complex reality and the need to ensure standardized and efficient parameter for its measurement. Different food security analysis exist, such as the budget standard approach, where food security is calculated based on the cost of a specific basket of goods and services (i.e. covering things like food, clothing, personal care, health related costs, farm family goods and services, educational costs, housing, transport and fuel) that are considered by experts or society in general to represent a basic standard of living. A second approach is food ratio method where the food secured are distinguished from the non-secured by the quantum of their income they spend on basic necessities such as food, clothes and shelter. Generally research has shown that low income earners spend a proportion of their incomes on basic necessities leaving almost nothing for participating in normal social, recreational and cultural activities.

According to World Bank (2016), the distribution of the food in-secured below the food security line measures the degree of severity of the insecured problem. Rao and Annadana (2017) further established that a cluster around the food security line is less serve than a distribution where a large number of people have income (or consumption) far below the food security threshold. This thresholds which could be upper and lower food security line thus referred to as food insecured and very food insecured. Other method adopted in the measurement of food security includes, but is not limited to the head count index, which is viewed as a proportion of the population whose measured standard of living (consumption) is less than the food security line, the food security gap incidence that shows difference between the food security line and mean income of the food insecured, expressed as the ratio of the food security.

Saltman *et al.* (2016) asserted that food security gap index captures the degree of income shortfall below the food security line as a good indication of the depth of food security and does not capture its severity. Foster Greer Thorbeck (FGT) index measures the mean of the individual poverty gaps raised to a power that reflects the social valuation of different degrees of poverty. Assuming the society place a greater value on helping the poorest, the measure is weighted to reflect extent that individual (or farm family) income falls below the poverty line. The greater weight used for the poorest in relation to the not so poor, the more sensitive is the measure to severe food insecured.

2.4.8 Food security, insecurity and vulnerability

Nigeria blessed as it is, with abundant agro-ecological resources and diversity, has become one of the largest food importers in Sub-saharan Africa (Kakwani, and Son, 2009). This statement implies that Nigeria is unarguably food insecure. Food security has been defined as "accesses by all people at all times to safe and nutritious food needed to maintain a healthy and active life (Food and Agricultural Organization (FAO), 2013). Food security is thus people-oriented and implies a situation in which all farm families have both physical and economic access to adequate food for all members and where, farm families are not at risk of losing such access. According to Davies (2009), what is implied in the definition of food security is that food must be available to the people to an extent that will meet some acceptable level of nutritional standards in terms of calorie, protein and minerals which the body needs. Food security depicts the possession of the means by the people to acquire (access) and reasonable continuity in food supply.

Food security also shows that a farm family does not only have access to food, but in the right quality, proportion and at the right time. Demorua *et al*. (2015) viewed food security as a major element in national security, alongside domestic law and order, as well as territorial defense and other forms of security. One could therefore say that a country that is food insecure is prone to war, insecurity, diseases and other social vices like kidnapping, robbery and youth restiveness. Food security is a vegetable tool to maintaining a secured nation. Paul *et al*. (2009) states that the right or ease of access to food means more to farm families who are food insecure than the right to basic education, participation in political and social life and so on.

Ofune (2010) indicated that food is not an ordinary commodity, but a powerful instrument of state policy that can be employed to punish enemies and recalcitrant nations, reward friendly states and influence the political and economic decision of nations. This definition implies that food security is a broad concept that is more than food production and food accessibility. In reality, it revolves round five pillars namely; food availability, food accessibility, food affordability, food utilization and stability of food supply. Food insecurity on other hand, represents lack of access to enough food and can be either chronic or temporary. Chronic food insecurity is a long-term or persistent inability to meet minimum food consumption requirement.

On the other hand, temporal food insecurity entails when food intake for adults in the farm family has been reduced to an extent that the adult have repeatedly experienced the physical sensation of hunger in most (but not all) temporary food-insecure farm families with children, such reductions are not observed by the children at this stage. In chronic food insecurity, which arises from a lack of resources to produce or acquire food, the diet is persistently inadequate (Uwandu *et al.,* 2019). Food insecurity makes farm families vulnerable to disease, exposes them to shocks, and increase the risk of chronic poverty and insecurity. Many farm families in Nigeria are vulnerable to food insecurity, which is now worsened by the non-utilization of improved technologies experience in most parts of the country.

According to Babatunde *et al.* (2008), vulnerability refers to peoples propensity to fall or stay below a pre-determined food security line. The food security line could be calorie-based (food requirement) or it could include all basic needs Zeller, (2006). Vulnerability is a function of exposure to risk/shocks and the resilience to these risks. Risks and shocks are therefore an event that threaten the rural farmer access to quality food in the right quality proportions, its availability and utilization. The subject of food insecurity can never be over emphasized for obvious and crucial reasons. Beyond obvious reasons however, food insecurity gives rise to other despicable social and health conditions.

For instance, Larai (2013) asserted that everyday life of the food unsecured increases vulnerability to the development of chronic illnesses. It should be noted that availability of food alone does not seem sufficient to explain the attainment of food security in a country. Food can be available in a country because of effective agricultural policy; good harvest in a particular year or massive importation of food, or food handout. Massive food import, particularly by developing countries, usually has negative effect on foreign reserves and causes budgetary hemorrhage (Davies, 2009). One could therefore argue that the sovereignty of a country is strengthened when it is food secured. Food has been used as an instrument of war, it has been used to test the independence and self-sustainability of a country and such, terrorists and miscreants have targeted farms, market places and ranches to carryout violent attacks.

Bai *et al.* (2010) in a perspective work identified four global threats that have significant implications for the food security of cities. Firstly, there are three types of incipient population explosions; Human, Livestock and Cars. The threats of increasing human numbers and urbanization are clear. However, less often considered, is the explosion since world war 11 of livestock numbers. Today some 38 percent of the world's grain crop is fed to livestock. Secondly, there is global warning, an issue beset by uncertainty and confusion. While a few regions may benefit from global warming, the latest projections suggest Africa agriculture is the most vulnerable. Thirdly, the loss of biodiversity is perhaps the greatest long-term threat to global sustainability. The fourth is the threat of poverty and globalization of poor yield continue, food will continue to scarce and many farm families or rural farmers will remain food insecure.

2.4.9 Food Security of rural farmers

Women play a decisive role in household food security, dietary diversity and children's health. According to Food and Agriculture Organization (FAO) (2016), an estimated one billion people are undernourished, and that each year, more than three million children die from under-nutrition before their fifth birthday. This worrisome statistics has continued to worsen due to the inequality faced by women, as men controls most of the livelihood assets and limit women's food production. In Developing countries, rural women carry out most home food processing, which ensures a diverse elicit, minimizes losses and provides marketable product.

Most farmers in Nigeria operate at the subsistence, smallholder level in an extensive agricultural system; hence, in their hands lay the country's food security and agricultural development. Particularly striking however is the fact that rural women, more than their male counterparts, take the lead in agricultural activities, making up to 60-80 percent of labour force. Ironically their contributions to agriculture and rural development are seldom noticed (Yemisi and Aisha, 2009). Furthermore, they have either no or minimal part in the decision-making process regarding agricultural development. Over the years, women have established more defined roles in agriculture. In Nigeria, women are involved in agricultural production, processing and utilization. A women's role in the agricultural sector is significantly affected by socio-economic factors such as income, education and access to infrastructure (Sahel, 2014).

In order for agriculture to advance and food security attained in Nigeria, specific policies tailored to women in the value chain and education should be developed as women's access to education is also a determining factor in levels of nutrition and child health. The role that rural farmers play and their position in meeting the challenges of agricultural production and development are quite dominant and prominent. Their relevance and significance, therefore, cannot be over emphasized. Yet women and girls globally encounter unfairness which is literarily or implicitly embedded in social norms, customs and practices. Notably, gender roles and attitudes towards same are primary normative mechanism through which the potential contributions of women are suppressed (Ibrahim *et al*, 2015).

According to the Federal Ministry of Agriculture and Rural Development (2012), women account for 75 percent of farming population Nigeria. Working as farm managers, and suppliers of labour. Though, women constitute a large portion of the farming population, women's possibilities in agriculture are hindered by formal and traditional rules. Lack of improved technologies have also added to the obstacle women face in optimizing the gains embedded in the agricultural sector as they can hardly meet up with the nutritional needs of their homes. One can reasonably assert that agriculture in sub-Sahara Africa and other developing countries can never attain the desired height or level if the roles of women are not recognized and the obstacles removed. This is supported by the study of Yemisi and Aisha (2009) which stated that the Nigeria women has proven to be more than a mere "bench-warming" spectator, even in the midst of the male-dominated professional congregation.

Generally, the extent of gender involvement in agricultural production varies across ethnic groups in Nigeria. Nigerian women farmers work alongside their male counterparts with some clear distinctions in activities between them. In most cases, the men execute the tedious tasks such as land clearing and falling of trees. Gathering and burning of bush, and making of heaps and ridges, while the women engage in planting. In addition, women also participate in weeding, harvesting, on-farm processing and selling of farm produce. The desire to support their families has spurred some Nigerian women to farming (Ofunne, 2010).

In terms of numerical participation and percentage contribution in farming, you may likely find more females in farming than their male counterparts in Nigeria and most developing countries.

For women have successfully used agriculture as a veritable tool in pulling their farm families out from the vicious circle of poverty and consequently out of food insecurity. National Bureau of Statistics (2019) in a harmonized Nigeria living standard survey, revealed that more females participated in agriculture than males in the following states of the federation, namely; Nassarawa (55.0%), Plateau (60.0%), Benue (55.5%), Katsina (63.0%), Kaduna (55.0%), Enugu (57.0%), Bauchi (63.0%), Bayelsa (69.0%), Edo (59.0%), Cross River (52.0%), Rivers (51.0%) and Abia (58.0%). Women have therefore, played significant roles in Nigeria's agricultural advancement, hence need for adoption of improved technology on vitamin A fortified cassava.

Poor technology adoption has made it difficult for women to have the needed psychological stability and economic prosperity to move their farm families out of the vicious circle of poverty, and usher them into food security. As a result poverty faced by the female headed households, it has made it virtually impossible for social vices and insecurity to be abated. (Umar, 2015), stated that women lag behind in the accessibility to health care, social welfare and security. As a result of this, the society suffers greatly in terms of achieving profound peace, increases, growth and sustainable development. No wonder, Nigeria, and in particular, the study area is currently militated by perpetual crisis as characterized by chains of social milieu, ranging from poor yield, corruption and under development, all threatening the very foundation of the name " Food Basket of the Nation" Benue State is known.

2.5 Effects of Vitamin A Fortified Cassava technologies adoption by rural farmers

Akinpelu (2017) on the study of "Assessment of the Impact of vitamin A cassava multiplication programme on farmers for sustainable development and food security in North central Nigeria" shows that lack of credit/ fund was reported by 67.5% of the respondents in the study area. The high interest rate and low repayment period could be the reasons for low access to credit from lending agencies. Furthermore, lack of government incentive like improved seeds/stems, farming tools such as tractors, garri processing machines, fryier and dryier to the farmers was complained by 60% of the respondent.

In the early stage of the project, government gives subsidies such as planting stems, fertilizer and pesticides, but these kind gestures were removed at later stage, hence affecting the farmers' attitude to continue with the programme. In addition, attitude of extension agents on information dissemination on the new technology/improved varieties to farmers is discouraging as many of them fail to keep to their fixed visit schedules to farmers' farm and homes (Aphunu and Atom, 2010).

2.6 Constraints Associated with the Adoption of Vitamin A Fortified Cassava Technologies by Rural Farmers

The constraints to "Vitamin A fortified" cassava production by the field survey,2015 of a research conducted by Onunka, *et al.* (2011) shown that credit/fund rank 1st with 67.5%, Government incentives rank 2nd with 60.0%, Extension personnel was 3rd ranking with 58.3%, he recorded yield quantity as number 4th in ranking with 57.5%, high cost of cutting ranked 5th with 54.4%, accessibility to market (value addition) was ranked 6th with 54.2%, farm land was ranked number 7th with 50.8%, high cost of cutting ranked 8th position with 50.0%, he recorded some variety not identified which ranked 9th with 41.7% and production practices with lowest ranking of 10th with 35.0% as the order of the 10 top ordered of the constraints to Attitude of farmers towards "pro-vitamin A" cassava production technologies.

Laria (2013) conducted a similar study on capital constraints to technology adoption in Africa agriculture and innovations for poverty Action reported that information, risk, land right among other is highest. Capital, 85.0% of farmers in Mali cite cost or lack of capital as reason for not using fertilizer. Returns to capital typically believed to be high. Farming businesses could grow if farmers had access to more capital, underlies policy focus on micro credit. The findings showed how important funding, government incentives and extension personnel are to production especially fortified vitamin A cassava production in particular (Omole,1996).

2.7 Theoretical Framework

2.7.1 Theory of Adoption

Adoption is a decision to continue full use of an innovation while adoption process is the mental process through which an individual passes from first hearing about an innovation to the adoption (Assefa and Vanden Berg, 2010). Generally while the diffusion process involves passing of news about an innovation between persons, the final decision to adopt or reject the innovation is purely a personal or individual decision. Umar (2015) stated that, the adoption process is essentially a decision-making process. Research studies in the United State of America particularly, have identified a number of stages in the process of adoption. While different researchers tend to claim different number of stages, the North Central Rural Sociology Committee has accepted five stages including awareness, interest, evaluation, trial and adoption-AIETA.

Alao has also claimed that in Nigeria these stages can be fused into three stages- awareness, trial and adoption. The farmer's decision for or against adoption of science-based production technology was described as a mental process, consisting of several stages. The objective of extension communication is to provide firm knowledge on which action can be based, to persuade the farmer to make a decision to try the new technology, to provide the information necessary for actual implementation, and to provide the information needed by the farmer to assess the results of that decision, and hopefully to confirm the decision (Alene *et al*., 2012).

Based on observations of farmers' behavior (earliness or lateness of adoption), it is possible to classify farmers as possessing more or less of that trait. Those few who are first to try out the new idea are called innovators. If the new idea survives for an appreciable length of time and is accepted by more than the first few, one can identify a second category of farmers, here called Early Adopters. Then, if the new idea continues spread, the bulk of farmers who ultimately accept the new idea can be classified as Early and Late Majority, depending on the time (relatively early or late) at which they make the decision to adopt. Finally, some minority of farmers accept the idea very late, and are conventionally called Laggards.

The socio-economic factors related to adoption of new technologies include both the personal characteristics of farmers and characteristics of the context in farmers act. Effort to explain adoption behavior have in the past, tended to focus on innovativeness as an individual trait, and other personal characteristics that tend to coincide with differences in innovativeness. In recent years there has been a realization that the focus on individual characteristics may be too limiting. Babatunde *et al.* (2008) from his studies of small-holder farmers was among the earliest to suggest that in addition unwillingness to adopt innovations, one should raise questions about inability to adopt.

The fact that a farmer is poor, means that he or she is not free or unable to make certain decisions. Information about improved technology like Vitamin A fortified cassava may be more appropriately directed to the rich and well to do farmers in such cases. Similarly, an individual may not be a member of supply or credit co-operative simply because no such institution exists in the area. Again, messages to persuade the farmers may be of little use because the support mechanisms which facilitate implementation are not in place. Development strategy, in such instance, ought to include efforts to develop service institutions.

The point here is that an information campaign directed towards persuading farmers to take certain action may fail, at least partially, because of farmers' inability to implement decisions to adopt the recommended technology of "Vitamin A fortified cassava". A good illustration of this type of situation is described by Edoh *et al*, (2016) on the introduction of an improved cassava variety in Brazil. Those smallholder producers who could not obtain credit that would have permitted them to plant the new variety and to wait one year for the new planting to come into production, were left behind. Innovativeness in this case hinged on farmers' differential ability to forego income on at least part of their land while new plantings matured and / or to obtain credit to tide them over. The laggards were not necessarily unwilling to adopt the new variety, but were unable to implement their adoption decision. The example given points to a need for a broad view of the context in which farmers are expected to make decisions. External constraints on adoption, such as a lack of credit or a lack of labour at crucial points in the production process, may be the limiting factors, and argue for a development strategy that goes behold an assumed unwillingness to take action on the part of the farmers.

2.7.2 Theory of diffusion

Ajayi *et al*. (2017) stated that Diffusion of innovations refers to the spread of those innovations through a population, and is simply the result of a host of individual adoption decisions. If individual adoption decisions are, to extent, predictable, then the larger diffusion process is also predictable. It follows a pattern, and that element of predictability has substantial implications for action programmes and for extension educational campaigns. Diffusion process is the spread of new ideas from its source of invention or creation to its ultimate users or adopters. The diffusion process involves four essential elements- the innovation, its communication from one individual group to another, a social system within which this process occurs and a time period over which the process is effected.

The Author further posited that time is an important factor in diffusion and adoption process. Studies in western Nigeria have shown that it took 4 years for poultry farming to be widely accepted among farmers in that area. Similarly soil testing took nearly 20 years to be accepted and adopted by farmers. The change agent must aim at reducing this time lag to a minimum. He can do this through an effective educational process hence an understanding of the diffusion and adoption process can enhance the change agent's effectiveness and efficiency in introducing changes and getting them adopted promptly. The specific information on which differences among improved farm practices as related to rates of adoption is based is taken from a relatively old study of diffusion in the United States (Ajayi *et al*., 2017).

Also, mechanization has had a key role in the transformation of agriculture in many of the industrialized nations, particularly in North America; there, labour, rather than land availability, has been a serious constraint in improving agricultural productivity (Ogwumike 2012; Council for Agricultural Science and Technology, 2018). In that context, the investment in labour-saving machinery has been an important element in a general increase in the capital intensity of agriculture, and that carries with it a need for formal farm accounts. The latter element, keeping accurate farm accounts, is a universal element in the agricultural transformation. Labour-displacing machinery, on the other hand, is a more location-specific type of technology, depending ultimately on the price of labour relative to capital.

In less developed nations the most common measure of productivity is based on land, the scare resource, rather than labour. The percentage increases of farmers having adopted new improved technology start slowly, with a few innovators who try a new technology of Bio-fortified cassava for season or two. The speed of the process increases as others are able to observed results, and as interaction between innovators and others take place. It is important to note that the "break" in the diffusion occurs at the point at which diffusion tends to progress at a more rapid rate after a slow start, results from a social process of interaction among farmers.

Extension workers can influence the steepness of the upward slope, by providing the knowledge for decisions to be based on. Extension communication is powerfully reinforced by the informal communication which takes place among farmers on a day-to-day basis, however. It is also the case that informal communication about performance would have to be consistent with persuasive messages from extension if the diffusion rate is to increase. That is, unless casual observation of results supports the persuasive message, rapid diffusion is likely to occur. The rate of diffusion differ substantially with time with respect to earliness or lateness in adoption. In either case the time span involved is a matter of several decades.

From a communications perspective, the challenge is to provide the knowledge which will speed up the rate of adoption, assuming that performance in the field warrants a continuation of the persuasion process. Another characteristic of rate of diffusion of the adoption is that they tend to level off after some years. As more farmers adopt, the potential for further adoption decreases; thus, the rate of diffusion slows down over time. Such a slowing may occur well short of total audience penetration, however, and therein lies a challenge. As a matter of fact, slow-moving diffusion processes are the major challenge to extension.

It has been argued, and not entirely without merit, that extension programmes are not needed when radically better technology is introduced to farmers, who will seek it out and put it to use (the input supply then become the major impediment to rapid diffusion). Two sets of facts argue against that point of view, however. Firstly, radically improved technologies (Vitamin A fortified cassava technologies) are not always available. The general case is one of incremental improvement over time, with limits depending on the state of scientific knowledge in a given area. Secondly, agricultural innovations can be described as separate, discrete entities, but their potential typically lies in their appropriate utilization in combination with a range of other items of technology, conventional and/or newly introduced.

Innovations achieve their potential in packages, in other words, and that places a heavy burden on management. When one speaks of implementation in the adoption process, one is speaking of a complex learning process, of learning to manage a range of resources in an optimally productive way. It at that point that need the need for extension efforts is greatest and the extension communication task most complex. It is at that point, also, that the need for feedback from farmers is most critical, if mistakes are to be avoided (De Morua *et al.,* 2015).

2.7.3 Theory of innovation-decision

Everet Rorgers, a rural sociologist (2014) define an innovation as an idea or thing perceived as new by the individual and it is essentially the newness or novelty of the idea that determines the individual’s immediate reaction to it. A farmer who is confronted with a new variety of seed is at once curious and suspicious. He is curious to know how or see this new variety performs vis-à-vis the older variety which he knows very well while on the other hand, the on uncertainty and risk entailed in accepting this new variety make him suspicious. While the term innovativeness refers to the degree to which an individual is relatively earlier in adopting new ideas than the older members of his social system (Ayinde and Adewumi, 2016). Apart from the individual's intrinsic inertia, the major factor that affects the acceptance of any innovation is the characteristics of the innovation itself (Garg *et al.*, 2018).

These characteristics he stated are relative advantage which he define as the degree to which an innovation superior to the one it is meant to super cede. This may be expressed either in economic or social terms. For instance, manual processing of Vitamin A fortified cassava tubers is tedious and inefficient. A farmer who is presented with a machine that can process cassava tubers in a matter of minutes and produce more per unit tubers would see this to be of a greater advantage than hand processing. He further say, crisis may underline the relative advantage of an innovation. A war or economic blockade for instance, may make the people start to use more of their internally manufactured goods which may have been underrated during peace time.

An innovation may be perceived as having advantages over the currently used practice but may not be adopted because of it cost Ofune, (2010). Generally the highest the cost of an innovation the more slowly it is adopted. An innovation may call for other investments even though by itself it may be very costly. For instance, if a farmer has enough money to pay for a tractor which he considers reasonably cheap, he still has to hire and retain a tractor driver and constantly service this new machine. He may need to build a garage for the tractor and other implements. These additional investment go a long way to increase the cost of original innovation adopted. Thus an innovation like the tractor which requires a chain of other investment would less readily appeal to a farmer in Nigeria than say the adoption of a new variety of cowpea. Cost may also be calculated in terms of time. The Nigerian farmer find it easier to obtain loan from a neighbor, family member, money lender or Esusu group than from the commercial and agricultural development Bank since it costs less in terms of the time required (Ibrahim *et al.,* 2015).

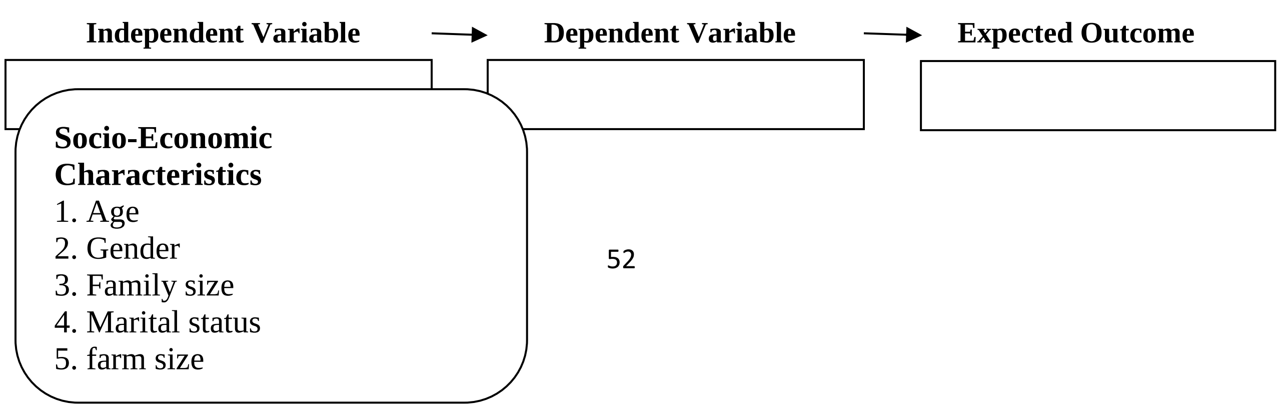
Complexity refers to the degree to which an innovation is relatively difficult to understand or use. Innovations that are relatively simple to understand and use will tend to be more readily adopted than those that are complex. Among Nigerian farmers, keeping of farm records is more complex than adopting a new variety of seed or fertilizer. Thus while most farmer are adopting these physical innovations, very few have adopted the keeping of farm records (Olatade, 2016). Nweke *et al.* (2004) stated that visibility of innovations vary in the extent to which their results or operation are easily seen i.e. visible. A housewife can see a vacuum cleaner and what it can do to her floor when operated. So also a Vitamin A fortified cassava farmer who see this innovation-decision.

Compatibility refers to the extent to which an innovation is consistent with the existing values, norms and past experiences of the adopter. An innovation is more rapidly adopted when it is compatible with existing cultural values and the past experiences of the adopter. Most innovations introduced to Nigerian farmers have had this acceptance–rejection experience because of incompatible experiences. When farmer remembers that when last he recorded better harvest as a result of adopting an innovation, he did not have a ready market for the product he become reluctant to adopt other innovations promising increased yield. In some instances the ministry of agriculture has to arrange to buy off the surplus produce to encourage adoption (Udensi *et al.,* 2012).

2.8 Conceptual Framework

A conceptual framework is a construction that shows relations existing among variables. The framework has been used in research primarily as tools for organizing knowledge gained in experimentation (Kehinde, 2019). Conceptual Frame work is a visual or written product, one that explains, either graphically or in narrative form, the main thing to be studied, which includes the key factors, concepts, or variables and the presumed relationships among them (Mittal and Mehar, 2016). Conceptual framework is primarily a conception or model of what is out there that you plan to study and what is going on. It is unarguably the system of concepts, assumptions expectations, beliefs, and theories that supports and informs your research. The framework must demonstrate an understanding of theories and concept that are relevant to the research topic and as well relates to the broader areas of knowledge being considered.

According to Swanson (2016), development of framework strengthens the study in conceptualizing of assumptions, development of hypotheses, choice of research methods, and description of phenomenon and identification of limits to generalization. The conceptual model for this research is captured in Figure 2.1. The model revealed the influence of intervening variables such as economic status, complexity of technology, bureaucratic bottle-neck, government policies affects the dependent and independent variables. More so, the independent variables such as socio-economic characteristics, diffusion of improved technology adoption of Bio-fortified Vitamin A cassava by the rural farmers and constraints influences the food security status of rural farmers which is the dependent variables. Technology have been shown to affect the food security status and poverty status of rural farmers, especially the women. This was affirmed by the study of Glopan (2015) which established that women and children constituted 80% poverty population and called for a closer examination of their experience.



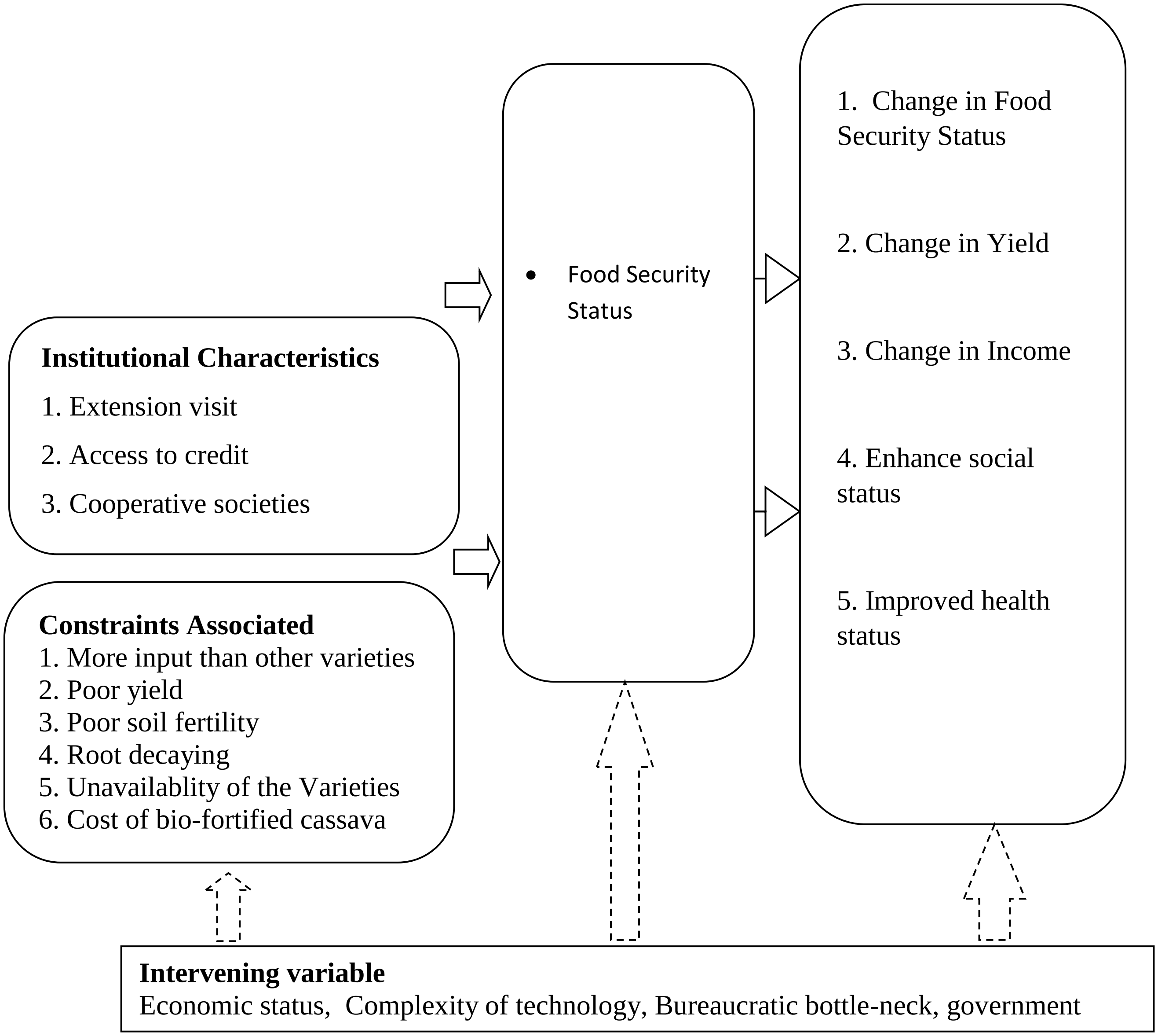


Figure 2.1: Conceptual model on effects of technology adoption on Vitamin A Fortified Cassava by Rural Farmers

Source: Researcher's Constructs, 2021

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study Area

The study was conducted in Benue State, Nigeria. Benue State with Makurdi as the State capital was created on 3rd February, 1976 from the old Benue-plateau state and has twenty three (23) local government areas. The state lies within the lower river Benue in the middle belt region of Nigeria with geographic coordinates of longitude $70^0.47^1$ and $10^0.0^1$East and Latitude $6^0.25^1$

and $8^{0}.8^{1}$ North; and shares boundaries with six other states namely; Nasarawa to the North, Taraba to East, Cross-River to the South, Enugu, Ebonyi to the South West and Kogi to the West. Benue state shares a common boundary with the Republic of Cameroun on the South-Eastern part of the country. (Ministry of Information and Culture , 2014).

The State has a land mass of 30,955 square kilometers and estimated population of 4,219,244 with 413,159 farm families (National population Commission (NPC), 2006). It has a projection of 7.8 million people by the year 2020 using annual population growth rate. Nigerian Info-pedia (NIP) 2015-2020. Benue State has three Agricultural zones which are Zone A, Zone B, with seven (7) local Government Areas (L.G.A) each and Zone C with Nine (9) LGA. Eighty five (85%) percent of the population in the state are Farmers, the inhabitants of the Riverian areas engage in Fishing as their primary or secondary occupations. Benue State experience two distinct seasons, wet and dry seasons. The rainy season last from April to October with annual rainfall between 1500mm – 1800mm and the dry season begins in November and ends March.

The State is acclaimed the nation's "Food Basket" because of its rich and diverse agriculture produce, these included yam, Vitamin A fortified cassava, Soya beans, Sorghum, Fruits and Vegetables. The state also boasts of the long stretches of river system in the country with great potential for a viable fishing industry, only season farming through irrigation and for an inland water way through irrigation (MIC, 2014) and this was supported by (Benue Agriculture and Rural Development Authority (BNARDA), 2019).

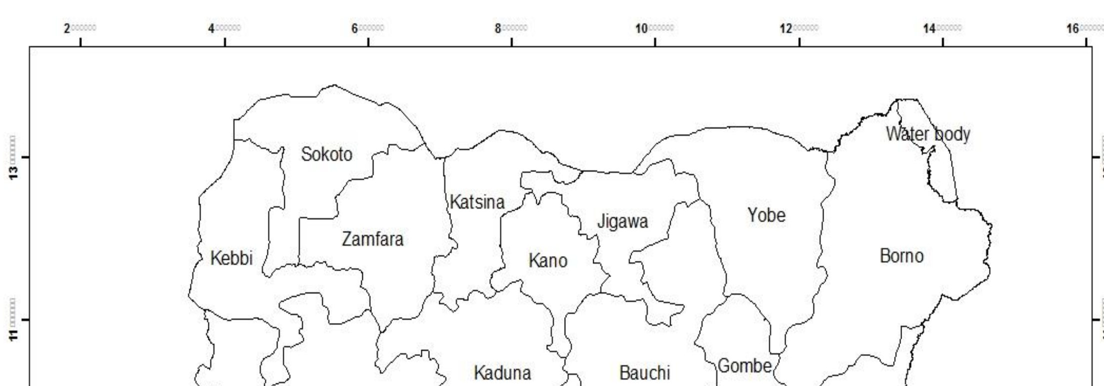


Figure 3.1: Map of Nigeria showing Benue State

Source: Benue Agriculture and Rural Development Authority (BNARDA), 2019

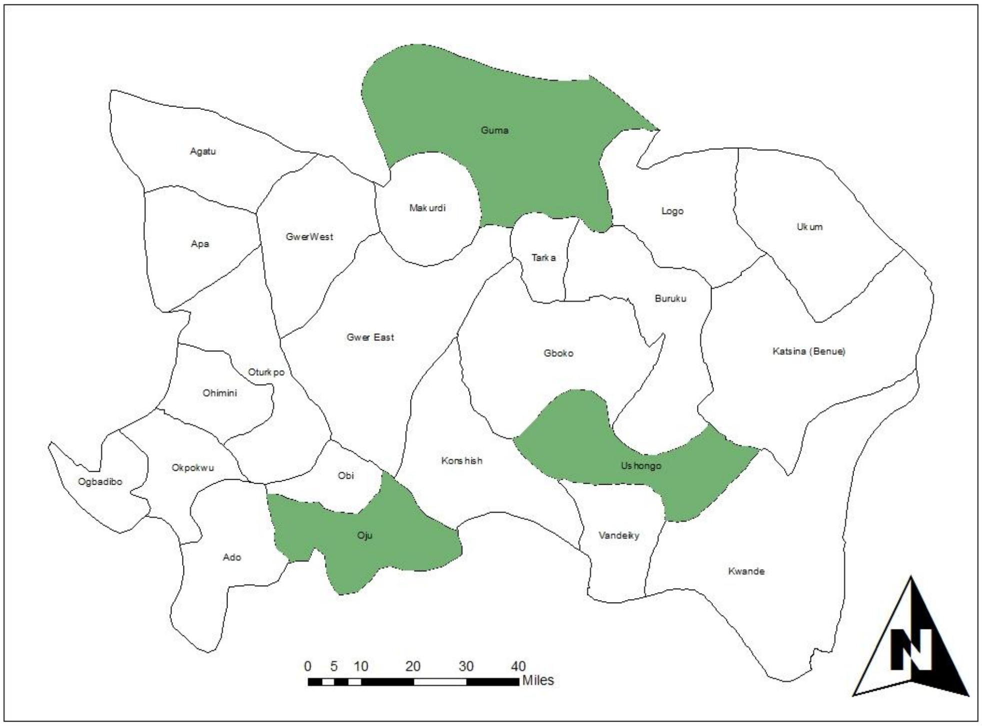


Figure 3.2: Map of Benue State Showing Selected LGAs

Source: Benue Agriculture and Rural Development Authority (BNARDA), 2019

3.2. Sampling Procedures and Sample Size

The population of the study was cassava farmers into Vitamin A fortified cassava production. A multi-stage sampling technique was used in selecting respondents for the study. The first stage involved purposive selection of one Local Government Areas (LGAs) from each of the three Agricultural Zones namely; Ushongo LGA with headquarters at Lease in Zone A, Guma LGA with headquarter at Gbajimba in Zone B and Oju LGA with headquarter at Oju in Zone C. The second stage involved random selection of three LGAs one out of seven in Zone A, one out of the seven in Zone B and one out of Nine in Zone C of the twenty three Local Government Areas of the state which make up of the extension block. The third stage involved simple random sampling of three communities out of Ten communities in Zone A, three communities out of Eleven communities in Zone B, and three communities out of Nine communities in Zone C based on presence registered household heads in the area as extension cell from each of the extension block. The fourth stage involved a proportionate selection of three villages from each extension cell based on the sample frame (2,400) of adopters and Non-adopters respectively. The fifth and final stage involved proportionate sampling of the respondents based on from the sample frame obtained using Yamane formula to get a total of 118 respondents as the adopters. Equal number of sampling was carried out to get a total of 118 respondents as the non-adopters.

Taro Yamane formula:

$$n = \frac{N}{1+N(e)^2}$$

where;

n= sample size

N= finite population

e= level of significance at (0.08)

1= unit

Table 3.1a: Sample Outlay for the Vitamin A Cassava adopters Study

LGA/ Zones	Extension Block (EB)	Extension Cell (EC)	Selected Villages	Sample Frame	Sample Size
Zone A	Ushongo	Mbaakoso	Wanze	300	15
(Eastern)		Lesses	Gbate	200	10
		Ushongo	Atekombo	200	10
Zone B	Guma	Gbajimba	Yogbo	270	13
(Northern)		Daudu	Daudu, Nyieu	300	15
		Yelewata	Tse-Tyonembe	230	11
Zone C	Oju	Uwokwu	Ibilla alache	300	15
(Central)		Owo	Ikwokwu	200	10
		Oju	Oju-Ipinu	400	19
Total				2400	118

Source: Benue Agriculture and Rural Development Authority (BNARDA), 2019

Table 3.1b: Sample Outlay for the Vitamin A Cassava non-adopters Study

LGA/ Zones	Extension Block	Extension Cell	Selected Villages	Sample Frame	Sample Size
Zone A	Ushongo	Mbaakoso	Kpor	300	15
(Eastern)		Lessses	Gbatse	200	10
		Ushongo	Msaswa	200	10
Zone B	Guma	Gbajimba	Uika	270	13
(Northern)		Daudu	Uikpan	300	15
		Yelewata	Yari-wata	230	11
Zone C	Oju	Uwokwu	Obussa	300	15
(Central)		Owo	Ukpa ochodu	200	10
		Oju	Iyeche	400	19
Total				2400	118

Source: Benue Agriculture and Rural Development Authority (BNARDA), 2019

3.3 Method of Data Collection

Data for this study was mainly from primary source. A well-structured questionnaire were designed to illicit information from the farmers. Well trained enumerators under the supervision of researcher were used to administer questionnaire.

3.4 Validity and reliability of Data Collection Instrument

3.4.1 Validity test

Validity of research instrument is the extent to which what should be measured is actually being measured by a given scale or index. It was carried out to ensure accuracy and effectiveness of the instrument for data collection. Face validity was employed in which the data collection instrument was given to the team of supervisors and experts knowledgeable in the subject area for their input before going to the field to administer the questionnaire.

3.4.2 Reliability test

Furthermore, Reliability is the ability of an instrument to consistently give the same result provided no real change has occurred in the characteristics. This study used test-retest method of reliability test which involved random selection of thirty five respondents from the study area. After a period of time (four weeks), the exercise was repeated on the same respondents. The two set of scores were correlated using Pearson's Product Moment Correlation (PPMC) analysis to estimate internal consistency or the instrument vis-à-vis objectives of the study. A reliability co-efficient value of 0.75 (i.e. r greater than_or equal to 0.75) was obtained for this study which signify the instrument is reliable.

3.5 Measurement of Variables

Measurement of dependent and independent variables were carried out as presented below.

3.5.1 Dependent variable

The dependent variables for this study was food security status of the cassava farmers into Vitamin A fortified cassava farming in the study area. To determine the food security status, information on quantifiable factors such as household expenditure and income in Naira were elicited to calculate the indices as follows:

Per capita expenditure = $\frac{Total\ expenditure}{household\ size}$

Mean per capita household expenditure (MPCHE) $= \frac{Total\ household\ PCE}{Total\ number\ of\ Households}$

The categorization of respondents were based on the food security line given as:

Extreme food insecure was calculated as less than 1/3 of MPCHE

Moderately food secure was calculated as less than 2/3 of MPCHE

Food secure was calculated as greater than 2/3 of MPCHE.

3.5.2 Independent variables

The following independent variables were measured as follows:

(A) Socio-economic characteristics of the rural farmers

Age (AG): Age of respondents was measured in years.

Marital status (MS): Respondent was asked to indicate whether married (1), single (2), divorced (3) or widowed (4).

Gender (GD): Gender is the categorization into male or female which was measured as a dummy variable one (1) is assigned to male while, zero (0) to females.

Labour (LB): Labour which could be family or hired labour (adult males, children or females) were measured in man-days.(Eight Hours per day)

Education (ED): This is respondent's acquisition of formal education which was measured as the number of years spent in formal schooling.

Experience (EXP): Number of years spent in farming generally, this was measured in years.

Household size (HSS): People living together under the same roof and eating from the same pot. This was measured in number of people per household.

Farm size (FS): This is the total land area put into cultivation of vitamin A fortified cassava by the respondents which was measured in hectares.

Credit access (CA): The respondents were asked to indicate their access to financial assistance inform of loan or kind. This was measured as a dummy variable (1 if access, 0 if otherwise).

Income (IC): This was the total amount of money realized from farming of vitamin A fortified cassava in the last cropping season measured in naira (₦)

Cooperative membership (CM): Cooperatives are organized social groups. Therefore, respondents' membership in cooperative was measured in number of years as cooperative member.

Extension visit (EV): This was measured based on the actual number of times that the rural farmers have contact with extension agents (EAs) per year.

Agro-chemicals (AC): this was measured in litres.

Cassava Cuttings/Seeds (SD): this was measured in kilogram/hectare.

Fertilizer (FZ): this was measured in kilogram/hectare.

(B) Adoption level of Vitamin A fortified cassava technologies

In order to ascertain level of adoption of Vitamin A fortified cassava, the responses of respondents were collected based on eight (8) recommended packages practices such as site selection, land preparation, planting date (June/July), spacing (50cmx50cm), planting material, herbicide application, fertilizer application and harvesting time. The total score for a respondent was obtained by summing up the score on each packages. The minimum was zero (0%) and maximum score was 100%. Based on the score obtained using the Adoption Index (AI), adopters of Vitamin A fortified cassava was classified under three categories of either low adopters, partial and high adopters

(C) Effect of Vitamin A fortified cassava on food security status

The effect of Vitamin A fortified cassava was based on the indicators that could likely have effect on the food security status of the respondents. These variables were incorporated into the model for analysis. However, the food security status was measured as One if food secure, Zero if otherwise.

(D) Factors affecting the adoption of Vitamin A fortified cassava

Perceived factors faced by the cassava farmers into Vitamin A fortified cassava production was measured using 3-point Likert rating type scale of Very Severe (VS) =3, Severe (S) =2 and Not Severe (NS) =1. These were added together (3+2+1=6) and divide by 3 to get a mean score of 2.0 which serve as the bench mark for decision making. Mean score value that is less than 2.0 was regarded as not severe constraints, while mean score that is equal to 2.0 and above was regarded as severe constraints by the respondents.

3.6 Method of Data Analysis

Objective i which describe the socio-economic characteristics of the respondents in the study area was achieved using descriptive statistics such as frequency distribution, percentages, mean and mode.

Objective ii which examine the adoption level of vitamin A fortified cassava technologies in the study area was achieved using adoption index.

Objective iii which determine the factors affecting adoption of vitamin A fortified cassava technologies in the study area was achieved using Foster-Greer-Torbecke (F.G.T) model.

Objective iv which examine the food security status of farmers in the study area was achieved using probit regression model

Objective v which determine the effect of vitamin A fortified cassava technologies adoption on food security status of the respondents in the study area was achieved using ordered probit regression model and production variables

Objective vi which examine the constraints associated with the adoption of vitamin A fortified cassava technologies in the study area was achieved using descriptive statistics such as frequency, percentages, means and mode.

3.7 Model Specification

3.7.1 Adoption index

The adoption level of the respondents was measured by making use of adoption index as cited by Zanu *et al.* (2012). The model is specified as:

$$AI = \frac{TAF}{MSO} \text{ X } 100 \qquad (1)$$

Where;

AI = Adoption Index

TAF = Total adoption score obtained by an individual farmer

MSO = Maximum score one can obtain

Depending on the level of adoption of Vitamin A fortified cassava packages, the respondents were categorized as follows: (1) Low adopters (up to 33%), (2) Moderate adopters (34-66%) and (3) High adopters (67-100%)

3.7.2 Foster-Greer-Thorbecke (FGT)

Food security indices was used to evaluate the food security status of the cassava farmers. It has become customary to use the Pα measures in analyzing the indices. The measures relates to different dimensions of the incidence of food insecurity P_0, P_1 and P_2 was used for head count (incidence), depth and severity of food insecurity respectively. The three measures was based on a single formula but each index puts different weights on the degree to which a household or individual falls below the food security line. The mathematical formulation of Food security measurements as derived from Foster, Greer and Thorbecke (1984) is estimated as:

$$P_{ai} = \frac{1}{n}\sum_{i-1}^{q}\left[{(z-y)}/{z}\right]^{a} \qquad (2)$$

Where;

a = 0, $P_o = \frac{1}{n}\sum_{i-1}^{q}\left[{(z-y)}/{z}\right]^{0} = \frac{q}{n}$ → Food Security incidence or head count (3)

a = 1, $P_1 = \frac{1}{n}\sum_{i-1}^{q}\left[{(z-y)}/{z}\right]^{1} \rightarrow \textit{food security depth}$ (4)

a = 2, $P_2 = \frac{1}{n}\sum_{i-1}^{q}\left[{(z-y)}/{z}\right]^{2}$ → food security severity (5)

Where;

a = degree of food security

n = number of households in a group

q = the number of households

y = the per capita expenditure (PCE) of the i^{th} household.

z = Food secured line

The 2/3 mean per capital expenditure is referred to as the moderate food secured line, while its 1/3 is referred to as the core food secured line. This study was however, limited to the moderate secured line, because it closely approximates the $1/day international food security line (NBS, 2007).

α = degree of food secured aversion

Per capita expenditure = $\frac{Total\ expenditure}{household\ size}$ (6)

Mean per capita household expenditure (MPCHE) $= \frac{Total\ household\ PCE}{Total\ number\ of\ Households}$ (7)

The categorization of respondents based on the food security line is given as:

Extreme food insecurity: those spending < 1/3 of MPCHE

Moderately poor and food secure: those spending < 2/3 of MPCHE

Food secure: those spending > 2/3 of MPCHE

3.7.3 Probit Regression Model

Probit model was used to determine the effect of Vitamin A fortified cassava technology adoption on food security status of rural farmers. The explicit form of the probit regression model as used by (Afees, 2017) can be expressed mathematically as:

$Y = ß_0 + ß_1X_1 + ß_2X_2 + ß_3X_3 + \ldots\ldots\ldots + ßnXn + U$………………………….(8)

Where;

Y = Food security status of Vitamin A fortified cassava farmers (measured as dicotonomous variable where Food Secure = 1, otherwise = 0)

AG = Age (years)

GD = Gender (male = 1, otherwise = 0)

HSS = Household size (number)

FS = Farm size (ha)

ED = Education (years)

FXP = Farming Experience (years)

EXV = Extension Visit (number)

INC = Income (₦)

ADL = Adoption level (Adoption score)

SOI = Sources of Information (number)

3.7.4 Kendell's Coefficient of Concordance

Kendell's coefficient of concordance was used to determine the Factors affecting the adoption of Vitamin A fortified cassava and is mathematically expressed as;

$$w = \frac{12\sum R^{-2} - 3N(N-1)^2}{N(-1)} \qquad (10)$$

Where

W = Kendell's Value

N = Total Sample size

R = Mean of the Rank

i = ith term

The Kendell's coefficient of concordance (W) is a measure of the extent of agreement or disagreement among farmers of the ranking obtained. The value of W is positive and ranges from zero to one where one denotes perfect agreement among farmers of the rankings and zero denotes maximum disagreement.

3.7.5 Person-Product Moment Correlation

Hypothesis i of the study was tested using correlation analysis. The formular is given below. The person correlation coefficient, often referred to as the person "r" test, is a statistical formula that measures the strength between variables and relationships

$$r_{xy} = \frac{N\sum xy - (\sum x)\,(\sum y)}{\sqrt{[N\sum x^2 - (\sum x)^2][N\sum y^2 - (\sum y)^2]}} \qquad (11)$$

Where;

r = Correlation coefficient

N = Total number of observation

y = level of Vitamin A fortified cassava adopters (farmers)

x = independent variables

$\sum$ = summation

3.7.6 z-test Statistics

Hypothesis II of the study was tested using t-test analysis. The formula is given below.

The Z-test statistics model for farmers' crop output is specified as;

$$Z = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{\sigma_1^{-2}}{n_1} + \frac{\sigma_2^{-2}}{n_2}}} \qquad (12)$$

$\overline{X_1}$ = th Variable mean of adopters of Vitamin A fortified cassava technology

$\overline{X_2}$ = th Variable means of non-adopters of Vitamin A fortified cassava technology

σ_1^2 = th Variable Variance of adopters of Vitamin A fortified cassava technology

σ_2^2 = th Variable Variance of non-adopters of Vitamin A fortified cassava technology

n_1 = th Number of observations of adopters of Vitamin A fortified cassava technology

n_2 = th Number of observations of non-adopters of Vitamin A fortified cassava technology

Th = Farmer's crop Output.

The Z-test statistics model for Farmer's Income is specified as;

$$Z = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{\sigma_1^{-2}}{n_1} + \frac{\sigma_2^{-2}}{n_2}}} \qquad (13)$$

Where;

$\overline{X_1}$= th Variable mean of adopters of Vitamin A fortified cassava technology

$\overline{X_2}$= th Variable mean of non-adopters of Vitamin A fortified cassava technology

σ_1^2= th Variable Variance of adopters of Vitamin A fortified cassava technology

σ_2^2= th Variable Variance of non-adopters of Vitamin A fortified cassava technology

n_1 = th Number of observations of adopters of Vitamin A fortified cassava technology

n_1 = th Number of observations of non-adopters of Vitamin A fortified cassava technology

Th = Farmer's Income

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents the findings based on objectives of the study. The chapter is divided into different sections which included socio-economic characteristics, adoption level of vitamin A fortified cassava technology, factors affecting adoption of vitamin A cassava technology and effect of adoption of vitamin A cassava technology on food security status and constraints associated with the adoption of vitamin A fortified cassava technology in the study area.

4.1 Socio-Economic Characteristics of the Respondents

The Socio-economic characteristic of the respondents discussed in this study includes age, marital status, gender, household size, educational status, farming experience, farm size, labour usage, cooperative membership, extension services, credit access and sources of credit. The results of these variables are presented in Tables 4.1 below:

4.1.1 Sex of the respondents

The sex of the respondents as showed in Table 4.1 revealed that majority (62.0%) of the respondents were male, while only 38.0% of them were female. This implies that male respondents were more involved in farming activities than female respondents which could be due to the tedious nature of agriculture. Thus, males are the dominant gender among the Vitamin A cassava production or farming households and the major decision makers in the rural household settings. This finding and results agrees with the finding of Ofune (2010) who reported that males dominate the work force in Nigeria's agricultural communities.

Table 4.1: Distribution of respondents based on socio – economic characteristics (n=236)

Variable	Adopters			Non - adopters			Pooled		
	Freq.	**%**	**Mean**	**Freq.**	**%**	**Mean**	**Freq.**	**%**	**Mean**
Sex									
Male	71	60.2		75	63.6		146	61.9	
Female	47	39.8		43	36.4		90	38.1	
Age (years)			43			48			45
< 21	01	0.8		1	.8		2	0.8	
21 – 30	07	5.9		7	5.9		14	5.9	
31 – 40	48	40.7		33	28.0		81	34.3	
41- 50	42	35.6		30	25.4		72	30.5	
>50	20	16.9		47	39.8		67	28.4	
Marital status									
Married	100	84.7		88	74.6		188	79.7	
Single	8	6.8		1 0	8.5		18	7.6	
Divorced	3	2.5		9	7.6		12	5.1	
Widowed	7	5.9		11	9.3		18	7.6	
Farming experience (years)			20			23			22
<11	25	21.2		27	22.9		52	22.0	
11 – 20	58	49.2		29	24.6		87	36.9	
21 – 30	24	20.3		34	28.8		58	24.6	
31 – 40	10	8.5		22	18.6		32	13.6	
>41	1	.8		6	5.1		7	3.0	

Source: Field Survey, 2021

4.1.2 Age of the respondents

The result of the pooled data based on their age is presented in Table 4.1. Age is the length of time an individual exits in the world. As shown in the Table, majority (64.8%) of the respondents were within the age bracket of 31 – 50 years with mean age of 43 years. This implies that majority of the two categories of rural farmers in study were in their productive stage of life where they could adequately make a decision regarding adoption of vitamin A fortified cassava technology production and improve food security status of their area and the country at large (Umar, 2015). Age is very important in agricultural production and adoption of new technologies. It has also been argued that age in correlation with farming experience has a significance influence on the decision making process of farmers with respect to risk aversion, adoption of improved agricultural technologies and other production-related decisions (Ume *et al*., 2017). Age has also been reported by Udensi *et al*. (2012) on changes in household food security status in Benue State to determine how active and productive farmers would be. More so, Uwandu *et al*. (2019) in their study reported that majority (75%) of farmers in Delta State were within the youth and middle with the likelihood of high productivity in their farms.

4.1.3 Marital status of the respondents

The distribution of respondents based on their marital status is presented in Table 4.1. The finding of the pooled data revealed that the majority (80.9%) of the adopters and non-adopters were married, while few (19.1%) were singe. This implies that majority rural farmers were married with the main purpose of pro-creation of younger ones that could assist in future farming activities. This finding is in agreement with Odoemekun and Anyim (2019) who reported in his study that majority of the respondents were married purposely for pro-creation of young ones that will assist in the future farming activities.

4.1.4 Farming Experience of the respondents

In the case of farming experience of the farmers in the study area, the result of the pooled data in Table 4.2 revealed that more than half 61.9% of the respondents had farming experience between 11 – 30 years, while 16.5% of the respondents had farming experience of more than 30 years and 21.6% of the respondents had farming experience of less than 11 years with mean farming experience of 22 years. This implies that most of the vitamin A fortified cassava farmers had been into farming for long period of time which could help them to have favourable perception about vitamin A fortified cassava technology adoption on food security of rural farmers. Vitamin A fortified cassava farmers with vast experience in farming tend to be rational in making decisions as regards their farming operations. This finding is in agreement with

Olaosebikan *et al*. (2019) who posited that, majority of the respondents in their study area had long years of farming experience which enabled them to make sound decisions as regards resource allocation and management of their farms.

4.1.5 Educational status of the respondents

The distribution of respondents according to their educational status is presented in Table 4.2. showed that 27.1% of the respondents had no education, 25.0% and 28.0% of the respondents acquired primary and secondary education, respectively. While only few 19.9% acquired tertiary education with a mean of 16 years spent in formal schooling. However, majority 69.5% of the respondents had formal education while, few 30.5% of the respondents had non – formal education. This implies that majority of the vitamin A fortified cassava producers had formal education, thus representing the generally high literacy level as many who attended primary, secondary and tertiary schools were literate (i.e they could read and write). This finding agrees with the position of Birol *et al*. (2015) who says that education is an important factor which can influence farmer's access to new innovations and practices including Vitamin A fortified cassava technology adoption.

4.1.6 Household size of the respondents

Table 4.2 revealed that about half (47.9%) of the respondents had household size between 6 – 10 people, while 29.2% of the respondents had household size of less than 6 people and 3.0% of the respondents had household size of more than 20 people with mean household size of 9 people. This implies that the Vitamin A fortified cassava farmers had relatively family household size in the study area which is an advantage in terms of farm labour supply. Large family size is important in general agricultural production especially within the rural setting as it could support farming operation through supply of labour thereby reducing cost of hired labour.

Table 4.2: Distribution of respondents based on socio – economic characteristics (n=236)

Variables	Adopters		Mean	Non-adopters		Mean	Pooled		Mean
Forms of education									
Formal	98	83.1		76	64.4		170	72.0	
Non –Formal	20	16.9	9	42	35.6	7	66	28.0	8
Educational Status									
None	20	16.9		42	35.6		62	26.3	
Primary	31	26.3		28	23.7		59	25.0	
Secondary	38	32.2		29	24.6		67	28.4	
Tertiary	29	24.6		19	16.1		48	20.3	
Household size (Number)									
< 6	37	31.4		34	28.8		71	30.1	
6-10	55	46.6		58	49.2		113	47.9	
11-15	15	12.7		17	14.4		32	13.6	
16-20	6	5.1		7	5.9		13	5.5	
> 20	5	4.2	9	2	1.7	9	7	3.0	9
Farm Size (hectare)									
<1.1	92	78.0		102	86.4		194	82.2	
1.1-2.0	19	16.1		9	7.6		28	11.9	
2.1-3.0	5	4.2		3	2.5		8	3.4	
3.1-4.0	2	1.7	1	4	3.4	1	6	2.5	1
Access to credit									
No Access	74	62.7		95	80.5		169	71.6	
Had Access	44	37.3		23	19.5		67	28.4	
		130233			**182826**			**148561**	
Co-operative membership									
Member	47	39.8		64	54.2		111	47.0	
Non-member	71	60.2	7	54	45.8	3	125	53.0	5
Extension contact									
No contact	26	22.0		54	45.8		80	33.9	
Had contact	92	78.0	9	64	54.2	3	156	66.1	5
Income (#)									
<200,001	47	39.8		79	66.9		126	53.4	
200,001-400,000	27	22.9		13	11.0		40	16.9	
400,000-600,000	21	17.8		16	13.6		37	15.7	
600,000-800,000	19	16.1		7	5.9		26	11.0	
>800,000	4	3.4		3	2.5		7	3.0	
S		**384915**			**301483**			**343199**	

Source: Field Survey, 2021

4.1.7 Farm size of the respondents

As revealed in Table 4.2 The results revealed that most (82.2%) of the respondents had farm size of less than 1.1 hectares, while 2.5% of the respondents had farm size between 3.1 – 4.0 hectares and 1.6% of the respondents had farm size of 5 hectares with mean farm size of 1 hectares. This implies that most of vitamin A fortified cassava farmers are small-scale farmers who ordinarily wants to expand their farming operation if farmland is accessible. Inaccessibility to farmland by the vitamin A fortified cassava farmers which is an important factor for agricultural production could greatly influence their perception about vitamin A fortified cassava technology adoption on food security of rural farmers.

4.1.8 Access to credit by the respondents

As revealed in Table 4.2, most (71.6%) of the respondents had no access to credit, while only few 28.4% of the respondents had access to credit. This implies that some of the vitamin A fortified cassava farmers had no access to credit in the study area which could negatively influence their perception about effects of vitamin A fortified cassava technology adoption on food security of rural farmers in Benue state, Nigeria. Access to agricultural credit has the propensity to break the vicious cycle of food insecurity and raise the production capacity of farming households. Credit is an important variable needed to acquire or develop farm enterprise. Access to credit will go a long way in improving individual farm enterprise in terms of agricultural production.

4.1.9 Cooperative membership by the respondents

As revealed in the pooled results in Table 4.2, more than half (53.0%) of the respondents in the study area were member of cooperative societies, while 47.0% of the respondents were not member of cooperative societies. This implies that most of the vitamin A fortified cassava technology farmers were into cooperative due to benefits they could get from it, particularly, information sharing with respect to effect of vitamin A fortified cassava technology adoption on food security of rural farmers. This finding is in agreement with the work of Ojeleye (2018) who reported that majority of the respondents in their study area were members of cooperative societies because Cooperative allows group of people with common interest comes together to meet certain needs that could not be achieve through individual efforts. It helps in identifying economic opportunities for the poor, empowering the disadvantaged to defend their interests and providing security to the needy. Cooperatives, therefore, represent one of the few options that farmers have for surviving and plays vital role in influencing adoption by members.

4.1.10 Extension contact by the respondents

Extension contact revealed by the respondents in Table 4.1.The pooled result showed that majority (66.1%) of the respondents had contact with extension agents with a mean contact of once annually, while 33.9% of the respondents had no contact with extension agents. This implies that some of the vitamin A fortified cassava farmers has contact with extension agents which could influence their perception about the effects of vitamin A fortified cassava technology adoption on food security of rural farmers in Benue state. The result agrees with the finding of Ayinde (2016) who posited that one of the objectives of extension programme is to make the farmers have a positive attitude towards the vitamin A fortified cassava enterprise.

4.1.11 Income of the respondents

The distribution of respondents according to their income is presented in Table 4.2 The pooled result revealed that (53.4%) of the respondents received less than 200,001.00 as income per farming season, while (16.9%) of the respondents earned income of 200,001–400,000. Furthermore, 15.7% of the respondents earned from 400,000–600,000, while 11.0% of respondents got 600,000–800,000. Finally, 3.0% of the respondents earned income of greater than 800,000.00 only with the mean income of three hundred and fourty three thousand one hundred and ninety nine naira (343199). Income is very important to every farmer to sustain food security by the rural farmers in the study area and general agricultural development for the economic prosperity.

4.1.12 Credit sources of the rural farming households

Table 4.3 comprises of the various credit sources of the respondents; co-operative has the highest percentage of (52.3%) as a source of credit for the adopters and the non-adopters respectively because most respondents engage in co-operatives to enable them help themselves in their farming activities. Family and Friends with 27.3% for the adopters and 13.0% for the non-adopters respectively, others (commercial Bank, Bank of agriculture, government programmes) 11.3%, 6.8%% and 2.1% for the adopters and 17.4%, 13.0% and 4.3% for the non-adopters respectively. Indicating that high interest rate charged, demanding for collateral by commercial banks and government policies could be responsible for lower patronage by the rural farmers in the study area. This finding of respondents based on sources of credit is in line with the findings of Okupukpara (2006) who found larger shares of credit sources 68% and 53% coming from the co-operatives and families and friends of the agricultural farm households in Anambra state, Nigeria.

Table 4.3: Distribution of respondents based on sources of credit

	Adopter (n = 44)	Non-adopter (n=23)	Pooled (n = 67)

Variables	Freq.	%	Freq.	%	Freq.	%
Bank of agriculture	3	6.8	3	13.0	6	9.0
Commercial Bank	5	11.3	4	17.4	9	13.5
Co-operative	23	52.3	12	52.3	35	52.2
Family and Friends	12	27.3	3	13.0	15	22.3
Government programmes	1	2.3	1	4.3	2	3.0

Source: Field Survey, 2021

4.2 Adoption Level of Vitamin A Fortified Cassava by Respondents

The results of the Adoption level of vitamin A fortified cassava technologies adoption on food security status of the respondents is presented in Table 4.4. The result on Soil selection revealed that loamy soil with 64.4% were mostly adopted by the respondents while, Light soil 39.8% were mostly adopted by the respondents. This result is in line with a socio – economic surveys of vitamin A Fortified cassava technology adoption in Benue state, Nigeria by Alene *et al* (2012), Mittal and Mehar (2016) and Ayinde (2013) confirmed that, adoption level depend on many factors such as; good soil selection, land preparation, planting date, good spacing, seed rate, herbicide and fertilizers application.

Table 4.4 results on the land preparation indicated that plough Before 55.9% respondents not adopted, plough after 58.5% were equally not adopted indicating that most respondents have little or no knowledge and important of land preparation on plough before and plough after planting which might lead to low output. The study is in line with Gender–based constraints affecting bio-fortified cassava production, processing and marketing among men and women adopters in Oyo and Benue states Nigeria by Olaosebikan *et al.* (2019) who revealed that there is a wide gap between what research findings have showed to be possible and feasible on the one hand and what actually obtains on the other.

The Table 4.4 showed results on the Planting Date by the respondents revealed that June – July (86.4%) Adopted, while, September (24.6%) Adopted on vitamin A fortified cassava. The results is in line with a similar studies by Laria (2013) on food insecurity and chronic disease, advantage nutrition, New castle whose said that the most effective way to increase the production of bio-fortified vitamin A cassava trough the adoption and efficient utilization of improved technologies by rural farmers that could lead to increased productivity and income to the farmers.

Table 4.4: Distribution of respondents based on recommended vitamin A fortified cassava practices (N= (236)

Recommended practices	Frequency	Percentage
Soil selection		
i. Light Soil (clay soil)	47	39.8
ii. Heavy soil (loamy soil)	76	64.4
Land Preparation		
i. Plough Before planting	52	44.1
ii. Plough After planting	49	41.5
Planting Date		
i. June – July	102	86.4
ii. September	29	24.6
Spacing		
25cm by 25cm	25	21.2
25cm by 50cm	71	60.2
50cm by 50cm	42	35.6
Seeds/Stem Cuttings		
20 – 35kg/ha	26	22.0
35 – 50kg/ha	74	62.7
50kg/ha	15	12.7
60kg/ha	10	8.5
150kg/ha	09	7.6
Herbicide Application:		
Systemic	69	58.5
Contact	40	33.9
Fertilizer application		
Organic	72	61.0
Inorganic(N:P:K)	29	24.6
Harvesting period		
9 – 10 month after planting	75	63.6
11 – 12 months after planting	42	35.6

Source: Field Survey, 2021

In Table 4.4 revealed the results of land Spacing on the adoption level of vitamin A fortified cassava varieties technology is presented in Table 4. It showed that 25cm by 50cm (60.2%) Adopted by respondents is the highest while 50cm by 50cm (35.6%) adopted is second and a land spacing with 25cm by 25cm (21.2%) adopted is the least by the respondents in the study area. This findings is in line with Nweke *et al* (2004) who reported that high and quality tubers cassava production in Nigeria is as a results of good planting spacing Table 4.4 revealed the results of the Seed /stem cutting. The results indicated that seed rate 35–50kg has (62.7%) had the highest adopted frequency and percentage by the respondent, followed by 20–35% with (22.0%), seed rate of 50 bundle adopted (12.7%), seed rate of 60 bundle adopted (8.5%), and the least seed rate of 150 bundle adopted with (7.6%). The findings is in line Ayinde *et al.* (2017a) and (2017b) on determinants of adoption of vitamin A bio-fortified cassava variety among farmers in Oyo State, Nigeria who define Technology as an organized capacity for some purposive activity. These processes include production of improved planting materials, mechanization, infrastructural development and inputs. Improved technologies available for practice for cassava which include plough and ridging before planting, planting on flat after plough, use of improved planting varieties, supply or replacement of un-germinated seedlings, weeding at least twice a year, fertilizer application , use of herbicide to control weeds and application of insecticides.

The results on Table 4.4 revealed Herbicide application on adopters of vitamin A fortified cassava technology by respondents. The results showed that herbicide application by Systemic (58.5%) adopted while, Herbicide application by Contact (33.9%) adopted by the respondents in the study area. Similarly, on Fertilizer application on adopters of vitamin A fortified cassava technology by respondents the Table revealed that application of Organic fertilizer is better (61.0%) adopted, while Inorganic Fertilizer application is less (24.6%) adopted by the respondents in the study area. This findings is in line with the study of Ayinde and Adewumi (2016) on risk and adoption analysis of innovation in cassava production in Oyo State, Nigeria who define Technology as an organized capacity for some purposive activity for better yield.

The Table 4.4 revealed the results on harvesting period of vitamin A fortified cassava. Harvesting period of 9 – 10 months after planting for vitamin fortified cassava 63.6% adopted while Harvesting period of 11 – 12 months after planting for vitamin A fortified cassava 35.6%

is adopted by the respondents in the study area. Early maturity and harvesting of any crop is the desired of every farmer for greater benefits. The results agreed with the study of Operinde *et al* (2013) on a technical review of modern cassava Technology adoption in Nigeria who said that Farmers preferred improved varieties of cassava because of their higher yields, early maturity, high suppression to weeds, higher nutritional contents and greater resistance to diverse diseases and pest.

4.2.1 Respondents' level of adoption of vitamin A fortified cassava technologies

Table 4.5 present the analysis of the results of the respondents' adoption level. The findings revealed that 11.02%, 55.93%, 33.05% indicate high, partial and low, while, 3.34%, 39.83% and 56.78% were high, partial and low under Non- adopters the pooled results revealed that 7.20%, 47.88 44.92% were high, partial and low respectively. The implication of the findings is that on the average on the adoption 55.93%, non- adopters has 56.78% and the pooled also 47.88% low by vitamin A fortified cassava technology the study area. The implication of this finding is that on the average most of the farmers in the area were partial adopters of vitamin A fortified cassava technologies with 55.93% compared to non- adopters with 39.83%. similarly, on adopter table, 33.05% are low while 56.78% are non- adopters, on the high adopters level 11.02% and 3.34% for non-adopter of vitamin A fortified cassava .the findings of this study negates the study conducted by Saltman *et al.* (2016) in his study on bio-fortification Techniques to improve food security. The implication of the finding is that the technologies were exceptionally useful and appropriate to the respondents because farmers are always ready to adopt improved and proven agricultural technologies.

Table 4.5: Distribution of the respondents based on level of adoption

Level of Adoption	Adopters	
	Frequency	Percentage
High Adopters	13	11.02
Partial Adopters	66	55.93
Low adopters	39	33.05
Total	118	100

Source: Field Survey, 2021

4.3 Factors Affecting Adoption of Vitamin A Cassava by Respondents

Factors affecting adoption of vitamin A fortified cassava in the study area is presented in Table 4.6. The results revealed that coefficient of determination. R-square values of pooled, adopters and Non-adopters samples were 0.6072, 0.6774 and 0.5904 respectively, this implying that about 61%, 68% and 60% respectively, variations in the vitamin A fortified cassava output of the rural farmers' was explained by the independent variables included in the model, the remaining 39%, 32% and 40% respectively, unaccounted could be due to errors or other variables not captured in the model. The results revealed that out of (11) variables included in the model, six (6), five (5) and four (4) respectively, variables were statistically significant at 1%, 5% and 10% probability level, respectively. Five (5) variables such as Marital status, farm size, education, Income and extension services were common among the Tables i.e. the pooled, the Adopters and the Non- adopters and were found to be positive and statistically significant thus directly influencing the vitamin A fortified cassava output of the rural farmers, while, gender and Age were found to be negative and statistically significant, thus inversely influence the vitamin A fortified cassava output of the rural farmers in the study area.

Table 4.6: Ordinary Least Square (OLS) Regression estimate on factors affecting adoption vitamin A fortified cassava technologies by respondents

Variables	Pooled Coefficient (t-values)	Adopters Coefficient (t-values)	Non adopter Coefficient (t-values)
Age	0.0178	-0.2627	-0.1079
	(0.16)	(-1.72)*	(-0.60)
Farming Experience	0.0117	-0.1142	0.0689
	(0.11)	(-0.76)	(0.47)
Education	0.4158	0.3094	0.6362
	(3.11)***	(1.74)*	(2.86)***
Household size	0.0081	-0.1493	0.1422
	(0.05)	(-0.62)	(0.63)
Farm size	9.9153	5.7025	11.6908
	(13.07)***	(5.20)***	(9.69)***
Credit access	0.0000	0.0000	9.16e6
	(2.14)**	(0.86)	(0.65)
Cooperative member	-0.0326	0.0033	-0.1632
	(-0.57)	(0.06)	(-0.64)
Extension contact	0.2006	0.4804	0.3053
	(2.07)**	(3.73)***	(2.03)**
Income	0.0000	0.0000	1.40e6
	(3.51)***	(4.30)***	(0.28)
Training received	-3.9498	-4.7686	-2.4152
	(-1.89)*	(-2.18)**	(-1.05)
Distance to market	6.9931	7.1218	5.2765
	(3.55) ***	(2.76)***	(1.69)*
Constants	3.9658	-3.0765	10.1796
R – squared	(0.6072)	(0.6774)	(0.5904)
Adjusted R-square	(0.5879)	(0.6440)	(0.5479)
F-ratio	(31.47)***	(20.24)***	(13.89)***

Source Field Survey, 2021 Values in parenthesis are the t - values

Note: *** significant at 1%, ** significant at 5%, and * significant at 10%.

The coefficient of farm size (9.9153), (11.6908) and (7.1218) were positive and significant at 1% probability level; implying that a unit increase in farm size of the respondents will increase vitamin A fortified cassava technologies output of the respondents. Access to farm land encourages individual farmers to actually increase area of cultivation for an increase output for food security and income generation.

The coefficient of education (0.4158) and (0.3094) were positive and significant at the 1% and 10% respectively probability level; implying that a unit increase in the level of educational by the respondents will increase level of knowledge on vitamin A fortified cassava technologies by the respondents. Education is associated with adoption of improved technologies that could increase vitamin A fortified cassava production because it enhances farmers' ability to make right and appropriate decisions.

The coefficient of distance to market were (6.9931) and (7.1218) were positive and significant at 1% and 10% respectively probability level; suggesting that a unit increase in the marital status of the respondents will surely increase vitamin A cassava production by the respondents. Marital status has been attributed to contribute to the amount of family labour that will be available to a farmer during farming activities.

The coefficient of extension contact were (0.4804) and (0.3053) were positive and significant at 5% and 1% respectively probability level; indicating that a unit increase in the extension contact with the respondents will increase vitamin A fortified cassava technologies by the respondents. Agricultural extension service constitutes a driving force for every agricultural development and vitamin A fortified cassava farmer as extension agents are responsible for extension service delivery such as improved seeds, information about new innovations and monitoring and evaluations on technologies adoption for better results and greater benefits by rural farmers.

The coefficient of income of the farmers by respondents were (0.0000) and were positive and significant both at 1% probability level; showed that increase in the income of a farmer by the respondents will leads to increase vitamin A fortified cassava production. Income is very important to farmers because without good income farming activities cannot be carried out effectively. Those farmers with better income are likely to take risk, try new innovations and consequently adopt new vitamin A fortified cassava technology. Income is an important tools to food security and good standard of living to the rural farmers in the study areas.

Finally, the coefficient of credit access of the farmers by respondents (0.0000) and was positive and significant at 5% probability level; indicate that an increase in the credit access by farmers will leads to an increase in vitamin A fortified cassava technology. Access to credit by rural farmers will enable them to purchase farm inputs for cultivation, hired labour and increase general farm business.

The coefficient of training received of the farmers by the respondents (-3.9498) and (-4.7686) and were Negative and significant 5% probability level; implying that a decrease in number of training received will decrease vitamin A fortified cassava technologies adoption output by the respondents. The results showed that young adults who are strong and energetic need good training in technologies of vitamin A cassava farming Business. This is because farming work is studious and require use of mechanization, improved technologies for practice by well trained professionals for better yields and general output.

The coefficient of age of the farmers by respondents (-0.2627) was negative and significant at 10% probability level; this implying that an increase in the age will result to decrease in vitamin A fortified cassava technologies adoption of the respondents. Age is a very important functions for adoption and acceptance of new technologies for innovation. As people grow older in their ages, they would not willing to take risk. A young age individuals would be more desire to try new things including adoption of vitamin A fortified cassava technology on food security by the rural farmers in the study areas.

4.4 Food Security Status of the Respondents

Food security indices was used to evaluate the food security status of vitamin A fortified cassava farmers in the study area and the results is presented in Table 4.7. The Table revealed the results of the Food security status of the rural Farmers in the study area. Food security line of #40,647.95 for the pooled, #44,251.80 for the Adopters and #37,129.48 for the Non-adopters for household heads were computed at 2/3 means for capital household income to separate the Food Insecure households from Food secure households. More so, to separate Food Insecurity severity households from Food Insecure households of the adopters and non-adopters. Based on the Food security line for the respondents obtained, 69.0% of the adopters' household were found to be food secured and 31.0% are not food secured category, while 53.0% of the non-adopters were found to be food insecure and 47.0% are not food secured category. This implies that the adopters of vitamin A fortified cassava technology were food secure compared to the Non-adopters of the vitamin A fortified cassava technology in the study area which could be due to their adoption of the improved technologies such as vitamin A fortified cassava technology which yielded more output and income thereby improving food security status and alleviating their poverty.

More so, the food security incidence, gap and severity of the non-adopters were found to be 0.53, 0.42 and 0.22, respectively, While the food security incidence, gap and severity for the adopters were 0.31, 0.36 and 0.18, respectively. This implies that the adopters of vitamin A fortified cassava technology had lower incidence of food security (i.e. people living below the food security line). Food security gap and severity as compared to the non-adopters of vitamin A fortified cassava technology. The incidence of food security which is the head count of those who fell below the food security line were found to be more among the non- adopters of vitamin

A fortified cassava technology compared to the adopters of the vitamin A fortified cassava technology. The food security gap which represent the amount of Income required by the food secured farmers to come out of the food security line (i.e. being food secured) was found to be lower among the non-adopters of vitamin A fortified cassava technology compare to adopters of vitamin A fortified cassava technology.

The food insecurity severity index which represent the situation of extremely being food insecure was found to be lower among the adopters of vitamin A fortified cassava technology as compared to the non- adopters of vitamin A fortified cassava technology. The food security severity index take in to account not only the distance separating the food secure and food insecure line, but also, the inequality among the food security. The results is in line with the findings of Umar (2015) that non-adopters of improved technologies were more food insecure than adopters of improved technologies. The main reason of adoption of new technologies among vitamin A fortified cassava technology is as a result of food security incidence. The low incidence of food security among adopters of vitamin A fortified cassava technology could be due to number of factors among which include education, Extension services and Income aimed to assisting adopters of vitamin A fortified cassava technology to raise their standards of their living and reduce the overall food security in the study area.

4.5 Effect of Vitamin A Fortified Cassava Technology on Food Security by Respondents

Results of the Probit regression estimate of the effect of vitamin A fortified cassava technologies on food security status of the respondents is presented in Table 4.8. The pseudo R-square value of 0.5891 for the Adopters of vitamin A fortified cassava and 0.5588 for the non-adopters of vitamin A fortified cassava technology implies that about 59% and 56% variation respectively in the food security status of the respondents in the study area was explained by the explanatory variables specified in the model. The chi-square value of 95.64 for the adopters of vitamin A fortified cassava technology and 89.86 for non-adopters vitamin A fortified cassava technology were significant at 1% probability level indicating the model's overall goodness of fit.

Out of the twenty explanatory variables specified in the model, Thirteen variable Loamy Soil, plough before planting, planting date of June - July, Herbicide Application, Harvesting period of 11-12 months after planting, Spacing of 25cm by 25cm, 25cm by 50cm and good stem of (20-35kg) significantly influenced food security status of the adopters of vitamin A cassava technologies, while seven variables (spacing of 25cm by 50cn, seeds/Stem Cuttings of 35 by 50kg, Fertilizer Application by systematic, Planting date of June-July and plough before planting) significantly influenced on food security status of the non-adopters of vitamin A fortified cassava technologies.

Seed/stem cuttings and land preparation of the non-adopters vitamin A fortified cassava technologies were least positive and significant at 10% level implying an inverse relationship with food security status. An increase in seeds/stem cuttings and land preparation of the non-adopters of vitamin A fortified cassava will decrease the likelihood of them not being food secured. This could be due to the fact that good seed/stem rate and land preparation has capacity to increase better yield while, poor seeds/stem cuttings and poor land preparation will decreases yield and the general production output of vitamin A fortified cassava technologies. Good seeds/stem cuttings, good land preparation among other technologies for vitamin A fortified cassava production are important factors of production for better yield to every farmer that could help improved their food security status. This findings is in line with Umar (2015) who revealed that soil with good PH value and good spacing in farming practices are more likely to do better than those that do not practice new technologies or a new innovations.

Loamy Soil of the vitamin fortified cassava adopters was positive and significant at 5% level implying a direct relationship with food security status. An increase in the level of loamy soil of the adopters of vitamin A fortified cassava technology will increase the likelihood of their technologies adoption of vitamin A fortified cassava production thereby improving their food security status, as loamy soil is a tools for to agricultural development. The results is in line with the statement of Ajayi *et al.* (2017) who says agriculture play a key role in the development of developing Nations.

Table 4.7: Probit estimate on effects of vitamin A fortified cassava technologies adoption on respondents' food security status

Variables	Pooled Coefficient (z-values)	Standard error	Adopters Coefficient (z-values)	Standard error	Non adopter Coefficient (z-values)	Standard error
Light soil (clay)	-0.1337 (-0.45)	0.3000	-0.3023 (-.60)	0.5020	0.3814 (0.52)	0.7365
Soil with PH (loamy)	0.8171 (2.47)**	0.3304	1.6667 (2.78)***	0.5986	0.1904 (0.22)	0.8733
Plough before planting	0.8776 (3.43)***	0.2558	1.9699 (3.62)***	0.5439	0.5912 (1.96)*	0.4853
Plough after planting	0.5806 (1.77)*	0.3288	1.1331 (2.15)**	0.5281	1.1597 (1.19)	0.9740
Planting by June – July	1.6938 (4.16)***	0.4068	3.1823 (3.64)***	0.8747	2.0962 (2.31)**	0.9079
Planting by September	-.3704 (-0.93)	0.3993	1.3440 (1.79)*	0.7493	0.9722 (0.93)	1.0446
Spacing of 25cm by 25cm	0.8196 (2.01)**	0.4087	1.4066 (2.18)**	0.6453	-0.7609 (-0.73)	1.0478
Spacing of 25cm by 50cm	1.0772 (3.88)***	0.2774	1.1265 (2.31)**	0.4877	2.1216 (3.70)***	0.5738
Spacing of 50cm by 50cm	-.2392 (-0.63)	0.3824	-0.4975 (-0.97)	0.5139	-1.2797 (-0.84)	1.5243
Seed rate of 20-35kg/ha	0.2553 (0.65)	0.3948	-0.5800 (-0.96)	0.6031	0.8167 (0.75)	1.0821
Seed rate of 35-50kg/ha	1.1750 (4.08)***	0.2882	-0.1330 (-0.26)	0.5132	1.8386 (3.57)***	0.5145
Seed rate of 50kg/ha	0.0211 (0.04)	0.5504	1.1635 (1.71)*	0.6805	4.9683 (1.87)*	2.6585
Seed rate of 60kg/ha	0.2683 (0.39)	0.6832	-0.4062 (-0.43)	0.9459	2.9254 (1.39)	2.1077
Seed rate of 150kg/ha	-.1726 (-0.34)	0.5153	-0.3144 (-0.44)	0.7079	1.5624 (1.04)	1.4953
Systemic herbicide	-.2386 (-0.76)	0.3144	1.3071 (2.51)***	0.5198	1.3101 (1.39)	0.9458
Contact herbicide	0.8241 (3.13)***	0.2634	1.7923 (3.40)***	0.5369	0.5481 (1.10)	0.4962
Organic fertilizer	0.8927 (2.63)***	0.3390	0.1941 (0.43)	0.4540	3.6331 (2.87)***	1.2681
Inorganic fertilizer(NPK)	0.7384 (1.79)*	0.4115	0.4106 (0.71)	0.5811	-1.7790 (-1.37)	1.3002
Harvesting 9-10 months	0.3811 (1.22)	0.3130	0.9128 (1.90)*	0.4809	0.8464 (1.02)	0.8300
Harvesting 11-12 months	0.9328 (3.13)***	0.2958	1.9270 (3.89)***	0.4956	0.6335 (0.83)	0.7630
Constant	1.4283 (6.45)***	0.2211	1.5983 (2.07)**	0.7707	1.7406 (5.57)***	0.3123

Source: Field Survey, 2021 Values in parenthesis are the t - values

Note: *** = 1% significant, **= 5% significant, *= significant at 10% probability level.

Herbicide Application of the Adopters of vitamin A fortified cassava technology was positive and significant at 1%level. This implying a direct relationship with food security status. As increase in Herbicide Application will increase the likelihood of the respondents increase the level of adoption for vitamin A fortified cassava technology thereby increasing food security status of the rural farmers. It had being known or established that Herbicide application is a major factor of production (Ayinde *et al.,* 2017). Therefore, access to more herbicide application will mean access to more yield for vitamin A fortified cassava technology for food security of the rural farmers in the study area.

Harvesting period of 11-12 months after planting of the adopters of vitamin A fortified cassava technology was positive and significant at 1% level and this implies a direct relationship with food security status of the respondents in the study areas. A harvesting period of 11-12 months after planting by the adopters of vitamin A fortified cassava will increase their livelihood of not being food insecure. The higher the harvesting period of 11-12 months by the adopters of vitamin A fortified cassava technology, the lower their chances of being food insecure as compared to those who had lower or no access to credit. This is because farmers with access to credit could easily acquire more productive resources and invest in income generating livelihood like vitamin A fortified cassava business that will enhance the overall adopters' welfare.

Seeds/stem cuttings by the adopters of vitamin A fortified cassava technologies was positive and significant at 10% level. This implies an increase rate has a maximum after which it will be negative or over crowding. seeds/stem cuttings by the respondents will increase the likelihood of them being food secured. Hence good Seeds/stem cuttings plays crucial roles in food security alleviation due to various benefits accruable to members such as good tubers yield and general production outputs. Thus, vitamin A fortified cassava households/farmers can stimulate investment in livelihood activities for enhance food security status

As revealed in Table 4.6, the Soil selection of vitamin A fortified cassava technology by respondents indicate a positive and significant at 1% probability level and this implies a direct relationship with food security status. An increased in Soil Selection by adopters of the vitamin A fortified cassava technology will leads to increase in their likelihood of not being food insecure. This is because farmers with better Soil selection with good pH value had a likelihood of doing better than those with poor soil selection light soil.

Table 4.6 revealed plough before planting of the adopters of vitamin A Fortified cassava technology was positive and significant at 5% probability level, while that of the non-adopters vitamin A fortified cassava technology was also positive and significant at 10% probability level implying a direct relationship. An increase in plough before planting will increase the likelihood of the respondents being food secured. This is in line with the Paul *et al.* (2009) who's expectation as increased plough before planting could be due to increase area of cultivation for greater output and livelihood innovations adopted by the vitamin A fortified cassava farmers.

4.5.1 Marginal effects of the Logit regression estimates

The result of marginal effects estimates of the significant variables is presented in Table 4.9. It revealed that the probability of Soil selection influencing the food security status of the adopters of vitamin A fortified cassava technologies increases by the coefficient of 0.2643, implying that for every unit increase in level of Soil selection of the vitamin A fortified cassava technology, there is about 1.3% increase in the likelihood of them being food secure. The coefficient of Land preparation (plough before planting), planting date (planting by June –

July), good spacing (25cm by 50cm), Herbicide application (systemic herbicide application) and Harvesting period (11 – 12 months before harvesting) were 0.3124, 0.5046, 0.1786, 0.7073 and 0.3056 respectively, implying that for every unit increase in land preparation, planting date, good spacing, herbicide application and harvesting period of the adopter of vitamin A fortified cassava technology activities increases the probability of them not being food secure by about 44.1%, 86.4%, 60.2%, 58.5% and 63.6%, respectively.

More so, the coefficient of variables like land preparation 0.3124, planting date 0.5046, Herbicide application 0.2842, Harvesting period 0.3056 and Soil selection 0.2643 increase the probability of the adopters of the vitamin A fortified cassava technology farmers not being food insecure by about 44.1%, 86.4%, 58.5%, 63.6% and 64.4% respectively. This showed that all the identified variables play significant roles in reducing the food security of the adopters of vitamin A fortified cassava farmers.

Table 4.8: Distribution of Respondents based on Food Security status

Indices	Pooled (#)	Adopters (#)	Non-Adopters (#)
Food security line	40,647.95	44,251.80	37,129.48
Food Insecurity Incidence	0.5636	0.3136	0.5339
Food Insecurity Gap	0.4384	0.3603	0.4198
Food Insecurity severity	0.2452	0.1829	0.2241

Source: Field Survey, 2021

Similarly, marginal effects of the significant variables for the non- adopters of vitamin A fortified cassava technologies in Table 4.9. revealed that the probability of Seed/stem rate influencing the food security status of the non- adopters of vitamin A fortified cassava technologies decreases by the coefficient of 0.8209, implying that for every unit increase in the seed/stem rate of the non-adopters of vitamin A fortified cassava, there is about 1.3% decrease in them not being poor, However, the coefficient of variables such as planting spacing 0.3506, seeds or stem rate 0.3038, Fertilizer application 0.6003, planting date 0.3464 and Land preparation 0.1572 increase the probability of the non- adopters household of vitamin A fortified cassava technologies not being food security by about 39.8%, 37.3%, 39.0% , 13.6% and 55.9% respectively. This shows that all the identified variables play significant roles in alleviating the food security status of the non- adopters of the vitamin A fortified cassava technology of the rural farmers in the study area.

Table 4.9: Marginal effects of the Logit regression estimate

Variables	Pooled Coefficient (z-values)	Standard error	Adopters Coefficient (z-values)	Standard error	Non adopter Coefficient (z-values)	Standard error
Soil with PH	0.1787 (2.56)***	0.0697	0.2643 (3.13)***	0.0844	-	-
Plough before planting	0.1919 (3.69)***	0.0521	0.3124 (4.51)***	0.0693	0.1572 (2.04)**	0.0770
Planting by June – July	0.3704 (4.58)***	0.0809	0.5046 (4.56)***	0.1105	0.3464 (2.43)**	0.1423
Spacing of 25 by 50cm	0.2356 (4.29)***	0.0550	0.1786 (2.54)***	0.0953	0.3506 4.55***	0.0771
Seed rate of 35 – 50kg	0.2569 (4.55)***	0.0565	0.1845 (1.78)*	0.1035	0.3038 (4.33)***	0.0702
Surface herbicide	0.1802 (3.31)***	0.0544	0.2072 (2.79)***	0.0694	-	-
Inorganic fertilizer	0.1952 (2.75)***	0.0711	-	-	0.6003 (3.13)***	0.1920
Harvesting 11-12 months	0.2040 (3.35)***	0.0601	3056 (5.22)***	0.0586	-	-

Source: Field Survey, 2021

Note: *** = significant at 1%, ** = significant at 5%, * = significant at 10% level of probability. Also, values in parenthesis are z-values.

4.6 Constraints Associated with Adoption of Vitamin A Fortified Cassava by Respondents

Distribution of the respondents according to constraints associated with effects of vitamin A fortified cassava technology adoption in the study area is presented in Table 4.10. These constraints as indicated by the respondents include Inadequate farm land for vitamin A fortified cassava, Inadequate Input for cultivation, cost of vitamin A fortified cassava technology, poor extension services to the cassava farmers, poor credit facilities to the cassava farmers, poor soil fertility for the vitamin A fortified cassava yield, Decaying of root tubers immediately after maturation, complexity of technology for adoption, Difficulty of sprouting in vitamin A fortified cassava, High cost vitamin A fortified pant, Inadequate information on vitamin A fortified cassava, High cost of hired labour, High incidence of pest and diseases and Transportation system.

Although, there was no general consensus on the constraints perceived by the farmers to hinder vitamin A fortified cassava technology adoption on food security, however the severe constraints according by the respondents includes inadequate Input for cultivation and poor credit facilities cassava farmers ($\bar{X}$ = 2.4), high cost of hired labour ($\bar{X}$= 2.3), high cost of vitamin A fortified cassava ($\bar{X}$= 2.1), Extension service ($\bar{X}$=1.9) ranked 1st, 2nd, 3rd and 4th respectively. Inadequate input for cultivation and poor credit facilities to vitamin A fortified cassava technology adoption on food security in the study area. The importance of inputs and credit to agricultural development cannot be overemphasized. Input for cultivation and Credit advantageously help farmers to increase their production, increase food security and general wellbeing of the people and economy. The provision of inputs and credit will reduce the costs of capital intensive technology and assets relative to family labour. Thus, instead of growing low yielding local varieties, for example, access to credit may allow an increased use of improved stems and fertilizers leading to higher vitamin A fortified cassava output per unit of labour and land (Ajayi *et al.*, 2017).

More so, high cost of hired labour could hinder to innovation triability (tendency to try an innovation without committing too much money) as well as complexity and technicality of using such technology and compatibility with cultural norms and farming relative advantage to farmer methods in economic gain. This is in agreement with Umar (2015) who reported that for a technology to be appropriate and to be adopted by the farmers, it must have the following characteristics, compatible with socio- cultural values and beliefs, less complex, have relative advantage, affordability and acceptable in the difference makes can be observed easily by the farmers.

Table 4.10: Constraints to vitamin A fortified cassava adoption by respondents

	Pooled (n = 236)				Adopters (n = 118)				Non-Adopters (n = 118)			
Constraints	**WS**	**WM**	**Rank**	**Rmk**	**WS**	**WM**	**Rank**	**Rmk**	**WS**	**WM**	**Rank**	**Rmk**
Inadequate input for cultivation	554	2.4	1st	S	284	2.4	2nd	S	270	2.3	1st	S
Poor Credit facilities to cassava farmers	554	2.4	1st	S	284	2.4	2nd	S	274	2.3	1st	S
High cost of hired labour	540	2.3	3rd	S	273	2.3	4th	S	267	2.3	1st	S
High incidence of pests and diseases	540	2.3	3rd	S	161	1.4	12th	NS	178	1.5	11th	NS
High cost of vitamin A fortified cassava stem	493	2.1	5th	S	296	2.5	1st	S	250	2.1	4th	S
Poor extension services to cassava farmers	442	1.9	6th	NS	215	1.8	7th	NS	227	1.9	7th	NS
Inadequate information on vitamin A fortified cassava	454	1.9	6th	NS	221	1.9	5th	NS	233	2.0	6th	S
Poor soil fertility for vitamin A cassava	433	1.8	9th	NS	215	1.8	7th	NS	204	1.8	8th	NS
High cost of Transportation	428	1.8	9th	NS	218	1.8	7th	NS	210	1.8	8th	NS
High cost of fortified cassava technology	374	1.6	11th	NS	175	1.5	10th	NS	199	1.7	10th	NS
Decaying of tubers immediately after maturation	351	1.5	12th	NS	176	1.5	10th	NS	182	1.5	11th	NS
Difficulty of sprouting in vitamin A fortified cassava	322	1.4	13th	NS	151	1.3	13th	NS	171	1.4	13th	NS
Complexity of technology for adoption	310	1.3	14th	NS	147	1.2	14th	NS	163	1.4	13th	NS
Inadequate farmland for vitamin A production	447	1.9	6th	NS	223	1.9	5th	NS	224	2.1	4th	S

Source: Field Survey, 2021

Note: WS = Weighted Sum, WM = Weighted Mean, Rmk = Remark, S = Severe and NS = Not-Severe. Bench cut-off mean score based on 3 point scale = 2.0

High cost of vitamin A fortified cassava stems and extension services are crucial in promoting good agricultural and farming practices among the stakeholders. A good number of Nigerian Universities and other institutions offer courses on agricultural extension services but the number of graduates each year that end up in the actual profession of agricultural extension services are still grossly inadequate, compared with the population involved in farming and the locations of those they are supposed to service (Afolami and Falusi, 2012). In Nigeria, the number of qualified agricultural extension workers is grossly inadequate to make meaningful impact on the economy. In some rural areas, such extension services are lacking completely and farmers are left to use their traditional knowledge to carry out farming operations. Therefore, one of the greatest challenges of extension in Nigeria in spite of the intervention of a World Bank and other assisted project is the inability to secure the commitment of government and mobilizing local funds to sustain the service (Ume *et al.*, 2016).

Other constraints associated with vitamin A fortified cassava technology adoption which were not perceived to be serve by the vitamin A fortified cassava adopters were inadequate farm land for the cultivation of vitamin A fortified cassava ($\bar{X}$= 1.9), poor soil fertility ($\bar{X}$= 1.8), cost of vitamin A fortified cassava technology $\bar{X}$ = 1.6), Decaying of tubers immediately after maturation ($\bar{X}$= 1.5), high incidence of pest and diseases, difficulty of sprouting in vitamin A cassava ($\bar{X}$= 1.4) and complexity of technology for adoption ($\bar{X}$= 1.3) ranked 4th,5th, 6th, 7th, 8th, and 9th, respectively. However, some of the serve constraints identify by the non-adopters of vitamin A fortified cassava technology in the study area include Inadequate input for cultivation, poor credit facilities to cassava farmers, High cost of hired labour ($\bar{X}$ = 2.3), High cost vitamin A fortified stem and inadequate farm land for vitamin A fortified cassava cultivation (=2.1) and inadequate information about vitamin A cassava technology (= 2.0). Inadequate information is always a challenge to technologies adoption in most parts of the country as farmers may not be aware of a technologies that could improve their production capacity(UNDP,2018).

4.7 Test of Hypotheses

4.7.1 Hypotheses I

The null hypotheses i which stated that there is no significant relationship between the selected socio-economic characteristics of the respondents (age, gender, marital status, household size, education, farm size, and Farming experience) and adoption level of vitamin A fortified cassava technology in the study area was tested using the Person-Product Moment Correlation (PPMC) analysis at 1% Level of probability and the result is presented in Table 4.11. From the estimated correlation value "r", Age (0.2614), Farming Experience (0.2145) with weak association and farm size (0.4680) strong association of the respondents were significant at 1% level of probability, respectively. Hence the null hypothesis was rejected based on the Age, farming experience and farm size. while Gender (-0.0006), marital status (0.1660), Education (0.0789) and Household size (0.0802) were not significant. Hence the null hypothesis on Gender, marital status, Education and Household size was accepted that there is no significant relationship between these variables and adoption level of vitamin A fortified cassava technology in the study area.

Table 4.11: PPMC estimate of the null hypothesis 1

Variables	Pooled r value	Adopters r value	Non-adopter r value
Age	0.1282*	0.2614*	0.2314*
Gender	0.0554	- 0.0006	0.0017
Marital status	0.1572*	0.1660	- 0.0091
Farming Experience	0.1157	0.2145*	0.0762
Education	0.0477	0.0789	0.2411*
Household size	0.1041	0.0802	0.2421*
Farm size	0.5558*	0.4680*	0.7921*

Source: Field Survey, 2021

4.7.2 Hypothesis II

The null hypothesis ii which stated that there is no significant difference in the food security status of the respondents and adoption of vitamin A fortified cassava technologies in the study area was tested using t-test analysis. The results of the pairwise t-test as presented in the Table 4.12 revealed t-analysis value of 5.20 and 3.92 at 1% level of probability for vitamin A fortified cassava adopters and food security status of the adopters. This implies that there was a significant difference in the adoption of vitamin A fortified cassava technology with regards to food security status of farmers in the study area. The null hypothesis was therefore rejected, while the alternative hypothesis which stated that there is a significant difference in the adoption of vitamin A fortified cassava technologies on food security was accepted.

Table 4.12: T – test estimate for the null hypothesis II

	Mean	Std deviation	t - value	Decision
Vitamin A fortified cassava Adopters	18389.83	14382.61	5.20***	Rejected
Vitamin A fortified cassava Non-adopters	11233.05	583632		
Food Security of Adopters	0.6017	0.4916	3.92***	Rejected
Food Security of Non- adopters	0.3983	0.4916		

Source: Field Survey, 2021
Note: * = significant at 1% probability level**

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the findings of the study, it can therefore be concluded that the respondents both the adopters and non – adopters were in their active ages of 31 - 50 years, which could be advantageous to innovations adoption such as vitamin A fortified cassava technology that are capable of improving their production, enhanced their food security status and income earning. Also, most of the vitamin A fortified cassava farmers or Adopters were experienced farmers with 11- 30 years and involved in cooperative societies because of its benefits to the farmers. Adopters of vitamin A fortified cassava technologies had more access to extension contacts compared to non- adopters of vitamin A cassava. Technologies used to enhance vitamin A fortified cassava farming include soil selection, Land preparation, planting Date, Spacing, Seed Rate, Herbicide application, Fertilizer application and Harvesting with planting Date been the most frequently adopted and seeds/ stem cuttings as the principal materials for planting.

More so, planting Date of June - July is most preferred technologies in the study area with Land preparation and seed Rate considered low of importance among the vitamin A fortified cassava Adopters. However, factors found to have significant influence on adoption of vitamin A fortified cassava technology were marital status, household size, farming experience, farm size, income, cooperative association and extension service. With regards to family labour, there was significant effect of vitamin A fortified cassava technology adoption by the rural farmers in the study areas. Vitamin A fortified cassava adoption has significant effect on the output, income and food security status of the respondent as majority of the vitamin A fortified cassava adopters were found to be food secured compared to their counterpart, the non – adopters.

Finally, Constraints limiting adoption of vitamin A fortified cassava indicated by the respondents in the study area include inadequate input for cultivation, poor credit facilities, High cost of labour, high cost of vitamin A fortified cassava stem, inadequate farm land for vitamin A Cassava and inadequate information.

5.2 Recommendations

In line with the objectives and the findings of the study, the following recommendations are suggested:

i. The study revealed that the respondents were in their active age, but large proportion of the respondent in the study area particularly, the vitamin A fortified cassava non – adopters in the study area failed to adopt vitamin A fortified cassava technology because they have no access to credit and capital for purchasing inputs for cultivation. Therefore, there is a need for the Government through ministries of agriculture at all levels and non-government Organizations (NGOs) to put more emphasis on the provision of loans, especially loans for seeds/ stem cuttings, herbicides and fertilizer to farmers who may not be able to purchase them.

ii. The study also revealed that some respondents in the study area do not adopt the vitamin A fortified cassava technologies due to low level of literacy and inadequate information on vitamin A fortified cassava. Therefore, it is recommended that more efforts should be on the provision of education in rural areas, especially adult education at villages or wards level. Such education should be inform of seminars, workshops and tour system whereby farmers from one village visits another village for the aim of sharing ideas and experience on vitamin A fortified cassava technology adoption. The state and local governments should be the main facilitators in the processes through the services of extension agency to the farmers. This could increase their level of adoption of new and better technologies for greater output.

iii. All the vitamin A fortified cassava adopters across the three zones in the study area recorded high production output 69% as against 31% of the non – adopters of vitamin A fortified cassava who suffered from low production output. In order to reduce the problem of low output therefore, government should make sure that appropriate decisions are implemented to boost farmer's productivity. Measure such as intensify farm size, income for utilization of vitamin A fortified cassava stems cultivation should encouraged, and supply of farm input be made available by the government at an affordable price to the farmers through an extension agents.

iv. Agricultural credit facilities should be made accessible to the farmer to ensure timely inputs supply and adequate vitamin A fortified cassava utilization. Also, the promotion of savings among farmers and farmer groups should be encouraged to secure loans for their members from agricultural banks. This could go along way in addressing the problems encountered in vitamin A fortified cassava technology adoption such as high cost of input for cultivation and inadequate capital for hiring labour. This will encourage increases in adoption of vitamin A fortified cassava and reduce food insecurity to farmers in general.

v. From the result of the t-test score estimates, vitamin A fortified cassava adoption had a positive effect on family labour, income, production output and food security status of adopters in the study area hence; there is need for the provision of good stem cuttings for cultivation, planting date of june- july, spacing of 25cm by 50cm, fertilizer and herbicide for application to improve crop yield and control incidences of pest and diseases, implements good harvesting period of 11-12 months after planting and adequate extension services which would improve the food security and overall welfare of the rural farming households in general.

vi. Finally, to remedy the food insecurity problems of the rural farming households in the study area of Benue state Nigeria, there should be an increase emphasis on vitamin A fortified cassava technologies adoption among smallholder farmers that will enhance availability, affordability, accessibility and utilization of food of households' consumption. Also, policy makers should endeavor to encourage extension practice / packages to assist farmers who are practicing vitamin A fortified cassava farming.

Contribution of the study to Knowledge

Farmers are more Food secure because of its high yielding and early maturing of vitamin A fortified cassava farming.

More Income to the farmers thereby reducing poverty and increase prosperity to the rural farmers of vitamin A fortified cassava technologies.

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APPENDIX I

DEPARTMENT OF AGRICULTURAL EXTENSION AND RURAL DEVELOPMENT,
SCHOOL OF AGRICULTURE AND AGRICULTURAL TECHNOLOGY,
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

RESEARCH QUESTIONNAIRE

Dear Respondent,

I am a postgraduate student of the above named institution and Department undertaking a research study on the topic "Effect of vitamin A fortified vitamin A cassava technology adoption on poverty and food security of rural farmers in Benue state, Nigeria". **This questionnaire will be used strictly for academic purposes only and should be treated with utmost confidentiality**. You are thus kindly required to tick or comment appropriately on each question. Thanks for your maximum co-operation.

UBOKWE, Sunday Adegwu
MTECH/SAAT/ 2018/8104

IDENTIFICATION DETAILS:

LGA…………………………………..… Extension block……………………………...
Extension cell…………………….….. Village…………………………………….……
Questionnaire number…………………………
Category of farmer: (a) Adopter [ ] (b) Non-Adopter [ ]

SECTION A: Socio-Economic Characteristic of the Respondent

1. Sex: (a) male [ ] (b) female [ ]
2. what is your age ?……………………….. (in years)
3. Marital status:
(a) married [ ] (b) single [ ] (c) divorced [ ] (d) widowed [ ]
4. How many years of farming experience?..in years

5. Forms of Education attained: (a) Formal [ ] (b) Non-formal [ ]

6. Level of formal education acquired:

(a) Primary [ ] (b) Secondary [ ] (c) Post-Secondary [ ]

7. How many years spent in formal schooling?..in years

8. What is your household size?...in numbers

9. What is your farm size under Vitamin A fortified cassava production? ….in hectares

10. Do you have access to credit for your farming work? (a) yes [ ] (b) no [ ]

11. What amount of credit do you received for your farming work? ₦………………

12. What is the interest charged on the credit collected?……………in percentages

13. Do you belong to a cooperative societies? (a) yes [ ] (b) no [ ]

14. If yes, how long have you been member of a cooperative society? …..…..in years

15. If yes, how many cooperative society? ………………………..in numbers

16. Do you have access to credit for your farming work? (a) yes [ ] (b) no [ ]

17. What is the source of your credit?

(a) bank of agric ( ) (b) comm. bank ( ) (c) cooperative ( ) (d) family/friends ( ) (e) others (specify)…….

18. Do you have contact with extension agents? (a) yes [ ] (b) no [ ]

19. If yes, how many time do you have contact with extension agents? ……in numbers

20. What is your estimated income from Vitamin A fortified cassava last season? ₦……..……

SECTION B: Respondents' Adoption Level of Vitamin A Fortified Cassava

21. Are you aware of vitamin A fortified cassava? (a) yes [ ] (b) no [ ]

22. What is your source(s) of information on vitamin A fortified cassava?

(a) extension agents [ ] (b) non-governmental organization [ ] (c) research institute [ ]
(d) mass media [ ] (e) fellow farmers [ ] (f) friends/relative [ ] (g) Field day [ ]
(h) Others (specify)……………………………………………………

23. Do you adopt vitamin A fortified cassava stem cutting? (a) yes [ ] (b) no [ ]

24. If yes, how long have you been growing vitamin A fortified cassava?...........in years

25. Kindly indicate your reasons for growing vitamin A fortified cassava?

(a) high moisture contents [ ] (b) health benefits [ ] (c) high yielding [ ] (d) early maturing [ ] (e) good tuber quality [ ] (f) tolerant to drought [ ] (g) resistant to storage pests [ ] (h) others (specify)………………....

26. What quantity of cassava stem cutting did you used last farming season?……...in kilogram/hectare

27. What quantity of fertilizer do you apply on you Bio-fortified cassava farm?……in kilogram/hectare

28. What is the amount of herbicide used in your cassava farm last farming season?…in litres

29. What is the amount of pesticide used in your cassava farm last farming season?…in litres

30. What is the amount of insecticide used in your cassava farm last farming season?..in litres

31. What is your estimated yield from vitamin A fortified cassava last farming season?.....................in kilogram

32. Kindly indicate the recommended vitamin A fortified cassava production practices adopted.

S/No	Recommended practices	Yes	No
1	**Site selection:**		
	Light soil (Loamy)		
	Soil with good Ph		
2	**Land preparation:**		
	Ploughing before planting		
	Ploughing after planting		
3	**Planting date:**		
	June / July		
	September / October		
4	**Spacing:**		
	25cm x 50cm		
	50cm x 50cm		
	50cm x 75cm		
5	**Stem cutting rate:**		
	20 – 35 kg/ha		
	35 – 50 kg/ha		
6	**Herbicide application rate:**		
	Systemic (1 litre / hectare)		
	Surface (litre / hectare)		
7	**Fertilizer application:**		
	Organic		
	Inorganic (Urea)		
8	**Harvesting time:**		
	9 – 10 months (Early maturing)		
	11 – 12 months (Late maturing)		

33. Do you wish to continue cultivating vitamin A fortified cassava? (a) yes [ ] (b) no [ ]

34. If yes, state the reasons for continue cultivation of vitamin A fortified cassava?

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35. If no, state the reasons for not continue cultivation of vitamin A fortified cassava?

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36. What type of labour do you employ in your farm?

(a) family labour [ ] (b) hired labour [ ] (c) other (specify)……………

37. How much do you pay your labourer in your cassava farm? ₦………………

38. Kindly indicate labour usage in mandays and cost in your vitamin A fortified cassava farming last farming season.

	Family labour						**Hired labour**					
	Adult male		**Adult female**		**Children**		**Adult male**		**Adult female**		**Children**	
Operations	No	Days	No	Days	No	Days	No	Days	No	Days	No	Days
Land clearing												
Ridging												
Planting												
1st Weeding												
2nd Weeding												
Herbicide Application												
Fertilizer application												
Harvesting												
Sorting:												
Grading												
Bagging												
Packaging												
Others (specify).........												

SECTION C: Factors Affecting Adoption of Vitamin A fortified Cassava by Respondents

39. Kindly indicate the factors that affect adoption of vitamin A fortified cassava.

Factors	**Yes**	**No**
Vitamin A fortified cassava varieties availability for adoption by farmers		
Accessibility to vitamin A fortified cassava technology by farmers		
There is good compatibility of vitamin A fortified cassava varieties to farmers		
The technology of vitamin A fortified cassava varieties is too complex to adopt		
Inadequate credit facilities affect adoption of vitamin A fortified cassava		
Poor market for cassava produce affects adoption of vitamin A fortified cassava		
Agricultural incentive influence the adoption of vitamin A fortified cassava varieties		
Extension services boost the adoption of vitamin A fortified cassava varieties		
Adoption of the vitamin A fortified cassava affect farm family income		
Allocation of resources affects vitamin A fortified cassava production		
Poor road networks influence adoption of vitamin A fortified cassava		
Others (specify)……………………………………………………………………………		

SECTION D: FOOD SECURITY STATUS OF VITAMIN A FORTIFIED CASSAVA FARMERS

40. What is your output from vitamin A fortified cassava cropping last season?…..in kilogram.

41. What is your income from vitamin A fortified cassava cropping last season?…….in Naira

42. Was there improvement in your saving? (a) yes [ ] (b) no [ ]

43. Was there investment in non-farming business? (a) yes [ ] (b) no [ ]

44. Was there investment in other farming business? (a) yes [ ] (b) no [ ]

45. Was there improvement in your consumption rate? (a) yes [ ] (b) no [ ]

46. Was there availability of food needed by your households? (a) yes [ ] (b) no [ ]

47. Does your households have access to food all time? (a) yes [ ] (b) no [ ]

48. Was there stability in food supply to your households? (a) yes [ ] (b) no [ ]

49. Was the food consumed by your households affordable? (a) yes [ ] (b) no [ ]

50. Was the food consumed by your households adequate? (a) yes [ ] (b) no [ ]

51. Does the type of food consumed by your households nutritious? (a) yes [ ] (b) no [ ]

52. Do you have the purchasing power to by food needed by your households?
(a) yes [ ] (b) no [ ]

53. Does your household frequently utilize balance diet? (a) yes [ ] (b) no [ ]

54. How much do your household spend on food last farming season? ₦……………

55. Kindly indicate your copping strategy during food scarcity?

(a) one meal per day [ ] (b) two meals per day [ ] (c) three meals per day [ ]

(d) no meal per day [ ]

56. Kindly indicate based on the following, frequency of food consumption in your household in the last 12 months:

Household Food Consumption Statements	**Often**	**Some times**	**Not at all**
Are you worried whether your food would finish before you will get money to buy more			
Are your children not eating enough because you could not afford enough food			
How often did you or other adults in your household cut the size of their meals			
Do you skip meals because there was no enough food or money for Food			
Do you ever eat less than you felt you should eat because there was not enough money to buy food			
Do member of your household lose weight because they did not have enough food to eat			
Do you lose weight because there was no enough food			
Do you or other adults in your household ever not eat for a whole day because there was not enough money for food			
How many time did you cut the size of your children's meals			
Have the children ever go hungry to bed because you just could not afford food for them			
Do your children ever stop schooling for a day because there was not enough money or food			
Are you ever hungry but did not eat because you could not afford to buy food			

SECTION E: Constraints Associated with Adoption of Vitamin A fortified Cassava

57. Kindly indicate how severe or not are the following constraints in relation to adoption vitamin A fortified cassava in the study area. Tick the box as appropriate (Very Severe = 3, Severe = 2, Not Severe = 1).

Constraints	**Very Severe**	**Severe**	**Not Severe**
Inadequate farm land for bio-fortified cassava production			
Inadequate input for cultivation			
Cost of vitamin A fortified cassava technology			
Poor extension services to the cassava farmers			
Poor credit facilities for vitamin A fortified cassava farmers			
Poor soil fertility for the vitamin A fortified cassava yield			
Decaying of root tubers immediately after maturation			
Complexity of technology for adoption			
Difficulty of sprouting in vitamin A fortified cassava			
High cost of vitamin A fortified cassava stem			
Inadequate information on vitamin A fortified cassava			
High cost of hired labour			
High incidence of pests and diseases			
Others (specify)……………………………………….			