ADOPTION OF RECOMMENDED COCOYAM PRODUCTION TECHNOLOGIES AMONG FARMERS IN ENUGU STATE, NIGERIA

BY

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Nigeria, like any other developing countries is principally an agrarian nation that still face continuous food crisis as the level of food production is yet to keep pace with demand (Amusa *et al*., 2011). Agriculture has been an important sector in Nigeria's economy for the past decades and still a crucial sector despite the oil boom (Central Bank of Nigeria (CBN), 2014). The sector remains substantially a family business in Nigeria with low inputs and local technologies. The sector provides employment opportunities for the teaming population, reduces poverty and contributes to the growth of the economy (CBN), 2014).

The challenges of inadequate food production, shortages in the supply of raw materials gave rise to the innovation of improved technologies in order to improve production and living standard of farmers. Implications raised by this is that, concerted efforts by everybody that has potential contribution towards agricultural development process is required if Nigeria is to make a realistic and positive step. This is because majority of the farmers in Nigeria depend entirely on farming for survival and generation of income (Adeniji, 2002).

Therefore, enhanced productive practices in farming should be utilized for economic development. The non-availability or inadequate use of modern agricultural technologies followed by low resource status of the farmers has made Nigeria's agriculture to remain local (Adeniji, 2002). Hence, any crucial development policy aimed at poverty alleviation should concentrate on farming activities which is the main occupation of the poor, because the nation's agricultural potentials are far from being fully realized and this has serious implications on food security and sustainable economic development. The underdevelopment of agriculture is indeed worrisome, given the fact that Nigeria is naturally and agriculturally endowed. In spite of the various food crop production programmes initiated and implemented by Federal government of Nigeria, there has been growing concern about the capability of Nigeria's agriculture to satisfy the food requirement of a fast-growing population and to provide enough raw materials for the agro-based industries (International Institute for Tropical Agriculture (IITA, 2013). Emphasis therefore, is placed on production of tuber crop like cocoyam, which has the potentials of alleviating poverty by improving the income earning capacity and food security of farmers in Nigeria.

Root and tuber crops are among the most important groups of staple foods in many tropical African countries which constitute the largest source of calories for the Nigeria population (Olaniyan *et al*., 2013). Among root and tuber crops, cocoyam is the next in importance after cassava, yam and as well as sweet potatoes (National Root Crops Research Institute (NRCRI), 2012). Nigeria, Ghana and Japan are the world's leading producers of cocoyam (Food and Agriculture Organization (FAO), 2014). The average production figure for Nigeria is 5.4 metric tonnes which accounts for about 37% of total world's output of cocoyam (FAO, 2012). Cocoyam is one of the major root crops produced in large quantity in Nigeria (NRCRI), 2012).

In Nigeria, cocoyam is regarded as a major crop especially in female headed households (Onwubuya and Ajani, 2012). Cocoyam is Nigerian's giant crop grown mainly for its corm and cormels. The crop has assumed nutritional and industrial significance in flour industries (Onwubuya and Ajani, 2012). It is nutritionally superior to yam and cassava in terms of its digestibility, contents of crude protein and essential minerals, such as Calcium, Magnesium and Phosphorus (Chukwu *et al*., 2012). All parts of the cocoyam (corm, cornel, leave and flower) are edible and it is used in the treatment of diabetes, prevention of cancer and as food for the aged people, individuals and children (Kundu *et al*., 2012).

The two varieties of cocoyam that are mainly produced in Nigeria are *Colocasia esculenta* known also as "taro" and *Xanthosoma saggittifolium* also known as 'tannia' (NRCRI, 2012; Obiora and Ajala, 2014). Both are members of *Araceae* family. Specifically, the two (*Xanthosoma sagittifolium* and *Colocasia esculenta*) varieties of cocoyam are grown and as well consumed in Enugu State, Nigeria. Although, many cultivars of each of these varieties exist in the study area and beyond, but grown under different local names in different parts of Nigeria. These include Ogoh, Mbatu, Okang, Mbajo, Okwa-akawa, Banenong and Okuna in Cross River State (Okoye *et al*., 2012). The preference depends on the State. In Anambra State for instance, both varieties are preferred but in Cross River and Delta States, *Xanthosoma* is preferred to *Colocasia* (Okoye *et al*., 2012).

Cocoyam grows in association with other food and tree crops in Nigeria. However, there has been decline in the yields of cocoyam in the past few years (National Agricultural Extension and Research Liaison Services (NAERLS, 2011). This was due to the use of low-impact technologies available to the local farmers that produce and market the crop. Insufficient improved planting materials, weeds problem and poor soil resulted to low productivity of cocoyam (FAO, 2011). The National Root Crops Research Institute, Umudike and extension agencies provide research-based information on improved cocoyam production technologies for adoption by the farmers. These efforts have been supported with the use of extension publications to communicate with educated farmers (FAO, 2011). The improved cocoyam production practices that have been developed, transferred to farmers and have been accepted by them over time includes cocoyam intercropping technique, cocoyam mini-setts technique, method of fertilizer application, plant spacing, planting depth (15 – 20cm deep), weed control method, mulching, pest control, time of planting and harvesting method (NRCRI, 2013).

1.2 Statement of the Research problem

Cocoyam is rarely found in most markets in Nigeria unlike root and other tuber crops like potatoes, cassava and yam (Suleiman, 2019). Besides, **c**ocoyam is regarded as a crop mainly for the poor and has played a very minor role in international trade. This misconception has been persisting due to lack of appreciation of the number of people who depend on the crop as their source of livelihood. More so, very little research attention has been extended towards cocoyam improvement resulting in knowledge gap for policies and programmes. In spite of the high productivity level and better storability of cocoyam compared to other tropical root and tuber crops, it has been marginalized in agricultural policies and research interventions on root and tuber crops (Quaye *et al*., 2010; Ramanatha *et al*., 2010).

The production of cocoyam in Nigeria however, has been on the decline in the last few decades due to several production inadequacies (Nwakor *et al*., 2015). Yield has remained relatively low ranging between 5.0 - 7.5 metric tonnes per hectare in Nigeria despite being among the world largest producing countries. The quantity of cocoyam in the market has continued to decline despite being a mandate crop for Michael Okpala University of Agriculture, Umudike. The drop is surely a clear indication that recent yield of the crop is below its potential yield of 15 – 20 metric tonnes per hectare in farmers' field (Onyeka, 2014). As a result, the production of cocoyam in Nigeria can gradually go into extinction if adequate steps are not taken to check the unfavourable situation.

It is based on the aforementioned that this research becomes imperative with the aim of assessing the adoption of recommended cocoyam production technologies in Enugu State, Nigeria. Thus, the study will attempt to provide answers to the following research questions:

i. What are the socio-economic characteristics of cocoyam farmers in the study area?

ii. What is the level of adoption of the recommended cocoyam production technologies among cocoyam farmers in the study area?

iii. What are the factors influencing adoption of the recommended cocoyam production technologies in the study area?

iv. What are the effects of recommended cocoyam production technologies adopted on the output of the cocoyam farmers in the study area?

v. What are the constraints associated with adoption of the recommended cocoyam production technologies in the study area?

1.3 Aim and Objectives of the Study

The aim of the study is to assess the recommended cocoyam production technologies adoption among rural farmers in Enugu State, Nigeria. The specific objectives are to:

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

ii. assess the level of adoption of the recommended cocoyam production technologies among the rural farmers;

iii. determine the factors influencing adoption of recommended cocoyam production technologies in the study area;

iv. determine the effects of adoption of recommended cocoyam production technologies on output of the rural farmers; and

v. ascertain the constraints associated with adoption of recommended cocoyam production technologies in the study area.

1.4 Hypotheses of the Study

HO_1: There is no significant relationship between selected socio-economic characteristics of the cocoyam farmers and adoption of recommended cocoyam production technologies in the study area.

HO_2: Adoption of recommended cocoyam production technologies has no significant effects on output of the farmers in the study area.

1.5 Justification for the Study

Cocoyam remains an under-exploited food resource (Falade and Okafor, 2013; Onyeka, 2014). Most of the scholarly works on cocoyam in Enugu State (Aniekwe, 2015; Appiah, 2016; Nwakor *et al.*, 2015) focused on marketing and profitability of its production with little or no attention on factors affecting adoption of the recommended production technologies among farmers in the study area. In Enugu state, it has become obvious that cocoyam features least in the markets among other root and tuber crops (yam, cassava and sweet potato) and by looking through past researches on root and tuber crops, cocoyam has received the least research attention (Quaye *et al*., 2010; Ramanatha *et al*., 2010).

To this end, this research work is hoped to provide an in-depth knowledge on the factors that affect adoption of recommended cocoyam production technologies in the study area and the entire south-eastern region at large. It would also help to explain how the improved cocoyam production technologies can assist to spread the crop among rural farmers in Enugu State. The study would also enable farmers to know the benefits of adopting recommended cocoyam production technologies and also assist them to improve their cocoyam production and income levels. The study would also be useful to the government of Nigeria, as a basis for rational and empirical policy formulation on cocoyam production in the country.

The study would avail research institutes with the basic ideas on the constraints to farmers towards utilization of improved cocoyam production technologies through the identification of problem areas for improvements. The study will provide useful information on the numerous benefits of cocoyam to consumers and producers that will enhance the crop acceptability in the local markets throughout Nigeria and foreign markets. Finally, it is hoped that this work would be of assistance to policy makers, farmers and future researchers as it will expand the existing body of knowledge in the areas of cocoyam farming.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Concepts and Conceptual Framework

2.1.1 Origin and distribution of cocoyam

The most common species of cocoyam in Nigeria are *Colocasia* and *Xanthosoma*. *Xanthosoma spp* originated from tropical America most probably Central and South America (Ramanatha *et al.*, 2010). This is where the species are believed to have been domesticated from the wild. The crop was introduced to Europe and Asia by the Spanish and later by the Caribbean in the late nineteenth century to Sierra Leone and Ghana (NRCRI, 2012). In West Africa, *Xanthosoma* is more important than *Colocasia*, although it was new in the pacific regions. It is also widely cultivated in Puerto Rico, Dominican Republic, Cuba and Central America. Thus, *Xanthosoma spp* is listed as invasive crop in many areas of the world (French Polynesia, Florida, the Galápagos Islands, Puerto Rico, and Costa Rica) in addition to being intentionally introduced to several other regions including Africa and Asia (Crop Trust, 2010).

The *Colocasia* specie of cocoyam originated in India and Southeast Asia over 2000 years ago, spread to Egypt and then to Europe (Arene and Eze, 2008). Subsequently, it was taken from Spain to tropical America and then to West Africa. Its cultivation now extends throughout the tropics and to the borders of the temperate regions. It was used in feeding slaves and was transferred to the West Indies during the slave trade (Arene, 2015). In order to distinguish it from the newer specie (*Xanthosoma*), *Colocasia* is referred to as "old cocoyam" in West Africa. *Colocasia* is a staple food in many Islands of the South Pacific such as Tonga and Western Samoa and in Papua New Guinea. Meanwhile, *Xanthosoma* is referred to as “new cocoyam” in West Africa.

Brown (2000) traced its introduction to West Africa as far back to 16th and 17th centuries, but Wright (1930) reported its introduction to Ghana in 1843 by the West Indian Missionaries. There is paucity of information on the species in the region between the 17^{th} and 19^{th} centuries, but

Xanthosoma is believed to have been first planted in Akropong Akwapim, eastern region of Ghana. It is cultivated as a cover crop, due to the plant's large leaves, for seedlings of cocoa, an important cash crop and this led to its gradual spread through the forest belt of the country notably, the Ashanti, Western and Brong-Ahafo regions as it was cultivated on cocoa plantations (Ramanatha *et al.*, 2010). *Xanthosoma* is an important crop in the humid areas of Southern Ghana, ranking third to cassava and yam as important national root and tuber staple.

2.1.2 Importance of cocoyam

Cocoyam is not only very important for the livelihood of farmers, but also serves as food security crop for the farmers across the country (Abena *et al*., 2018). This is because farmers depend on cocoyam as a major staple food especially during critical periods such as conflict, famine and natural disasters. As a versatile staple crop, cocoyam can also be used as weaning food for children. Cocoyam may be processed and eaten in many different forms. The *Colocasia* corms and cormels may be boiled, pounded as fufu, cooked as porridge or used as soup thickener. Cocoyam chips are much of children and youths delight as school snacks and take-away packs. More so, several confectionaries such as biscuits, chin-chin, flakes and balls can all be produced from flours of cocoyam through various value addition technologies developed by National Root and Tuber Crops Research Institute (NRCRI) Umudike, Nigeria (Obiefuna, 2010).

With this, the consumption of cocoyam has been diversified and increased, while new market frontiers are being opened. Cocoyam is an important crop in Nigeria and ranks after cassava and yam among the root and tuber crops cultivated and consumed (Okoye *et al*., 2012). Generally, all plant parts (cormels, petioles, leaves, and inflorescence) of cocoyam are edible (Vaneker and Slaats, 2013; Centre for Agricultural and Bio-science International (CABI), 2014). The wide distribution of the crop in different geographical areas and cultures has resulted in varying usage of the crop from one location to another (Vaneker and Slaats, 2013). Cocoyam is mainly used as food where it is cultivated and the plant parts are also used as fodder/feed and medicine, including its use as anti-poisonous agents against tarantula, scorpion and snake bites. In its application as food, none of the plant parts are consumed raw because of its anti-nutritional factor (Ramanatha *et al.*, 2010). Thus, traditional cooking methods employ boiling by heating, baking, roasting or frying either alone or in combination with other ingredients to obtain delicacies (Lim, 2016). These may be snacks, main meals or special dishes for vulnerable groups.

In West Africa, there are significant similarities in the use of indigenous root and tuber crops for consumption (Falade and Okafor, 2014). However, cocoyam is of limited native use as only a handful of traditional dishes are popular across the major cocoyam producing areas (Ghana, Nigeria, Cameroon, and Côte d'Ivoire), and Ghana seems to dominate in diversity of indigenous cocoyam dishes. Indigenous dishes usually carry deep socio-cultural sentiments and values (Ramanatha *et al.,* 2010; Vaneker and Slaats, 2013). However, with the exception of few traditional delicacies that have been improved to meet growing consumer needs for convenience, most dishes are prepared using traditional recipes and methods which are tedious and time-consuming (Ramanatha *et al.,* 2010; Acheampong *et al.*, 2015). This is a major limitation to sustained consumption of these delicacies in an era of consumers' demand for shelf-stable, ready-to-prepare and ready-to- eat (instant) dishes due to changing work schedules and responsibilities of women. Lack of convenient dishes/products from cocoyam also limits the exploitation of the crop in international retail industry like supermarkets. Preliminary studies by the researchers have indicated a high consumer need for improvement and enhancement in the preparation processes and storability of these traditional dishes, especially in the urban settlements (Lim, 2016).

The pressing need for research to improve these culturally acceptable dishes for convenience in preparation and trade cannot be over-emphasized. Lessons can be learnt from the Asian food industry, where *Colocassia spp* had been widely exploited. For instance, high quality flours have been developed and commercialized for use in home-made dishes and in various sweet desserts across the continent. Japan in particular, has successfully expanded the use of cocoyam through the dissemination of novel and old recipes in popular media. As a result, the crop is held in high esteem even among the younger generations, ensuring its sustained utilization and trade while simultaneously establishing its contribution to food and nutrition security in the region (Ramanatha *et al.,* 2010).

2.1.3 Ecology of cocoyam

Cocoyam is a food crop that belongs to the genera of *Colocasia* or *Xanthosoma.* They are herbaceous and develops large spherical or elongated and swollen underground storage stem (corm), which gives rise to few large leaves from its base. The petioles of the leaves stand erect and can reach lengths of about 1m (3.3ft). Cocoyam is tolerant to water-logged and drought conditions and requires minimal water supply when it has become established (Mbaga and Folmer, 2011). It is cultivated under flooded condition in several parts of the world and the field is kept flooded throughout the growing period of the crop (Okoye *et al*., 2012). Taro grown this way, yields higher than those grown in un-flooded conditions and takes longer to mature. Tannia on the other hand does not tolerate waterlogged condition.

Generally, cocoyam tolerates shade conditions and they are best grown between stands of plantation tree crops such as cocoa, oil palm, citrus and coconut since they have the ability to trap and utilize the low light intensities filtering through the canopy of the trees. They are often grown as annual crops and harvested after one season. The leaf blades are large and heart-shaped and can reach 50cm in length. The corm produces lateral buds which give rise to tubers (cormels) and suckers (stolon) (NRCRI, 2012). The NRCRI, Umudike is charged with the mandate to develop and improve cocoyam.

Some of the Institute's specific terms of reference are to collect, maintain, screen and classify local and exotic cocoyam cultivars as effective breeding programme for crop improvement which largely depends on the availability of a wide genetic base. So far, all materials in the germ-plasm are grouped into ten (10) distinctive groups, three (3) for *Xanthosoma spp* of cocoyam and seven

(7) *Colocasia spp* of cocoyam with representative cultivars of each group. These cultivars can be distinguished according to their different colours of flesh such as white, pink, yellow, green and purple (NRCRI, 2012).

2.1.4 Trends in cocoyam production

Cocoyam has largely been cultivated on a subsistence basis since its introduction to Africa including Nigeria, Cameroun and Ghana. It served as a cover crop for seedlings of cocoa and eventually spread through the forest belt along with cocoa plantations due to its ease of adaptation to diverse habitats (Manner, 2011). Exceptional, keeping qualities of the cormels and prolific sprouting after clearing and burning of secondary forests, cocoyam has become an important agricultural commodity. It was one time ranked the most important staple root crop in Ghana with estimated production level of 509.6 thousand metric tonnes as opposed to 504.2 thousand metric tonnes of cassava, the closest competitor. However, there were no concerted efforts to promote the growth and performance of cocoyam relative to other root and tuber crops until the outbreak of the root rot complex disease in 1925 after which two formal studies on the species were conducted in Ghana (Manner, 2011).

There was also lack of information and follow-up studies on domesticated varieties until 1971 when Karikari carried out a germ-plasm assessment and collection. Similar individual studies were also carried out by Tortoe and Clerk (2011) but with an absence of a common front to purposefully enhance the growth and performance of cocoyam (Quaye *et al.,* 2010; Ramanatha *et al.,* 2010). The marginalization in agricultural policies and research interventions left the cultivation of the crop largely in the hands of resource-poor rural farmers who undertook selective cultivation of varieties to the detriment of the already limited germ-plasm (Ramanatha *et al.,* 2010).

At present, there are only two commercially cultivated varieties (Acheampong *et al.,* 2015), cocoyam now ranks third in importance after cassava and yam and there has been a steady decline in its production levels since 2009 (Ramanatha *et al.,* 2010; Acheampong *et al.,* 2015). The reduced production has reflected in a drop in cocoyam exports from 242 thousand tonnes in 2009 to 33 thousand tonnes in 2012 (Appiah, 2016). Other challenges to optimal production of cocoyam include decreasing rainfall and soil condition, loss of forests, weak technical and institutional support as well as high cost of inputs (Quaye *et al.*, 2010; Acheampong *et al.*, 2015). With a prevailing production of 5 – 7.5 tonnes per hectare against a potential production of 23.5 – 35 tonnes per hectare, efforts to strengthen the performance of staple root and tuber crops have addressed some challenges of cocoyam production (Onyeka, 2014). Notable among these interventions are the Root and Tuber Improvement and Marketing Programme (2007–2015), West African Productivity Programme (2008–2018) and the DANIDA Strengthening Root and Tuber Value Chains Project (2013–2017). However, cocoyam researchers lament the many existing knowledge gaps that influence the performance of cocoyam utilization and advocate for more interventions specifically tailored to promote the production, processing and utilization of the crop (Acheampong *et al.*, 2015).

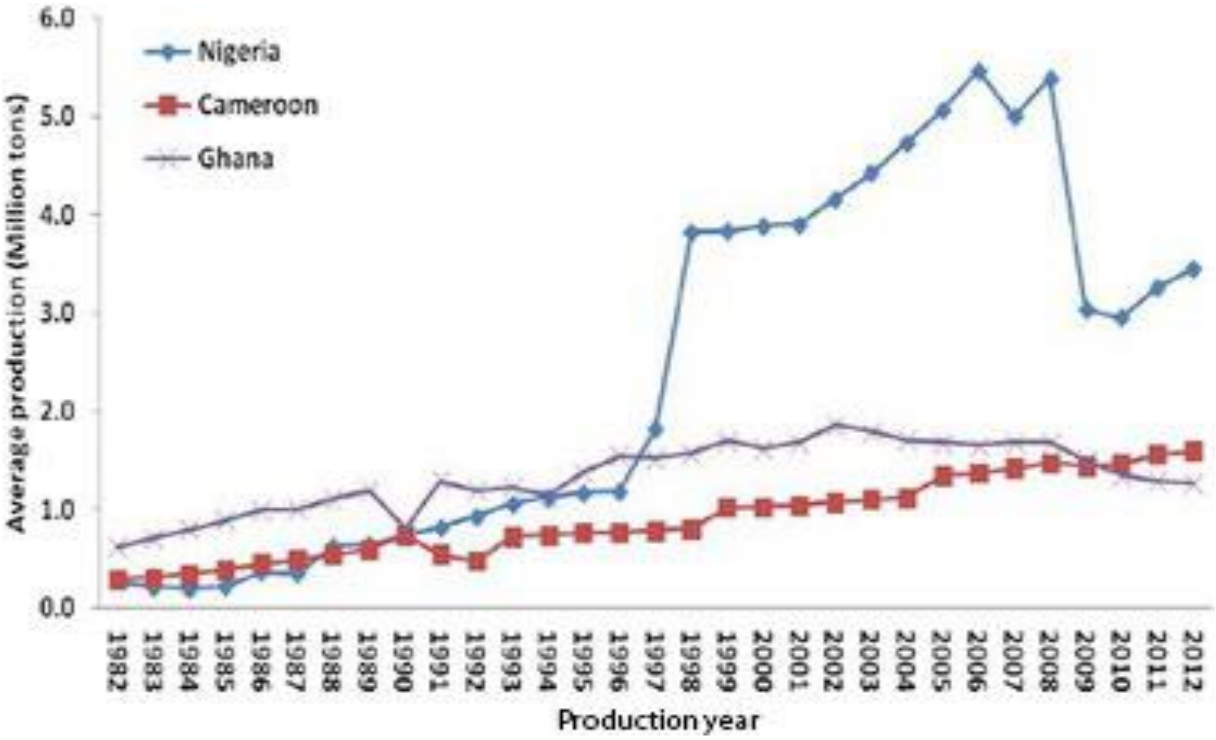


Figure 2.1: Cocoyam production trend in three African countries (Nigeria, Cameroon and Ghana) between 1982 and 2012

Source: Onyeka (2014)

2.1.5 Cocoyam production in Nigeria

Cocoyam grows well in shade which facilitates its intercrop with permanent plantations like banana, coconut, citrus, oil palm and cocoa. It is also intercropped with annual and perennial crops, making it a choice crop in the farming systems of the forest/savannah regions in most countries. The bulk of Nigerian cocoyam is produced in the humid forest and derived savannah agro-ecological zones. This is currently the area where cocoyam is an integral part of the farming system and where about 10 – 30% of the crop land is under cocoyam cultivation. The official figures from the National Bureau of Statistics (NBS) 2012 identified 21 out of the 36 States of Nigeria with appreciable hectares planted with cocoyam (Oyeka, 2014).

However, in the field survey of Taro leaf blight (TLB) in 2012, a substantial amount of cocoyam production was also observed in some other States in Savanna ecological zones which are not captured in the 2006 NBS data. In general, cocoyam represents a prime mover of socio-economic development and activities in most rural households where it is produced for food and/or market. In the South-East and South-South regions of Nigeria, cocoyam production, marketing and consumption is a means of sustenance among the rural dwellers. The livelihood of rural dwellers in these regions revolves greatly around women investing their resources in cocoyam production and sale in local markets. Incomes generated from these activities are channelled into meeting various family needs (Okoye *et al*., 2012).

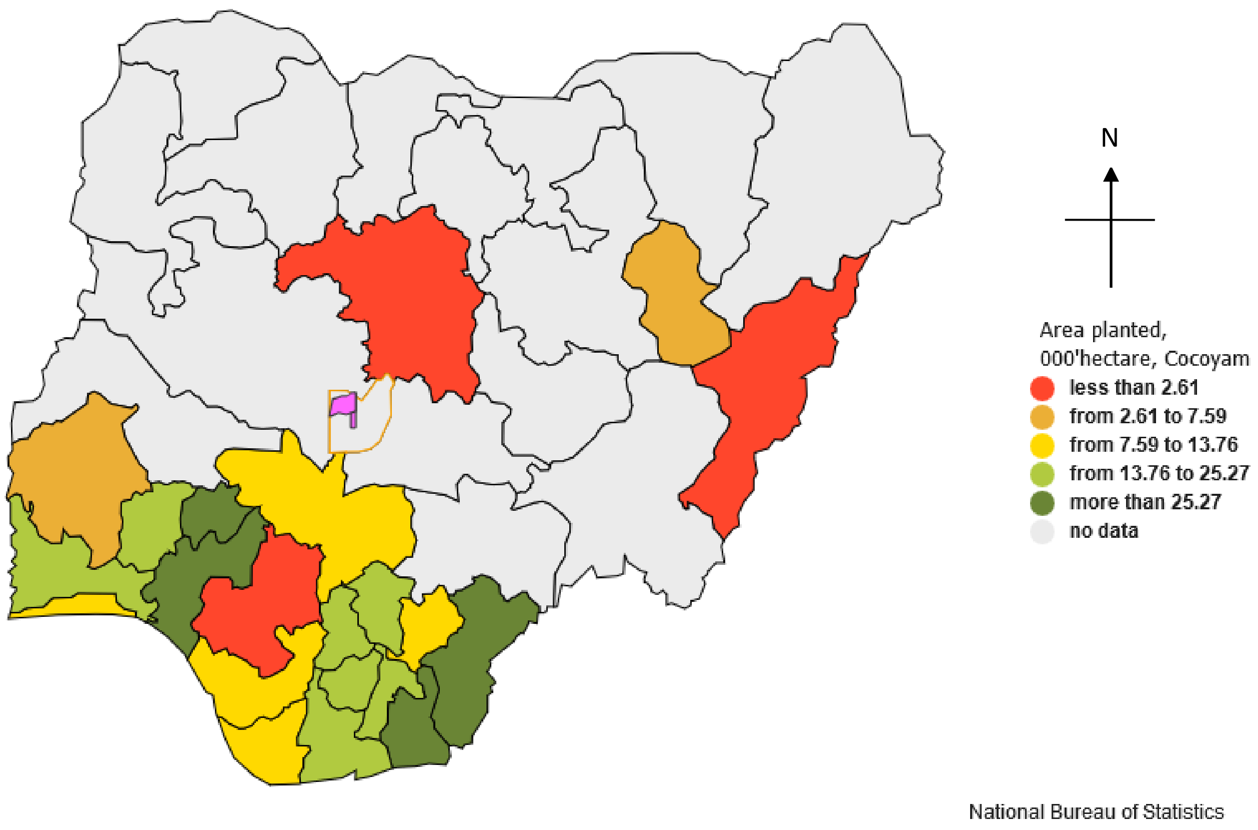


Figure 2.2: Cocoyam production by States in Nigeria
Source: National Bureau of Statistics (NBS) (2012)

2.1.6 Recommended cocoyam production technologies

The term technology has been given various definitions in previous literatures. Technology can be seen as the process by which humans modify nature to meet their needs and wants (David and David, 2010). They also defined technology as the systematic application and collective human rationality to the solution of problems through the assertion of control over nature and all kinds of human processes. Famoriyo (2010) also defined technology as the accumulation of scientific know-how and its adoption to suit the environment and needs of man. It is the use of scientific knowledge to solve practical problems. Technology includes the use of materials, techniques and sources of power to enhance efficiency and make life easier (Famoriyo, 2010). Technology and knowledge are inseparable. It is also information that is necessary to achieve certain production and processing outcomes. The non-acceptance of improved innovations and the logistic problems in the transfer of improved modern technologies to the predominantly farming populace is one of the greatest hitches facing agricultural scientists and extension service delivery in Nigeria (Adekoya and Tologbonse, 2010).

Some of the technologies transferred to farmers are adopted initially while some eventually discontinued. The reason for this is due to inadequate consideration of potential adoption impediments that face the target farmers. Poor storage facilities, insufficient planting materials, weeds problem and poor soil result to low productivity in cocoyam (FAO, 2011). Therefore, National Root Crops Research Institute (NRCRI), Umudike and extension agencies provided research-based information on improved cocoyam production technologies to improve yield. The efforts have been supported with the use of extension publications. The improved cocoyam production practices that have been developed and transferred to farmers over time includes cocoyam intercropping technique, cocoyam mini-setts technique, method of fertilizer application, plant spacing, planting depth (15 – 20cm deep), weed control method, mulching, pest control, time of planting and harvesting method (NRCRI, 2013).

2.1.6.1 *Cocoyam intercropping technique*

This method was developed and confirmed by NRCRI, Umudike that cocoyam can be intercropped with other crops and still maintains high yield. For instance, *Colocasia spp* does well when intercropped with maize or groundnut while *Xanthosoma spp* produce high yields when intercropped with plantain. For effective intercropping, 20,000 stands/ha of *Xanthosoma spp* are recommended to be intercropped with 1,600 stands of plantain per hectare. Similarly, 20,000 stands/ha of *Colocasia spp* can intercrop well with 40,000 stands/ha of maize and groundnut respectively four weeks before planting the cocoyam (NRCRI, 2012).

2.1.6.2 *Cocoyam mini-setts technique*

Cocoyam mini-sett technique is defined as cutting of corm/cormels into many setts weighing about 25g each. The mini-sett technique is a means of rapidly multiplying limited number of cocoyam (corm and cormels) to produce large quantities of planting materials in the shortest possible time. Since cocoyam corms and cormels serve as food and planting materials, this therefore leads to shortage of planting materials. To eliminate this, NRCRI, Umudike developed cocoyam mini-setts technique. In the preparation of this technique, the apical bud is cut off with enough portion of the flesh to about 25g. This, on its own is a planting material. The remaining portion of the corm or cormel is cut cross-sectionally through the internodes at 1-2cm thickness which are sliced into two, four sets or more but each one not less than 25g in weight (NRCRI, 2012).

2.1.6.3 ***Method of fertilizer application***

It is recommended to apply N.P.K 15:15:15 fertilizer immediately after weeding by using the ring method (Okoye *et al.,* 2010) while organic manure is applied immediately after planting the tuber.

2.1.6.4 ***Plant spacing***

When planting on ridges, the recommended space is 1m X 1m. The same plant space can also be used when planting on flat land and heaps. Planting cocoyam on flats beds makes the operation easy. It also saves money and time when compared to planting the tuber on ridges or mound. It worth noting that, when sowing cocoyam manually, planting space should be kept constant to create uniform rows and columns. This makes it easier to conduct some other farm operations such as weeding (Chemical and Manual) and fertilizer application.

2.1.6.5 ***Planting depth***

Cocoyam is planted on top of prepared heaps or ridges and covered with light soil at about 15 - 20 cm deep in the soil. The cut surface of the planting material should face upward in a slanting position.

2.1.6.6 ***Weed control method***

Weed control is total, from furrow to the crest of the ridge or mound. This is necessary to eliminate possibility of weed competing with the crop for space, light, nutrient and water at active growth stage. Weeding from furrow (base) to the crest (top) of the mound or ridge will ensure enough sanitary condition towards pests and diseases prevention and also boost aeration in the entire farm.

2.1.6.7 ***Mulching***

This is the covering of topsoil with plant materials such as leaves, grasses, crop residues, straw.

Mulch on cocoyam would enhance the activities of soil organisms such as earthworms. The soil is protected from sun rays thereby reducing loss of moisture. The plant remains also decay and increase humus content to the soil. This creates conducive soil condition that enables the plant thrive better.

2.1.6.8 ***Pest control***

This involves improved cultural practices such as early planting, use of well drained soils, use of disease-free planting material and pest resistant cocoyam cultivars to reduce pest and disease attack.

2.1.6.9 ***Time of planting***

The recommended period by NRCRI is May – June. This is the period of rainfall which the crop requires for sprouting and emergence. This period enables the soil to become cool and conducive.

2.1.6.10 ***Harvesting method***

Harvesting is done by digging manually with hoe round the cocoyam plant at about 30cm away from the stalk. The plant is then lifted from the soil carefully followed by cutting off petiole (leafstalk) from the base of the plant if it is not totally dead before detaching the cormels from the plant's base (NRCRI, 2013).

2.2 Empirical Review of Past Studies

2.2.1 Socio-economic characteristics of cocoyam farmers

One basic step towards cocoyam transformation is to investigate the socio-economic determinants as critical issue in the production process. Earlier research reported by Onyenweaku and Ezeh (1987) had blamed low cocoyam production on inadequate priority attention on the part of government administrations and agricultural policies. There seems to be paucity of information on land, labour and other socio-economic variables as well as inputs determinants of production among the cocoyam farmers in South-South, Nigeria (Nwakor *et al.,* 2014).

2.2.1.1 *Age of cocoyam farmers*

The work of Davies *et al.* (2014) reported that the majority of cocoyam farmers in South-Eastern Nigeria are between the age ranges of 41-50years. This age group could be regarded as the economically active age group in which their energies could be utilized for productive purposes. Age is also a vital factor that affects technologies adoption and usage. It is a primary latent characteristic in decision of technology acceptance. However, there is a contention on the direction of the effect of age on the use of technology. Age was found to positively influence integrated pest management on cocoyam (*Colocasia*) production in Delta State (Agbamu, 2006).

The effect stemmed from accumulated knowledge and experience of farming system obtained from years of observation and experiments with various technologies. Since acceptance of technology occurs over a long period of time, it can have a profound effect on technology acceptance. However, age has been found to be either negatively correlated with acceptance of technology or not significant in farmers' acceptance of technology. In studies on adoption of improved cocoyam varieties in Cross River State (Baidu-Forson, 2011; Eluagu, 1999), age was negatively related to adoption.

As a matter of fact, it was expected that older people adopt new technologies at slower pace because of their tendency of adapting less swiftly to a new phenomenon. In technology acceptance, a study in the south-south in Nigeria showed that the mean age of heads of farm households was between 45 and 50years, with the age graph skewed towards the right. This study also shown that there was no association between age and acceptance behaviour of farmers on the intercropping of plantain and cocoyam (Obiefuna, 2010). Age of farmers is also paramount in ideas or technology acceptance. According to Asiabaka (2003), youths are often energetic, motivated and adaptive individuals. This finding contradicted the finding of Awoke and Obeta (1998) whose work was dominated by aged farmers, who are often conservative to technology adoption and as well cannot withstand the rigors and strains involved in farming.

2.2.1.2 *Sex*

Many researches showed mixed evidence regarding different roles of men and women in technology usage. In one of such studies, Ahmadu (2009) in his study on factors influencing the use of improved cocoyam varieties in Akwa Ibom State, showed insignificant effects of gender on the use of cocoyam varieties. Since the acceptance of a practice is guided by the utility expected from it, the effort put into using it is reflective of this anticipated utility. It might then be expected that the relative roles women and men play in technology acceptance are similar, suggesting that males and females accept practices sometimes equally or differently depending on their social values and perceptions (Aguegia, 2011).

In another study, Nsabimana and Masobo (2013) found that gender was not significant in the use of chemical control of cocoyam leaf-rot. Aguegia (2011) reported that the result of socio-economic analysis of the farmers revealed that females were involved more in cocoyam cultivation than men. This fact cannot be disputed since Nigerian women are known to play indispensable role in solving many problems that constitute bottlenecks in smallholder farming systems especially weeding, harvesting, and storage. Also, many of the small-scale farmers who live in the rural areas of Nigeria are women who engage not only in on-farm production activities, but including post-harvest activities such as processing. This is because a sizeable proportion of Nigeria's annual food output is produced by small-scale women farmers.

Therefore, given the important roles women play in economic development, one would not be surprise if the pride of higher cocoyam production is given to women. It was also reported in the work of Admiral *et al.* (2013) who showed that majority (55%) of the farmers in cocoyam production were females while 45% were males. Although, cocoyam is produced mainly by males in some Nigeria's farming communities, but the traditional roles of women in the production and utilization processes in South-South Nigeria seems to attribute cocoyam production to women as major apostles in nutritional needs of households. Aguegia (2011), report on the socio-economic analysis of farmers revealed that females were more involved in cocoyam cultivation than male.

2.2.1.3 *Educational status*

Studies on the effect of education on technology acceptance in most cases related to number of years of formal schooling. Education is a vital tool which creates conducive mental behaviour towards accepting new ideas especially on information and management intensive practices (Ekong, 2005). Adesina and Baidu-Forson (2015) noted in their study that education positively affects acceptance of technologies. According to Rogers (1993), technology complexity has a negative effect on its use but education reduces the level of complexity in a technology thereby increasing acceptability of such technology due to the ability to read and understand sophistications accompanying information packaged with the technologies.

In another study, Tokula *et al.* (2008) found that educational level positively influenced acceptance of improved cassava varieties by farmers in Kogi State of Nigeria. This implies that, there was possibility of understanding the usage of new innovations by respondents. According to Iheke (2010) in his study, the mean educational level of (7.5 years) implied that most of the sampled

farmers had formal education and they are expected to be more receptive to improved farming techniques than farmers that have no formal education. The level of educational attainment by farmers as affirmed by Eze and Akpa (2010) will not only increase their farm productivity but also enhance their ability to understand and evaluate new production technologies.

This finding of Ume (2014) who posited that high educational status facilitates adoption as it makes one to be more objective in evaluating innovations which would positively influence his/her production capacity. Okoli (2012) found the coefficient of schooling to be inversely related to the adoption index of the improved cassava technology package. Okoye *et al.* (2012) found that the probability of adoption of soil conservation practices was higher among farmers who had attended formal education.

2.2.1.4 *Household size*

The 2006 population census in Nigeria has adopted the definition of a household as all the people living together under one roof, eating from the same pot and recognizing one person as the head of the household. Analysis of the 2006 census indicated that 70% of rural communities in some states like Jigawa, Kebbi, Sokoto, Bauchi and Katsina had 5 – 7 persons per household (National Population Census (NPC) 2006). Nsabimana and Masobo (2013) in their study found that large household size imposes pressure on the output of the farm and as such affect the use of technology. Ekong (2005) reported that rural areas tend to have large household than urban areas. According to Ogunwale (2012), larger family sizes are more likely to accept soil improvement technologies due to sufficient labour. A study on acceptance of agricultural technologies found positive correlation with household size and farm labour, suggesting that a large household yields a high labour force (Agwu, 2000).

In general, large household size has high food demands than smaller households. Hence, farmers are likely to accept any technology that improves food production needs. In the study of agricultural technology acceptance, Tokula *et al.* (2008) found that household size was significant to technology utilization of root and tuber crops implying that, the more the number of people in a household, the higher probability of accepting improved root and crops technology.

2.2.1.5 *Farming experience*

Farming experience (number of years in farming) is also an important factor among the socio-economic characteristics of farmers. It deals with the number of years the farmer had been exposed to steps towards meaningful cocoyam production. Tanko and Opara (2010) remarked that years of farming experience enable farmers to set a realistic goal. However, Ume *et al.* (2008) reported that farmers counted on farming experience more than educational attainment to attain higher productivity. Suleiman (2019) in his study shows that 49.64 percent of cocoyam farmers had between 11-15 years farming experience and only 17.03 percent had farming experience of between 6 -10 years. The mean year of experience of farmers is 12 years. Based on the result as presented, he concluded that the farmers experience in farming is long enough to be able to make sound decisions as regards the use of improved cocoyam production practices in their farms.

2.2.1.6 *Membership of cooperative organization*

A cooperative organization is an autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled enterprise (International Cooperative Alliance (ICA), 2010). It could be single or multipurpose depending on the needs of the forming members. There are performance indices used in measuring performance of cooperative societies such as loan recovery ability, access to credit facilities from public financial and government institutions, access to agricultural input, leadership training and regular organization of annual general meetings (Kanoma, 2011).

Cooperative is vital towards social, political and economic gains realization. The organization is formed when a number of people with common interest and ideas come together to share certain values and interests and thereby identify closely with one another. Membership of such organizations is generally perceived as a more efficient way of disseminating technologies to farmers in rural communities as well as a source of social capital that facilitates exchange of resources between members. Social capital manifested in community-based organization or personalized social network has been found to play an important role in the acceptance of crop production technologies (Akinrele, 2012; Adekoya and Tologbonse, 2010). Cooperative organizations play important roles in agricultural development by providing farmers with production input like fertilizer, seeds and as well agro-chemicals (Aref, 2011).

Therefore, it is expected that membership of social organizations of cocoyam farmers would positively influence acceptance of improved cocoyam production practices. Membership of organization coefficient had positive relationship with technology adoption rate according to Onyenweaku *et al.* (2010). Cooperative organization is capable of enhancing members' access to agricultural information, training, credit and other production inputs for effective adoption of innovation. Several authors (Akpa, 2007; Ume and Okoye, 2009) concurred to this assertion. The coefficient of off farm income was positive, implying that farmers that engage in off farm income have the probability of having additional income which could be used to purchase modern inputs, hire labour and reduce the variability of farm income and smooth out their consumption.

Several studies confirm this assertion one of which is Idachaba (2003) who reported poor access to credit as the most prominent problem that confronted cocoyam farmers and represented by 81.7 percent of the respondents. This finding agrees with Iheke (2010) who asserted that paucity of fund for adoption of the technology was a persistent problem in the adoption process. Credit is a very important production resource which helps in transforming agriculture from subsistence to commercial type (Adepoju and Daramola, 2008). Unfortunately, this resource eluded most farmers because of lack of collateral, lack of knowledge and experience on how to complete loan application forms, rigorous process involved in obtaining loan and high interest rate (Ume and Okoye, 2009).

Nwakor *et al.* (2010) opined that agricultural credit procurement had been dwindling over the years in Nigeria. Without credit, most farmers cannot afford recommended inputs because the income of a small-scale farmer is very low in Nigeria (Ogunwale, 2012). Baidu-Forson (2011) found amount of credit received to be associated with higher degree of soil conservation. This suggests that individuals with low income and inability to obtain credit for conservation investments may not be willing to adopt soil conservation techniques.

2.2.1.7 *Extension visit*

On extension visit, this is vital and a means of coordinating information-based technologies from research to the farmers and feedback from farmers back to research. Extension services have not been much effective due to World Bank sponsorship withdrawal (Nwakor *et al.*, 2010).

The major problem in the Sub-Saharan Africa is that year after year extension workers who are hardly afforded in-service training and are loosely linked to research continue to disseminate same message repeatedly to the same audience. This situation has consequently arisen where the disseminated messages to the majority of the extension audience have become technically redundant and obsolete (Effiong, 2005).

The more farmers' access to the extension services, the higher the rate of adoption of such innovation. This could be because extension services help to disseminate information on the mode of application or usage of the technologies as well as the availability of the technological inputs to the farmers. Therefore, frequent extension contact would minimize doubts among farmers, ensure timely procurement of inputs and most probably encourage sustained usage of the improved technologies (Rogers, 2003).

Nwakor *et al.* (2010) reported positive relationship between adoption of improved cassava varieties in Abia State of Nigeria and the number of extension visits. Nevertheless, this assertion contradicted Eze and Akpa (2010) who cited inefficient transfer of information to farmers as well as a bottleneck that militated against enhancing the adoption of technology as a critical reason for the behaviour of the variable. According to Ume *et al*. (2015) in their study, extension visit, cooperative membership, off-farm income and educational level were the major determinants of extent of technology adoption of cocoyam production in the study area.

2.2.1.8 ***Labour usage***

Labour also is an important socio-economic characteristic towards significant production increase. It is the human efforts towards production. A high proportion of sampled farmers (81.7%) encountered the problem of high labour cost (Ume *et al.*, 2015). Labour cost constituted about 35 – 40 % of the total cost of production as most of traditional farm level operations are nearly zero mechanized (Tanko and Opara, 2010). With increase in population, rural-urban migration, the ageing of the rural farming population and feminization of agriculture, labour would likely be inelastic and expensive. The effect was high cost of production and consequently low returns. Yusuf *et al.* (2011) found rate of use of improved technologies to be relatively high because, the technologies were easy to operate requiring available affordable labour. Labour constraints affect farmers' choice of technology in several ways (Enyong *et al*., 2013).

2.2.2 Adoption level of recommended cocoyam production technologies

Ogunwale (2012) posited that results of research do not serve any useful purpose until it is introduced to farmers, adopted by them and put into practice on their farms. Many factors come into play in the process of technology acceptance. This is because reasons for change are many and complex. Some of the reasons relate to the farmer himself, some are social and cultural and some are situational in nature. More so, the adoption of a technology is not a sudden event, but a process because farmers do not adopt innovation immediately. They need time to think over before making a decision. The reluctance of a farmer to adopt a certain innovation could be that he has not reached the appropriate stage of development and does not see the practice as essential for the continuing development of his/her enterprise. Ogunwale (2012) emphasized two kinds of forces which can affect a farmer as change-inhibiting and change-promoting forces. He considers the following as inhibitors to acceptance of a technology and diffusion process as discussed below:

(i) Inadequate knowledge or information concerning the innovation

This could lead to lack of awareness of existence of innovation and how innovation operates. This makes it even difficult for the farmers to comprehend simple instructions on improved agricultural technologies. Eleazu *et al.* (2014) reported that if farmers' knowledge in environmental management is increased, they will likely adopt more of the practices related to it.

(ii) Perceived attributes of an innovation

There is a clear distinction between the actual attributes of an innovation and the farmer's perceived attributes. Perception is a cognitive process influencing the acceptance and use of information or technology (Enyong *et al*., 2013). Each time a person comes across new information/technology, whether it is improved or local, the process of selection, organization, interpretation and consideration occurs in the mind of the individual (Ikoku, 2000). It is practically impossible to isolate perception of production technologies from agricultural production and productivity (Yusuf *et al.,* 2011). The perceived attributes of an innovation include; its relative advantage, its complexity (ease of understanding the innovation); its trial (the possibility of trying the innovation initially on a small scale to observe if the attributes of the innovation are negative or satisfactory).

One of the most important determinants of the outcome of innovation-decision process is the adopters' perception of a technology (Akpoko, 2014). In taking a decision, the individual may be influenced by issues involving social pressures (Nuwangi *et al.*, 2013) such as competitors, government compliance, customers, vendors or employees (subjective norms) (Alarifi and Sedera, 2013). In addition, individual conditions such as perceived ease or difficulty (perceived behaviour control) help to facilitate the adoption or rejection of new technology (Bulgurcu *et al.,* 2010).

(iii) Use of wrong communication channels

Acceptance and diffusion studies show that, mass media channels are more effective for less complex innovations while interpersonal channels (face to face interactions, training, workshops meetings and seminars) are more effective for complex innovations. For instance, radio appears to be the most widely used mass media channel for agricultural information delivery because of its versatility. On the other hand, the use of print media in illiterates dominated society would definitely hinder diffusion and acceptance of innovation. In some cases, information carried by extension agents are not tailored to the information needs of rural farmers even when the information is relevant, there may be no right logistic support for the transfer of the information (Adams, 2014). Adoption level decreases as this situation persist resulting to non-realization of intended objectives.

(iv) Apathetic of change effort

If the extension agent is not personally interested in the innovation or not socially sound enough to come to the level of the farmers, diffusion and acceptance would be hindered because farmers may notice the lack of enthusiasm in the change agent and consequently approach the technology with apathy. Akpoko (2014) and Yusuf *et al*. (2011) found positive relationship between farmers' social status and adoption of innovations. Also, the situation is not helped by the rather poor extension system that currently exists in the country.

2.2.3 Adopter categories

All individuals in any given social system do not accept an innovation at the same time. But they accept in an over-time sequence, so that individuals can be classified into adopter categories on the basis of when they first started using a new idea. We could describe each individual adopter in a social system in terms of his or her time of adoption, but this would be very tedious. It is much more efficient to use adopter categories, the classification of members of a system on the basis of their innovativeness. Each adopter category consists of individuals with a similar level of innovativeness. So, adopter categories are a means of convenience in describing the members of a system. The five adopter categories (Rogers, 2003) set forth in this section are ideal types, concepts based on observations of reality that are designed to make comparisons possible. Ideal types are not simply an average of all observations about an adopter category. Exceptions to the ideal types can be found. Ideal types are based on abstractions from empirical investigations.

(i) Innovators

They are venturesome. Their interest in new ideas leads them out of a local circle of peer networks and into more cosmopolite social relationships. Communication patterns and friendships among a clique of innovators are common, even though these individuals may be quite geographically distanced. Being an innovator has several prerequisites. Control of substantial financial resources is helpful in absorbing the possible losses from an unprofitable innovation. They are adventurers and are very eager to experiment with new ideas (Ahmed, 2015). The ability to understand and apply complex technical knowledge is also needed. The salient value of the innovator is venturesome-ness, due to a desire for the rash, the daring, and the risky. The innovator must also be willing to accept an occasional setback when a new idea proves unsuccessful, as inevitably happens. While an innovator may not be respected by other members of a local system, the innovator plays an important role in the diffusion process; that of launching the new idea in the system by importing the innovation from outside of the system's boundaries. Thus, the innovator plays a gate-keeping role in the flow of new ideas into a system. Innovators constitute 2.5% in any social group.

(ii) Early adopters

Early adopters are a more integrated part of the local social system than are innovators. Whereas innovators are cosmopolites, early adopters are localities. This adopter category has the highest degree of adoption leadership in most systems. Potential adopters look unto early adopters for advice and information about any given innovation. The early adopter is considered by many to be the individual to check before adopting a new idea. This adopter category is generally sought by change agents as a local missionary for speeding the diffusion process. Because early adopters are not too far ahead of the average individual in innovativeness, they serve as a role model for many other members in a social system. Early adopters help trigger the critical mass when they adopt an innovation. They are educated and this enables them develop positive mind towards new technologies acceptance.

Aphunu and Ajayi (2010) show that, an increase in knowledge will lead to change in perception which in turn influences behaviour towards an innovation. The early adopter is respected by their peers, and is the embodiment of successful, discrete use of new ideas. The early adopter knows that to continue to earn this esteem of colleagues and to maintain a central position in the communication networks of the system; he or she must make judicious innovation-decisions. The early adopter decreases uncertainty about a new idea by adopting it, and then conveying a subjective evaluation of the innovation to near peers through interpersonal networks. In one sense, early adopters put their stamp of approval on a new idea by adopting the idea and they constitute about 13.5%.

(iii) Early majority

They adopt new ideas just before the average member of a system. The early majority interacts frequently with their peers but rarely hold positions of opinion leadership in a system. They are important link in the diffusion process due to their location between the very early and the relatively late to adopt members. They provide interconnectedness in the system's interpersonal networks. The early majority are one of the most numerous adopter categories, making up one third of all member of a system. The early majority may deliberate for some time before completely adopting a new idea. Their innovation–decision period is relatively longer than that of the innovators and the early adopters. They follow with deliberate willingness in adoption of innovations but rarely lead. They constitute 34% in the adopter categories as stated also by Ahmed (2015) in his study.

(iv) Late majority

The category adopts new ideas just after the average member of a system. Like the early majority, the late majority make up one third of the members of a system. Adoption may be both an economic necessity for the late majority and the result of increasing peer pressures. Innovations are approached with scepticism and cautiousness. The late majority do not adopt until most others in their system have already adopted the idea. Akinrele (2012) indicated that a decision to accept or reject is not the terminal stage because, the human mind is dynamic and an individual constantly evaluates a particular situation. Therefore, if the individual perceives that the innovation is consistently being satisfactory or not satisfactory, he/she may accept or reject the innovation as the case may be. The weight of system norms must definitely favour an innovation before the late majorities are convinced to accept it. The pressure of peers is necessary to motivate adoption. Their relatively scarce resources mean that most of the uncertainty about a new idea must be removed before the late majority feel that it is safe to adopt.

(v) Laggards

Laggards are the last in a social system to adopt an innovation. They possess almost no opinion leadership. Laggards are the most primitive of all adopter categories. Many are near isolates in their social networks. The point of reference for the laggard is the past. They interact primarily with others who also have relatively traditional values. Laggards tend to be suspicious of innovations and of change agents. Their innovation-decision process is relatively lengthy, with adoption and use lagging far behind awareness knowledge of a new idea. Resistance to innovations on the part of laggards may be entirely rational from the laggard's viewpoint, as their resources are limited and they must be certain that a new idea will not fail before they can adopt. They are uneducated and in most cases, do not have meaningful association with members within the social group hence, do not share in the view of Idiong *et al*. (2014) who stated that membership of social organizations affords farmers the opportunity of sharing information on innovation together about modern farming practices and its timely adoption. Their precarious economic position forces the individual to be extremely cautious in adopting innovations. Laggards constitute 16% of the adopter categorization.

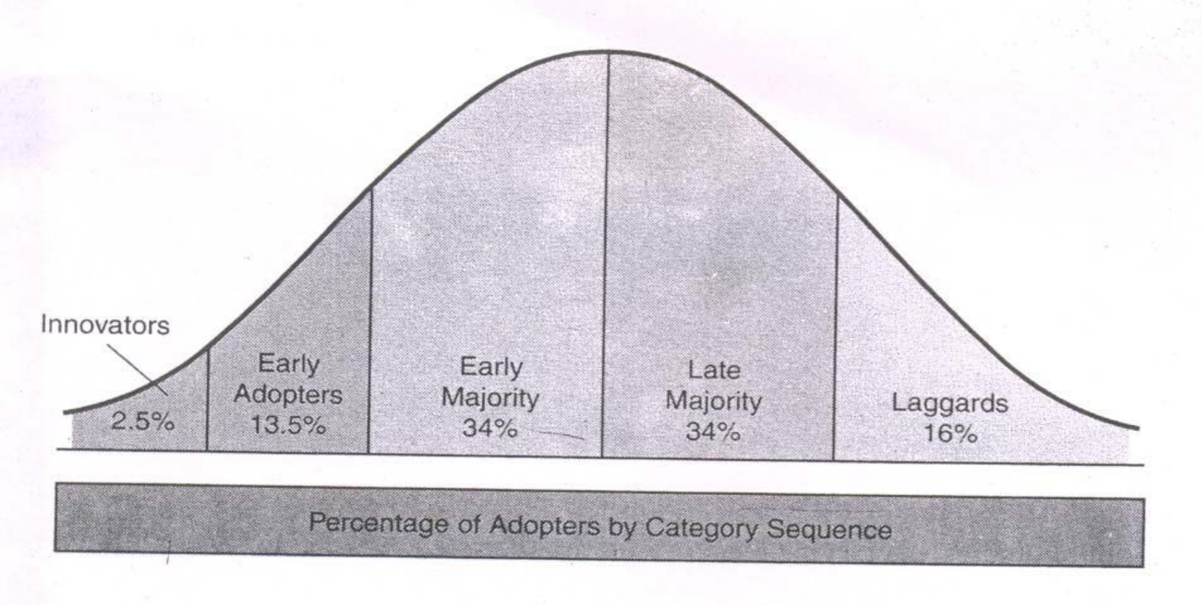


Figure 2.3 Classification of Adopters in a social system
Source: Rogers, 2003

2.3 Theoretical Framework

The study will be guided by theory of social change, diffusion and adoption perspectives, perception and innovation-decision process.

2.3.1 Theory of social change

The social change has been defined by Ekong (2005) as 'the process by which alteration occurs in the structure and function of a social system or society'. Any change that occurs either in ideas, norms, values, attitudes, roles, social habits and improved technologies to people or organization can be referred to as social change. Social change on the other hand could mean large number of persons engaging in group activities, interaction and relationships when viewed within the context of a social system. Social change may be planned or unplanned. Planned change entails the direct human intervention in the shaping and direction of change towards a defined goal (Admiral *et al.*, 2013).

For instance, National Root Crop Research Institute (NRCRI) Umudike improved cocoyam production practices developed for rural farmers are perceived as planned change to bring about improvement in traditional method of cocoyam production with the primary purpose of increasing yield and income of farmers. Therefore, the theory of social change within the framework of this study will help understand the social reality which demonstrated the changes that have taken place in the analysis of rural farmers" use of improved cocoyam production practices in South-East, Nigeria. Hence, the occurrence of social change can better be explained by diffusion and adoption perspectives.

2.3.2 Diffusion and adoption perspectives

Diffusion – Adoption model was comprehensively developed by Rogers (1995) to explain how, why and to what extent new ideas or practices spread and used by an individual and organizations. He defined the term diffusion of innovation as a process by which innovations spread. Diffusion involves four essential elements: innovation, its communication from one group to another, a social system within which this process occurs and the period (time). The distinction between adoption and diffusion concepts is that, adoption is the acceptance and continuous use of an idea or practice while, diffusion on the other hand, is the spread of idea or practice through the whole of potential audience or social system.

According to Rogers (1995), adoption is a decision to continue full use of an innovation. Adoption is not a sudden event, but a process. The adopters of any innovation or idea can be classified into one of five categories: innovators, early adopters, early majority, late majority and laggards. The decision to use or adopt an improved practice by a farmer involves a series of stages which include awareness, interest, evaluation, trial and adoption. Farmers do not accept innovations immediately. They need time to think things over before making a decision. Therefore, the improved cocoyam production practices were developed and taken to the doors of the rural farmers and the usefulness of the practices to them is what this study has analysed. Therefore, this theory assisted in understanding and explaining the rural farmers‟ use of improved cocoyam production practices in the study area. It will also help to explain how the improved cocoyam production practices have spread among the rural farmers in South-East Nigeria.

2.3.2.1 ***Stages of adoption***

Past studies on technology adoption have focused predominantly on a single action (a snapshot to adopt or not to adopt) (Aguirre-Urreta and Marakas, 2012) without considering other actions (information search or awareness, interest, evaluation and trial). Such explanation prevents a holistic understanding of the technology adoption process especially for organisations having widespread technology resources where the process needed to arrive at the final decision is a far more complex phenomenon (Damanpour and Schneider, 2006). Few other studies, however, have recognised the importance of illustrating technology adoption as a process (Campbell *et al.*, 2013) who demonstrated the fact that determinants of technology adoption vary during the adoption process (progression from one stage to another). The five stages are awareness, interest, evaluation, trial and adoption (Shoham, 1992). But According to Fichman and Kemerer (2012), the term ‘technology adoption stages’ refer to processes of spanning an organisation’s awareness of technology through to its widespread deployment. This view is in line with the broader stages of technology adoption, including pre-adoption, adoption and post-adoption.

(i) Awareness stage

It is the knowledge of existence of a phenomenon or ideas. To create awareness on government policies and programmes, public enlightenment organs such as the mass media, National Orientation Agency (NOA), Ministry of Information and Agricultural Extension Service were formed, funded and charged with the responsibility of information dissemination (Federal Office of Statistics, 1999). Oyenweaku and Mbaba (2013) discovered that the most limiting factor of innovation acceptance is lack of awareness of the technology. Without awareness campaigns, knowledge and ideas may hardly reach those in need of it (Swanson *et al.*, 1984). The importance of awareness creation as a component of agricultural extension in introducing new ideas, technologies and practices has since been given premium recognition.

Awareness is the first step in the adoption process when considering new ideas or technologies. At the stage of awareness, mass media tools such as radio, newspaper, magazine, television, motion pictures, slide shows, exhibitions and printed materials are used to introduce new ideas and practices to alert people on emergencies such as the urgent need for the use of sustainable agricultural land management practices. Although, the awareness stage gives little information about the idea it portrays but it serves as an appetizer, catalyst or stimulant that arouse clients’ interests to seek additional information on the idea in the subsequent stages of adoption process (Ume *et al.*, 2015).

The success or failure of the other stages of the adoption process which include interest, evaluation and trial depends on how the awareness stage is managed. It is however observed that, at this stage, the farmer has limited knowledge about the technology. Therefore, he might want to know more about the information after hearing about it from other family members, friends, neighbours, mass media, extension agents, researchers, sales promoters and local cooperative organizations (Ekong, 2003). Exposure to information about new technologies significantly affects farmers' choices about such technologies. Sometimes in adoption process, interest may precede awareness especially in a situation where farmers may need to control new and unknown disease or pest outbreak that negatively impacted their progress (Famoriyo, 2010).

Firms tend to switch to other technologies if they do not receive adequate information during the early stages of the adoption process (Cisco, 2012). This indicates the critical nature of actions at the start of the adoption process and their importance in relation to the successful adoption of technologies. In understanding the process of technology awareness as a stage in adoption, we follow the definition of Rogers (1995) which states that technology adoption is a process in which the technology is communicated through certain channels over time among the members of social systems. This view has stated that a holistic explanation comprising (but not limited to) process and time elements are essential in the adoption of new technologies.

(ii) Interest stage

This is the second stage of the adoption decision making process. Sometimes interest stage may precede awareness stage particularly in critical situations where farmers are faced by pressing need of controlling new and unknown diseases and pests' outbreak that negatively impacted their progress (Famoriyo, 2010). At this stage, the farmer takes further personal steps or initiatives to acquire more information on the technology such as its nature, how it operates, applicability that could necessitate his movement to the next stage or rejection of the technology at this stage. The interest stage is crucial as it enables the farmer acquire sufficient information and become familiar with the new agricultural knowledge (Aremu *et al*., 2018).

(iii) Evaluation stage

According to Aremu *et al*. (2018), this stage is also known as a stage of persuasion. The farmer analyses the information obtained on the technology and considers the positive as well as the negative that may arise from the use and non-use of the innovation (what he stands to gain by accepting the innovation and what he stands the chance of losing following the rejection of the innovation).

(iv) Trial stage

Based on the positive outcome of the evaluation stage, the farmer will first use the technology on a small scale and later, increase its application as outcome from the use continues successful resulting to increased yield and gain. On the other hand, if the results of the mental evaluation are negative, the farmer will reject the new technology (Aremu *et al*., 2018). Farmers may not take up any new idea on a large scale at this because of the risk evaluation need by the individual farmer even though the potential of the idea has been proved. They actually apply the new idea on a small scale in order to determine its utility, feasibility or applicability in own situation. Even though, people take a decision to try the idea by virtue of its plus points or merits, generally the effectiveness of the idea is tested by taking it on a small scale.

(v) Adoption or Rejection stage

This is the final stage of decision – making process to accept or reject an innovation or new technology by farmers in agriculture. It is a stage of consequences consideration and conclusion according to information obtained by the individual in the previous four stages with he will make the decision whether to adopt the agricultural techniques for good, or reject them based on past experience (Aremu *et al.,* 2018). Being satisfied with the performance of the new idea that was tested on small scale in their own situation, the people use the new idea continuously on a full scale. Trial may be considered as the practical evaluation of an innovation. Based on feedback from trial, people take final decision and apply the innovation in a scale appropriate to own situation on a continued basis. Events of the adoption stages are sequential, favourable end of one stage is a necessary step towards the next stage.

Oyenweaku and Mbaba (2013) discovered profitability as the major reason for acceptance of technology. In any social system, the adoption period differs between individuals within such system and the concern or role of extension in this regard is to strive at shortening individuals' length of adoption period through rapid diffusion of the innovation within the social system thereby improving on their productivity and economic power. The time taken from awareness of an innovation up to its adoption is called the 'adoption period'.

2.3.3 Theory of perception

It is a cognitive process that enables acceptance and application of information or technology (Enyong *et al*., 2013). Each time a person comes in contact with new information/technology, whether it is improved or local, the process of selection, organization, interpretation and consideration occurs in the mind of the individual (Ikoku, 2000). It is practically not possible to isolate perception from production technologies of agricultural products (Yusuf *et al.,* 2011). Perception as part of cognitive process is in the centre of interest of several scientific disciplines, while the acceptance or refusal of improved agricultural practices and technologies is dependent upon the individual (Enyong *et al*., 2013).

The penetration of perception into production practices or technologies is fast gaining attention. Perception is defined as the process by which people receive information or stimuli from their environment and transform it to psychological awareness (Enyong *et al*., 2013). This is because people live in the same world and receive similar impression of things through the eyes, ears and to a lesser extent through other senses of touch, taste and smell, but people interpret experiences differently. It is a more or less permanent feelings, thoughts and pre-dispositions a person has about certain aspects of his environment. For instance, attitude has three components; knowledge, feelings and inclination to act. It is an evaluative disposition towards a subject or an object which has consequences on how a person will act about the object being perceived. Aphunu and Ajayi (2010) reported that increase in knowledge will lead to change in perception which in turn influences behaviour. According to them, perception has known general principles and these are:

(i) **Relativity**

Farmers' perception is relative rather than absolute as individual farmer is influenced by the environment in different ways, thus giving room to different interpretations.

(ii) Selectivity

A farmer tends to be selective and may pay attention to only a selection of different stimuli being experienced by him or her. Selective perception is influenced by attitude, past experiences and other physical and psychological factors.

(iii) Organization

Farmers' perceptions are organized. A farmer tends to make meaning out of confused situation by structuring the sensory experiences into meaningful order.

(iv) Direction

Farmers perceive what they expect or are set to perceive. A technology, innovation or information must from the onset show direction for the user in order to give the right perception of the message it is meant for.

(v) Cognitive style

Farmers' perceptions differ sharply from others due to differences in tolerance to various cognitive styles. Also, their mental processes are at variance due to personality factors such as tolerance of ambiguity, degree of openness and close-mindedness, authoritarianism, and other forms of communication errors. Perception is made up of beliefs that a person accumulates over his lifetime. Some beliefs are formed from direct experience, some are from outside information and others are inferred or self-generated.

Aphunu and Ajayi (2010) however, affirmed that only a few of these beliefs actually work and they are said to be immediate determinants of a person's attitude. According to them, attitude is a person's salient belief about whether the outcome of his/her action is positive or negative. Three types of attitudinal change in social psychology exist. These include cognitive change (new information from media), affective change (experience) and behavioural change (force). It has been noted that policy makers cannot be expected to understand the complex psychology of human perception, but they should appreciate why people interpret their environment differently and these different perceptions and knowledge influence individual's attitude towards the acceptance of an innovation. Perception is a major driving force towards other innovation decision processes to recommended cocoyam production technologies.

2.3.4 Theory of innovation-decision process

Innovation can be defined simply as a new idea, device or method (Adeniji, 2002). Innovation is often viewed as the application of better solutions to meet new requirements or needs of the people. The term innovation can also be defined as something original and more effective and as a consequence or new thing that breaks into the society (Famoriyo, 2010). Innovation in agriculture means the invention of improved plant and animal varieties, technologies and practices that are disseminated to farmers in order to improve productivity. According to Ikoku (2000), innovation is the process of applying new ideas to create value for an organization. This means, creating a new service, system or process to enhance existing ones.

Innovation generally refers to changing processes or creating more effective processes, products and ideas. Once innovation occurs, it is spread from the innovator to other individuals and groups. Innovations usually start from research institutes, who send to extension agents to transfer to the farmers. Farmers have the choice of accepting or rejecting the innovation. The innovation-decision process can be distinguished from the diffusion process. The major difference between the two processes is that, diffusion occurs among the units in a social system, whereas innovation decision making takes place within the mind of an individual. The innovation-decision is a special type of decision-making that involves an individual choosing from new alternatives over those previously in existence. In adoption, the process is simply referred to as AIETA meaning; Awareness, Interest, Evaluation, Trial and Adoption. This consists of a series of actions and choices over time through which an individual or an organization evaluates a new idea and decides whether or not to incorporate the new idea into the on-going system.

According to Rogers (1995) and Akinrele (2012), innovation-decision is a process that occurs over time and is conceptualized to have five stages which are knowledge, persuasion, decision, implementation and confirmation. The knowledge stage involves exposure to the existence of an innovation and understanding of its functions making a farmer to be more highly educated, has higher social status and more open to both mass media and interpersonal channels of communication and change agents. Persuasion entails the formation of a favourable attitude to it. At this stage, innovation decision may be optional, collective or authoritative-based. The decision stage is a commitment to use the innovation. The implementation stage occurs when an individual or other decision-making unit puts an innovation into use. At this stage, the individual is generally concerned with where to get the innovation, how to use it and what operational problem will be faced and how these could be solved. Implementation may also involve changes in management of the enterprise and or modification in the innovation to suit the specific needs of the particular person who accepts it. Finally, confirmation is the stage of reinforcement based on positive outcomes from the innovation.

The entire innovation-decision process is a series of choices of each function. For instance, in the knowledge function, the individual must decide which innovation messages to attend to and which one to disregard. In persuasion function, he must decide to seek certain messages and to ignore others. But in the decision function, the type of choice is different from those previous. It is a decision between two alternatives to accept or reject a new idea. Akinrele (2012) further indicated that a decision to accept or reject is not the terminal stage in the innovation-decision process. This is because, the human mind is dynamic and an individual constantly evaluates a particular situation. Therefore, if the individual perceives that the innovation is consistently giving satisfactory or unsatisfactory results, he/she may continue to accept or reject the innovation as the case may be.

2.4 Conceptual Framework

According to Akinrele (2012), a model simply means “an attempt at classifying the major elements of an entity or a phenomenon with regard to their functions and inter-relationships in order to observe more closely how the elements function together within the entity”. Asiabaka (2003) reported that these relationships and functions can be represented schematically or mathematically. The rural farmers’ decision to use improved cocoyam production practices would be determined by their socio-economic factors (age, education, household size, farming experience, marital status and sex) and institutional factors (extension contact, government policy). In compliance with this, Ogunwale (2012) reported that some forces affected farmers’ technology acceptance such as previous knowledge of the farmers (farming experience), attributes of an innovation (relative advantage, complexity, compatibility and costs). Others are use of communication channels (extension contact).

In the model as shown in Figure 2.4, the use of recommended cocoyam production technologies is subject to farmers’ socio-economic and institutional factors. Hence, these factors labelled independent variables affected the farmers’ use of improved cocoyam production practices (dependent variable) with an arrow linking them together. The relationship between independent and dependent variables resulted to the outcomes which has a link or a dotted arrow from the dependent variable to the outcomes. The implication of the dotted arrow is that, the result of the interaction between independent and dependent variables may increase the level of outcomes. Similarly, the intervening variables such as prices of the recommended cocoyam production technologies, change in government policies, climatic/soil factor, culture and value system intervened with a dotted arrow into the relationship between independent and dependent factors.

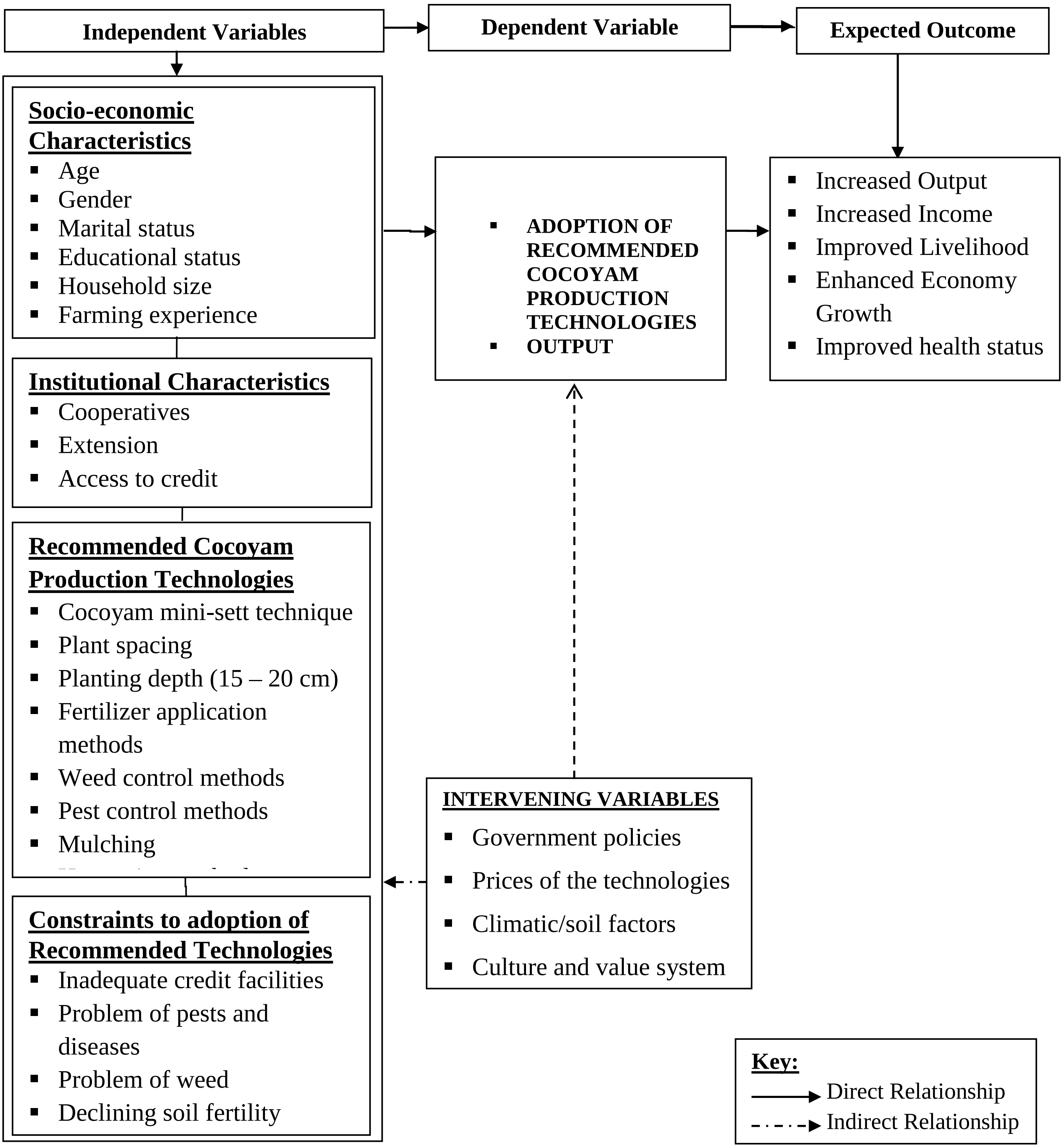


Figure 2.4: Conceptual model of factors affecting the adoption of recommended cocoyam production technologies in Enugu state, Nigeria.

Source: Author's Construct, 2021

CHAPTER THREE

3.0 METHODOLOGY

3.1 The Study Area

The study was conducted in Enugu State, Nigeria. The State is in South-East agro-ecological zone of Nigeria. Enugu State derived its name from her capital city, Enugu. The word "Enugu" (Enu-Ugwu) means 'top of hill'. It is also called Coal City (its slogan) due to the abundance of the mineral. The State was created on 27th of August, 1991 out of the old Anambra State. It has 17 Local Government Areas (LGAs) with three Agricultural zones namely: Enugu-North, Enugu-East and Enugu-West. The State lies between Latitude 7º 29' and 8º 55' North of the equator and Longitude 6º 26' and 7º 28' East of the Greenwich meridian with an altitude of 192 meter above sea level. It shares boundary with Abia and Imo States to the South, Ebonyi State to the East, Benue State to the North-East, Kogi State to the North-West and Anambra State to the West.

Enugu State covers an estimated land area of 7,161kilometre square (2,765sq mi) and ranks 29th out of the 36 States of Nigeria in terms of land area (Enugu State Ministry of Information (ESMI), 2019). The population of Enugu is about 3,267,837 comprising of 1,596,042 males and 1,671,795 females with population density of about 460 kilometres square (National Population Commission (NPC), 2006). The projected population as at 2020 using 3.2% growth rate (World Bank, 2019) was 5,078,975 with 2,480,619 males and 2,598,356 females.

More so, the State is located in the tropical humid rain forest zone with derived savannah and experiences bi-modal rainfall pattern. It has annual rainfall of about 1500mm – 2100mm. The lowest rainfall of about 0.16 cubic centimetres is recorded in February, while the highest rainfall of about 2.18 cubic centimetres is recorded in July. Wet season lasts between 7 – 8 months with a break or dry spell around August (August break). Enugu also experiences harmattan, a dusty trade wind lasting between December and January. The State has good climatic condition all year round with mean temperature of 30.6°C (87.2°F) around the hottest month of February, while the lowest temperatures occur in the month of November reaching 15.9°C (60.5°F) and mean daily temperature of 26.7°C (80.1°F) (Enugu State Ministry of Information (ESMI), 2019).

Major tribes include Igbo and few Idoma and Igala people in Etiti (Igbo-Eze North) of Enugu State. Enugu State has a well-drained fertile soil for agricultural purposes and the major occupation of the people is farming. Arable crops produced include yam, cassava, rice, sweet potatoes, vegetables and cocoyam, while tree crops include palm fruits, mango, cashew and citrus. The State is endowed with mineral resources such as coal, oil shale, gas, glass sands ironstone, clay minerals, limestone, gypsum and alum.

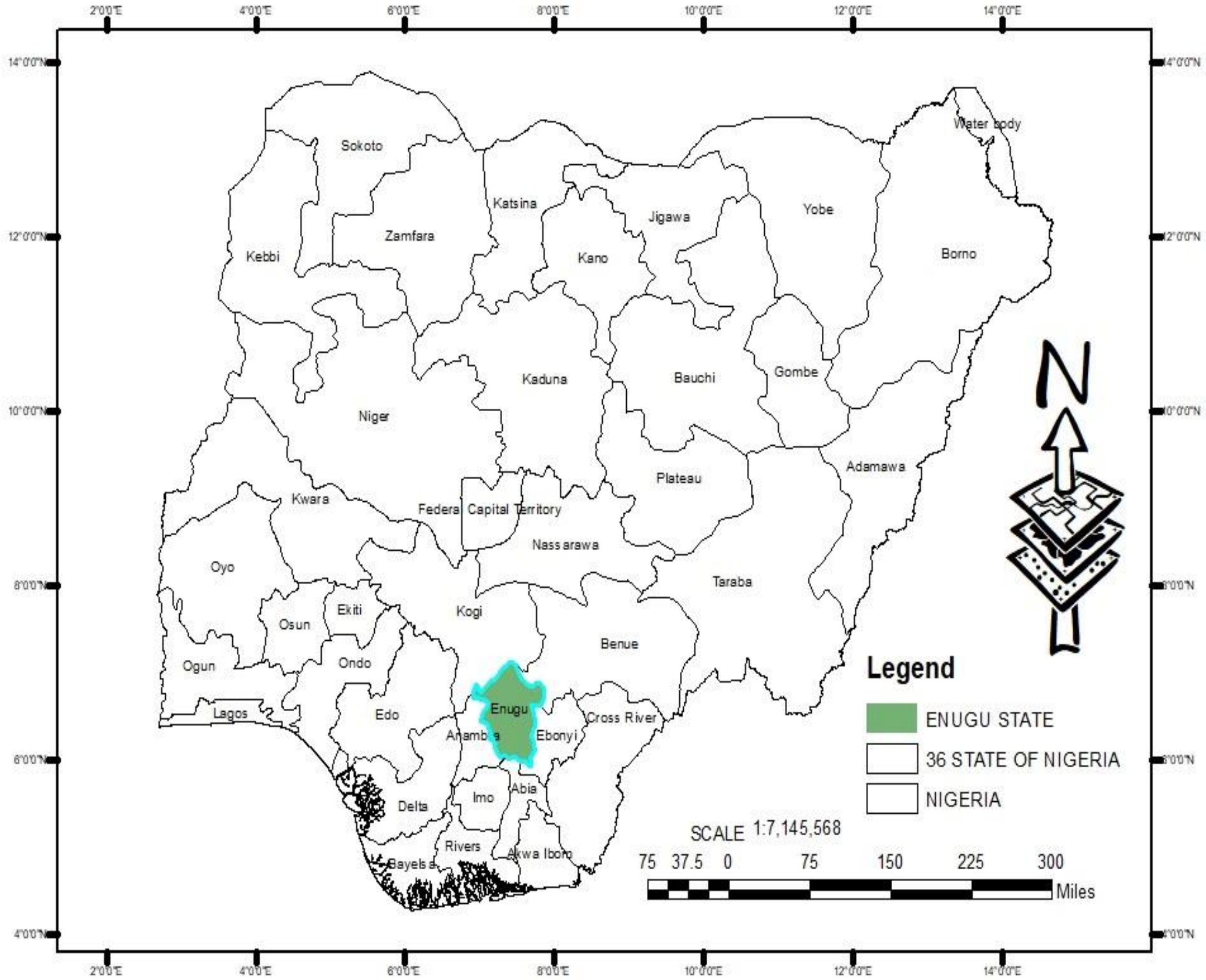


Figure 3.1: Map of Nigeria showing Enugu State

Source: Author's Construct (2021) using Geographical Information System (GIS)

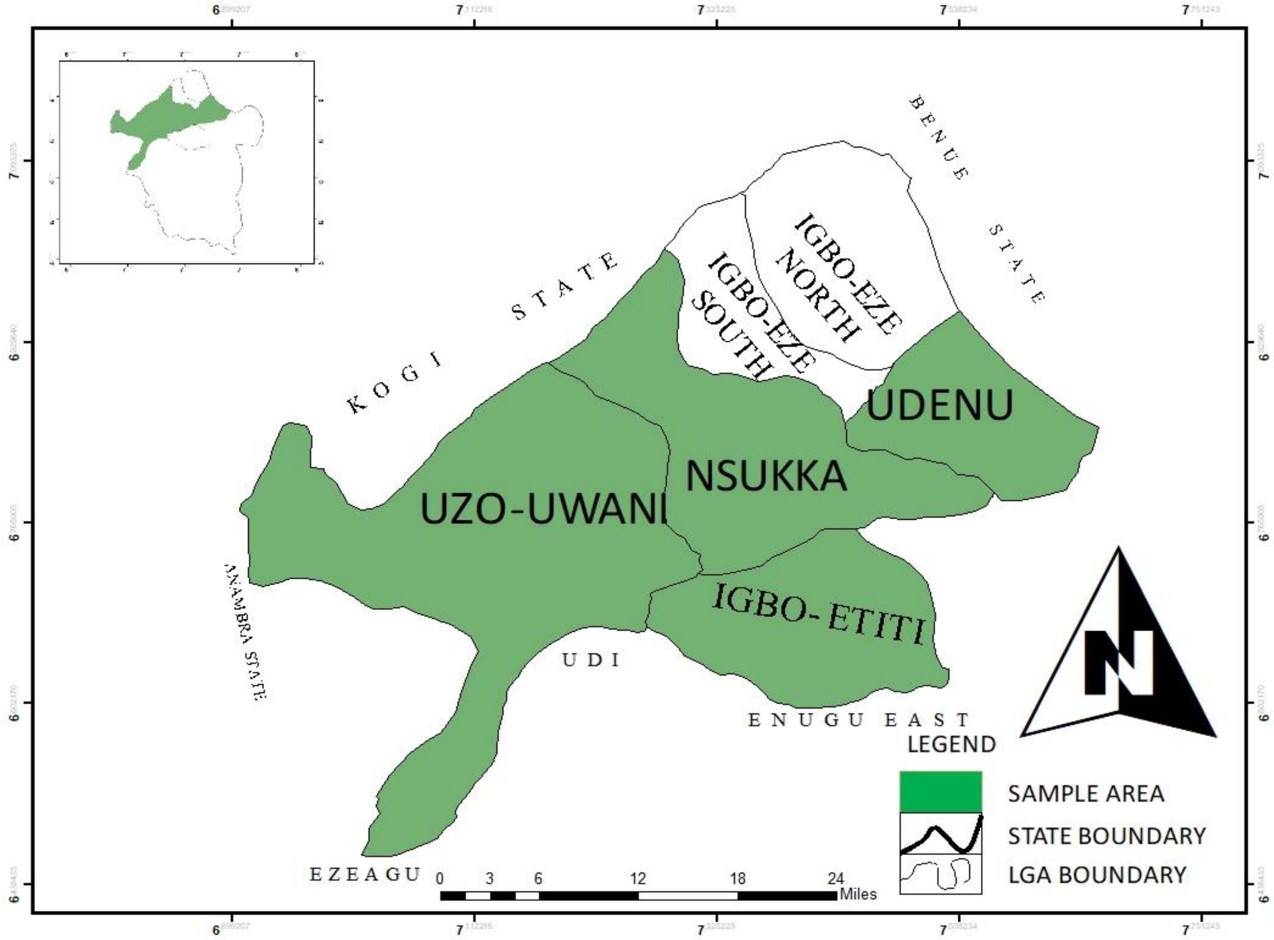


Figure 3.2: Map of Enugu State showing the selected Local Government Areas
Source: Author's construct (2021) using Geographical Information System (GIS)

3.2 Sampling Procedure and Sample Size

The population for the study consists of cocoyam farmers in the study area which comprises both the males and females. Five-stage sampling technique was used to select respondents for the study. In the first stage, Enugu-North out of the three agricultural zones was purposively selected due to preponderance of cocoyam farmers in the zone. The zone consists of six Local Government Areas (LGAs) and eight extension blocks. In the second stage, four LGAs were randomly selected namely: Udenu, Nsukka, Igbo-etiti and Uzo-uwani. Third stage involved selection of one extension block from each of the LGA selected to get 6 extension blocks (Nsukka I and Nsukka II extension blocks from Nsukka LGA, Uzo-uwani I and Uzo-uwani II extension blocks from Uzo-uwani LGA, Igbo-etiti extension block from Igbo-etiti LGA and Udenu extension block from UdenuLGA). Fourth stage involved random selection of two extension cells from each of the extension blocks

(Block I -Udenu: Ezimo and Orba; Block II- Igbo-Etiti: Ukehe and Ohodo; Block III and IV-Uzouwani I and Uzouwani II: Uvuru, Nimbo, Opando and Nrobo; Block 5 and 6 – Nsukka I and Nsukka II: Okpuje, Okuto, Obimo and Opi) to get 12 extension cells. In the fifth and last stage, sample size of two hundred and forty-five (245) cocoyam farmers were selected using Taro Yamane (1967) sampling determination formula based on the list of registered cocoyam farmers obtained from Enugu State Agricultural Development Programme (ENADEP). The sample size was proportionately distributed across the extension cells selected as presented in Table 3.1. The formula is mathematically expressed as in equation (1):

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

Where;

n = Sample size

N = Total Population

1 = Statistical constant

e = margin of error (precision level of 0.06

Table 3.1: Sample outlay of the respondents in the study area

Selected LGAs	Extension block	Extension cells	Sample frame	Sample Size
Udenu	Udenu	Ezimo	168	20
		Orba	172	20
Igbo-Etiti	Igbo-Etiti	Ukehe	146	17
		Ohodo	214	25
Uzo-uwani	Uzo-uwani I	Uvuru	172	20
		Nimbo	163	19
	Uzo-uwani II	Opando	160	19
		Nrobo	205	24
Nsukka	Nsukka I	Okpuje	191	22
		Edem	180	21
	Nsukka II	Obimo	209	24
		Opi	120	14
4	**6**	**12**	**2100**	**245**

Source: Enugu State Agricultural Development Project (ENADEP), 2021

3.3 Method of Data Collection

Primary data were used for the study. In order to obtain requisite information from the farmers for the study, structured questionnaire with close and open-ended questions was administered to the respondents complemented with interview schedule to obtain information on socio-economic characteristics of the rural farmers, adoption level of the recommended cocoyam production technologies, factors influencing the adoption of the recommended cocoyam production technologies, effects of recommended cocoyam production technologies adopted on output and constraints associated with the adoption of the recommended cocoyam production technologies. The researcher was assisted by trained enumerators during data collection, while primary data were collected within the time frame of three (3) months.

3.3.1 Validation of Data Collection Instrument

Face and content validity test was used to ascertain the cogency (factual soundness) of the data collection tool. The questionnaire as much as possible was focused on the objectives of the study. The variables were separated into their specific themes for ease of response from respondents. The data collection instrument was subjected to scrutiny by the experts in field of agricultural extension and rural development to ensure its validity.

3.4 Measurement of Variables

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

3.4.1 Dependent variable

The dependent variable of the study is the adoption of recommended cocoyam production technologies. This was measured using the adoption scores generated from the adoption index model as used by Zanu *et al.* (2012).

3.4.2 Independent variables

The independent variables to be measured include:

Age: this was measured in actual number of years of the farmers.

Marital status: this was measured as dummy (married =1, otherwise = 0).

Sex: this was measured as a dummy variable (1 if male, 0 if female).

Labour: Labour was measured in man-days.

Education: this was measured in number of years spent in formal schooling.

Experience: this was measured in years of farming.

Household size: this was measured in number of people per household eating from the same pot.

Farm size: this was measured in hectares.

Credit access: this was measured as a dummy variable (1 if access, 0 if otherwise).

Amount of credit: this was measured in Naira (₦).

Income: this was measured in Naira (₦) per annum.

Cooperative membership: this was measured in number of years as cooperative member.

Extension visit: this was measured using the number of contacts with extension agents (EAs).

Agro-chemicals: this was measured in litres.

Seeds: this was measured in kilogram/hectare.

Organic Fertilizer: this was measured in kilogram/hectare.

Inorganic Fertilizer: this was measured in kilogram/hectare.

(B) Adoption level of recommended cocoyam production technologies

To ascertain the adoption rate of recommended cocoyam production technologies, Adoption scores were generated from the following recommended cocoyam production technologies such as Cocoyam mini-sett technique (50kg/ha), Planting spacing (1mx1m), Planting depth (15–20 cm), Fertilizer application (Inorganic (250kg/ha) and Organic (500kg/ha), Weed control (Herbicide, 2 litre/ha), Pest control (Pesticide, 1 litre/ha), Mulching (100kg/ha of wood shaving or grasses) and Harvesting methods (digging 30cm around the crop before lifting). The total score for a respondent was obtained by summing up the score of each technology expressed in percentage. The minimum score was zero (0) and maximum score was 100. Based on the scores generated, the respondents were classified into low, moderate and high adopters.

(C) Constraints associated with adoption of recommended cocoyam production technologies

The perceived constraints associated with adoption of recommended cocoyam production technologies in the study area as presented in the questionnaire was measured using 3-point Likert type rating scale of Severe Constraint (SC) =3, Less Severe Constraint (LSC) =2 and Not a Constraint (NC) =1. The decision mean score value was calculated by adding together the scores (3+2+1=6) and divide by 3 to get 2.0. Mean score value of less than 2.0 was regarded as not severe while mean value of equal to 2.0 and above was regarded as severe.

3.5 Method of Data Analysis

Data collected were analysed using both descriptive and inferential statistics. Descriptive statistics includes the mean, standard deviation, frequency counts and percentage while the inferential statistics involved the use of adoption index model, Ordinary Least Square (OLS) and multiple regression analysis.

Objective I

The objective was achieved using descriptive statistics such as frequency counts, percentages and mean.

Objective ii

This objective was achieved using adoption index model as used by Zanu *et al.* (2012).

Objective iii

This objective was achieved using Ordinary Least Square (OLS) regression analysis.

Objective iv

This objective was achieved using multiple regression analysis.

Objective v

This objective was achieved using descriptive statistics such as frequency counts, percentages and mean. However, 3 – point Likert rating type scale was used to measure the severity of the constraint.

Test of Hypotheses

Hypothesis I was tested using the t-values obtained from the OLS regression analysis while the t-values obtained from multiple regression analysis was used to test for hypothesis II.

3.6 Model Specification

3.6.1 Adoption index model

The adoption score of the respondents was generated by using the adoption index model as employed by Zanu *et al.* (2012). The model is specified as in equation (2):

$$AI = \frac{TAF}{MSO} x\ 100 \quad (2)$$

Where;

AI = Adoption Index

TAF = Total adoption score obtained by an individual farmer

MSO = Maximum score available

Depending on the adoption score, the respondents were categorized as follows:

(1) Low adopters (up to 33%),

(2) Moderate adopters (34-66%) and

(3) High adopters (67-100%)

3.6.2 Ordinary least square (OLS) regression

Ordinary Least Squares (OLS) regression shows the relationship between several independent or predictor variables and the dependent variable. This was used to achieve objective (iii) which is to determine the factors affecting adoption of recommended cocoyam production technologies in the study area. Thus, implicit form of the OLS regression model as used by Muhammed *et al.* (2021) is given as in equation (3):

$$Y = f\,(AG, GD, MS, HS, EDU, FS, EXP, EC, CM, IN, FO, SI, CP, CX, RA) \quad (3)$$

The explicit form is expressed as in equation (4):

$$Y = \alpha + \beta_1 AG + \beta_2 GD + \beta_3 MS + \beta_4 HS + \beta_5 EDU + \beta_6 FS + \beta_7 EXP + \beta_8 EC + \beta_9 CM + \beta_{10} IN + \beta_{12} FO + \beta_{13} SI + \beta_{14} CP + \beta_{15} CX + \beta_{16} RA + e \quad (4)$$

Where;

Y = Adoption of recommended cocoyam production technologies (this was measured using the adoption index model to generate the adoption scores in percentage)

a = constant

$\beta_1 - \beta_{16}$ = coefficient to be estimated

e = error term

AG – RA = independent variables/parameters to be estimated

AG = Age (years)

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

MS = Marital Status (married=1, otherwise=0)

HS = Household size (number of people)

EDU = Education (number of years spent in school)

FS = Farm size (number of hectares cultivated)

EXP = Experience (years)

EC = Extension contact (number of visits)

CM = Cooperative membership (years)

IN = Income (naira)

FO = Farmland ownership (owned = 1, otherwise = 0)

SI = Source of information (numbers)

CP = Compatibility of the technology (compatibility score)

CX = Complexity of the technology (complexity score)

RA = Relative advantage of the technology (relative advantage score)

3.6.3 Multiple regression analysis model

Multiple regressions analysis model was used to achieve objective iv which is to determine the effect of recommended cocoyam production technologies on output of the respondents. The model as used by Oyediran (2016) is implicitly specified as in equation (5):

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14}, X_{15}, X_{16}) \quad (5)$$

The explicit functional forms of the multiple regression models were as in equation (6) to (9):

Linear

$$Y = \beta_o + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + ... + \beta_{16}X_{16} + u_i \quad (6)$$

Cobb-Douglas

$$LnY = \beta_o + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + ... + \beta_{16} lnX_{16} + U_i \quad (7)$$

Semi-log

$$Y = \beta_o + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + ... + \beta_{16} lnX_{16} + U_i \quad (8)$$

Exponential

$$lnY = \beta_o + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + ... + \beta_{16}X_{16} + U_i \quad (9)$$

Where;

Y = Cocoyam output (kilogram) per annum

X_1 = Farm size (hectare)

X_2 = Labour usage (man-days)

X_3 = Recommended cocoyam mini-sett seeds (kilogram)

X_4 = Recommended planting date (number of days)

X_5 = Recommended planting spacing (centimetres)

X_6 = Recommended planting depth (centimetres)

X_7 = Recommended Herbicides (litres)

X_8 = Recommended Pesticides (litres)

X_9 = Recommended inorganic fertilizer (kilogram)

X_{10} = Recommended organic fertilizer (kilogramme)

X_{11} = Recommended mulching (kilogramme)

X_{12} = Recommended intercropping technique (number of stands)

X_{13} = Recommended harvesting spacing (centimetres)

X_{14} = Amount of credit accessed (₦)

X_{15} = Extension contact (number of contacts per annum)

X_{16} = Cooperative membership (years)

β_o = constant

$\beta_1 - \beta_{16}$ = coefficients of the independent variables

$X_1 - X_{16}$ = independent variables

U_i = error term

ln = natural log

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents the findings of the study based on objectives. It is divided into different sections which included socio-economic characteristics of the farmers, adoption level of recommended cocoyam production technologies, factors influencing adoption of recommended cocoyam technologies, effects of adoption of recommended cocoyam technologies on output and constraints associated with the adoption of recommended cocoyam technologies in the study area.

4.1 Socio-economic Characteristics of the Respondents

The Socio-economic characteristics of the respondents discussed in this study include age, sex, marital status, household size, educational status, farming experience, farm size, credit access, extension contact and cooperative membership. The results of these variables are presented in Table 4.1.

4.1.1 Age of the respondents

As revealed in the Table 1, about half (49.8%) of the respondents were within the age bracket of 51 – 70 years with a mean age of 56 years. This implies that most of the cocoyam farmers are in their middle age but still actively engages in cocoyam production activities. This finding agrees with Ojeleye *et al*. (2018) who reported that a good proportion of his respondents were in their middle age with a mean age of 49 years and have positive attitude towards adopting improved technologies. However, it is in contrast with the work of Uwandu *et al*. (2018) who reported that majority of farmers in their study area were within their youthful age.

4.1.2 Sex of the respondents

The sex of the respondents as shown in Table 4.1 revealed that more than half (55.1%) of the respondents were male, while 44.9% of them were female implying that male were more involved in cocoyam farming than female which could be due to the tedious nature of work involved in cocoyam production. This finding agrees with the work of Ume *et al.* (2016) who reported that majority of their respondents were males. This is in contrast to that of Aguegia (2011) who reported that females were involved more in cocoyam cultivation than males due to their traditional roles in production and utilization process.

Table 4.1: Distribution of respondents based on their socio-economic characteristics (n = 245)

Variables	Frequency	Percentages (%)	Mean
Age (years)			
< 31	9	3.7	56
31 – 50	84	34.2	
51 – 70	122	49.8	
> 70	30	12.3	
Sex			
Male	135	55.1	
Female	110	44.9	
Marital status			
Married	202	82.4	
Widowed	32	13.1	
Single	4	1.6	
Divorced	7	2.9	
Household size			
< 5	98	40.0	6
5 – 7	87	35.5	
8 – 10	51	20.8	
> 10	9	3.7	
Educational status			
Primary	102	41.6	9
Secondary	79	32.2	
Tertiary	25	10.3	
Non-formal	39	15.9	
Experience (years)			
< 11	55	22.4	24
11 – 20	66	26.9	
21 – 30	54	22.0	
31 – 40	48	19.6	
> 40	22	9.1	
Farm size (hectares)			
< 1.1	217	88.6	0.82
1.1 – 2.0	28	11.4	
Access to credit			
Yes	50	20.4	
No	195	79.6	
Extension contact			
Yes	119	48.6	
No	126	51.4	
Cooperativemembership			
Yes	64	26.1	
No	181	73.9	

Source: Field Survey, 2022

4.1.3 Marital status of the respondents

Table 4.1 further revealed that 82.4% of the respondents were married, while 17.6% were not married (singe, widowed or divorced). This implies that majority of the farmers were married with the main purpose for pro-creation of younger ones that could assist in future farming activities. This finding agrees with Odoemekun and Anyim (2019) who reported that majority of farmers married purposely for pro-creation of young ones.

4.1.4 Household size of the respondents

As revealed in the Table 4.1, more than half (56.3%) of the respondents had household size of between 5 – 10 people with a mean of 6. This implies that the farmers had relatively large household size which is an advantage in terms of farm labour supply and adoption of new technologies. Large household size could help farmers reduce the cost of hired labour and boost agricultural production. This is in agreement with the study of Birol *et al*. (2015) who noted that large family size aids farmers' adoption of new technologies for increased returns in order to sustain their families.

4.1.5 Educational status of the respondents

With respect to education, Table 4.1 revealed that 84.1% acquired formal education (i.e. primary, secondary and tertiary) with a mean of 9 years of formal schooling. This implies that the farmers were literate which could help them to make better decisions as regards adoption of technologies. Educational level of an individual plays a significant role in sharpening the ability and mind of farmers for rational decision making. Education help reduces the level of complexity in a given technology thereby increasing its acceptability. This is in agreement with the work of Iheke (2010) who reported mean education of 8 years in his study area implying that most of the sampled farmers had formal education and they are expected to be more receptive to improved farming techniques than farmers that have no formal education.

4.1.6 Farming experience of the respondents

Table 4.1 revealed that most (68.5%) of the respondents had farming experience of between 11 –

40 years with a mean of 24 years of farming. This implies that the farmers had been into farming for long period of years which could enhance their favourable perception about adopting recommended cocoyam technologies. This agrees with Olaosebikan *et al*. (2019) who reported that majority of the respondents in their study area had long years of farming experience which help them to make sound decisions about their farms. Farming experience is a major factor in adoption of technologies which should serve as an advantage for increased investment and technologies utilization.

4.1.7 Farm size of the respondents

Also, Table 4.1 revealed that 88.6% of the respondents had farm size of less than 1.1 hectares with a mean of 0.82. This implies that majority of the cocoyam farmers are operating on small-scale farm holdings which could be due to competitive nature for farmland in the study area. Poor access to farmland by the cocoyam farmers which is an important factor for production could have negative influence on adoption of recommended cocoyam technologies in the study area. This agrees with the work of Quaye *et al.* (2010) who reported that cocoyam production level in their study area was very low with an average acreage of 0.8 hectares per farmer.

4.1.8 Access to credit by the respondents

In terms of access to credit, Table 4.1 revealed that 79.6% of the respondents had no access to credit with only 20.4% who had access. This implies that majority of the farmers had no access to credit which could negatively affect adoption of technologies. Credit is an important variable needed to acquire or develop farm enterprise. Thus, amount of credit available to farmers will enhance adoption of improved technologies. Therefore, access to credit is a catalyst for increased agricultural production as well as imperative for adoption. This finding is in agreement with Nwakor *et al.* (2016) who reported that access to credit is one of the major factors limiting cocoyam production in their study area.

4.1.9 Extension contact by the respondents

Table 4.1 revealed that almost half (48.6%) of the respondents had contact with extension agents, while 51.4% had no contact. This implies that considerable proportion of the respondents had contact with extension agents. This is expected to influence farmers' decision to adopt recommended cocoyam production technologies. Extension agents play vital role in dissemination of information on agricultural technologies that could improve production. It is a crucial means of coordinating information–based technologies from research institutes to the farmers and vice versa. The more farmers have contact with extension agents, the higher is the rate of adoption of agricultural technologies. This finding corroborates the work of Ume *et al*. (2015) who reported that extension visit is a major determinant of technology adoption on cocoyam production in their study area.

4.1.10 Cooperative membership by the respondents

More so, 73.9% of the respondents were not members of cooperative societies while 26.1% of the respondents were members, implying low involvement of the farmers in cooperative societies. Membership of cooperative societies plays significant role in technology adoption behaviour of farmers. Cooperative society is generally perceived as an efficient medium of disseminating information on technologies to farmers in rural communities as well as a source of social capital that could facilitate production among members. Poor participation in cooperative societies will tend to hinder farmers' access to agricultural information, training, credit and other production inputs. This is in line with the work of Akinrele (2012) who reported that poor participation of cocoyam farmers in cooperative societies could negatively influence acceptance of improved cocoyam production practices.

4.2 Level of Adoption of Recommended Cocoyam Technologies by the Respondents

The result in Table 4.2 presents the recommended cocoyam technologies adopted by the respondents. The findings revealed that majority of the farmers adopted all the recommended cocoyam production technologies such as timely planting between May – June (99.2%), plant spacing (83.3%), planting method using heap/ridge top (98.8%), cocoyam intercropping technique (93.1%), use of cocoyam mini-setts of about 25g/1-2cm thickness as planting material (91.4%), fertilizer application immediately after planting and (NPK 15:15:15) after weeding (99.6%), weed control (98.0%), mulching (90.6%), pest control (98.0%) and harvesting by digging around cocoyam plant at about 30cm (98.8%). This implies that the cocoyam farmers adopted all the recommended cocoyam production technologies in the study area. This is in corroboration with the report of National Root Crops Research Institute (NRCRI) (2013) that farmers adopted recommended cocoyam production technologies developed and transferred to them to boost production.

Table 4.2: Distribution of respondents based on recommended cocoyam technologies adopted

Recommended cocoyam technologies	Adopted (%)	Not Adopted (%)
Timely planting between May – June	243 (99.2)	2 (0.8)
Plant spacing of 1m x 1m	204 (83.3)	41 (16.7)
Planting method using heap/ridge top	242 (98.8)	3 (1.2)
Cocoyam intercropping technique	228 (93.1)	17 (6.9)
Cocoyam mini-setts of about 25g	224 (91.4)	21 (8.6)
Fertilizer application (NPK 15:15:15) after weeding	244 (99.6)	1 (0.4)
Weed control by herbicides	240 (98.0)	5 (2.0)
Mulching using crop residues	222 (90.6)	23 (9.4)
Pest control by pesticides	240 (98.0)	5 (2.0)
Harvesting by digging around the plant at about 30cm	242 (98.8)	3 (1.2)

Source: Field Survey, 2022
Note: Numbers in parenthesis are the percentages

More so, figure 4.1 shows the distribution of the respondents based on adoption level of recommended cocoyam production technologies in the study area. The result revealed that in overall, 71.0% of the respondents indicated high level of adoption while 29.0% of the respondents indicated low adoption level of recommended cocoyam production technologies. The high adoption level implies that the technologies were useful and appropriate for the farmers to adopt for improved production and productivity. This finding substantiates that of Ogunwale (2012) who reported that research output does not serve any useful purpose until it is introduced to farmers, adopted by them and put into practice on their farms.

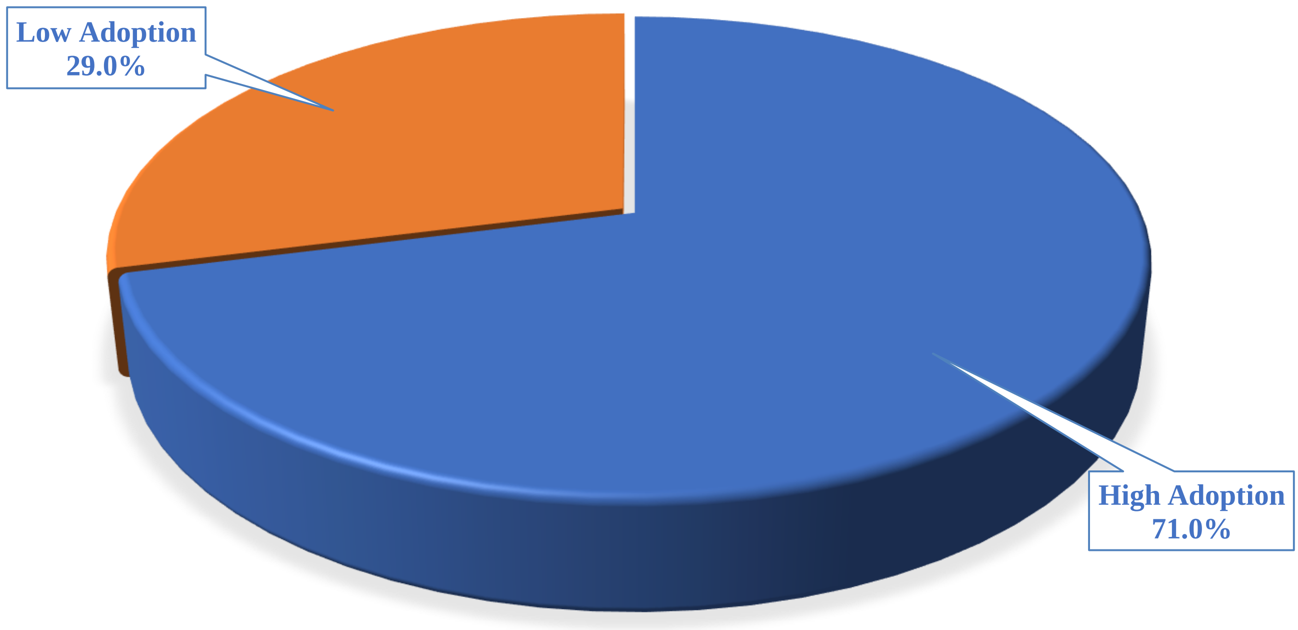
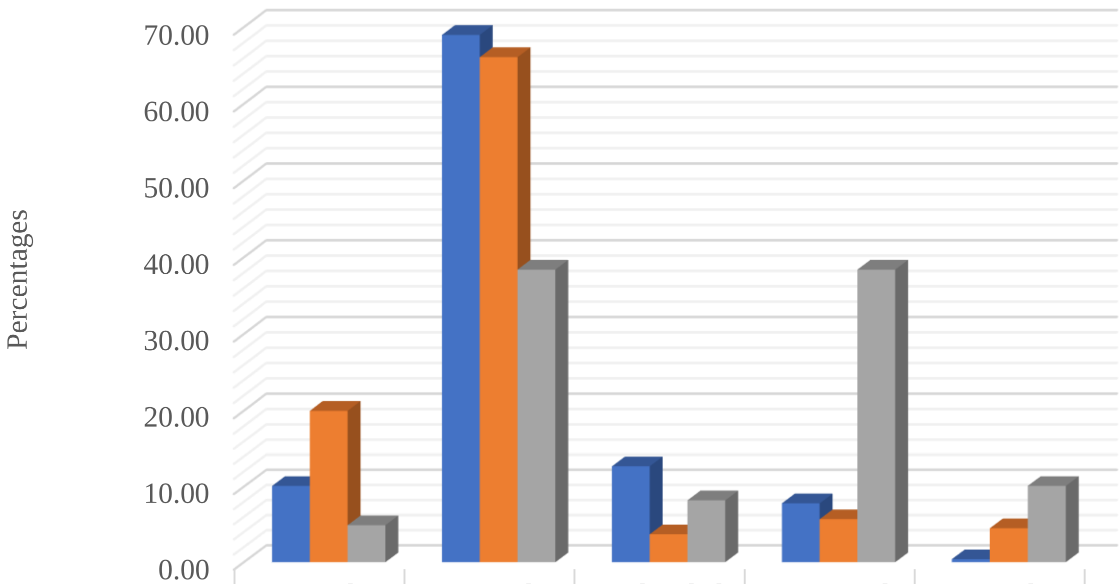


Figure 4.1: Level of recommended cocoyam technologies adoption by respondents

4.2.1 Perceived attributes of recommended cocoyam technologies by respondents

The perceived attributes of technologies considered in the study includes the relative advantage, compatibility and complexity (ease of understanding the innovation). As shown in Figure 4.2, 69.0% and 66.1% agreed that the recommended cocoyam production technologies had relative advantage and compatible with their existing practices with mean score ($\bar{X}$ = 3.81 and $\bar{X}$ = 3.91) respectively. However, 38.4% of the respondents agreed and disagreed respectively that recommended cocoyam production technologies is complex to put into practise with mean score ($\bar{X}$ = 2.89). Adoption of agricultural technologies is a function of a number of attributes and factors. This is in line with the work of Ayoade *et al.* (2011) who reported that the farmers' perception on attributes of innovations are related to rates of innovations' adoption.



	Strongly Agreed	Agreed	Undecided	Disagreed	Strongly Disgreed
Relative Advantage	10.10	69.00	12.70	7.80	0.40
Compatibility	20.00	66.10	3.70	5.70	4.50
Complexity	4.90	38.40	8.20	38.40	10.10

Figure 4.2: Perceived attributes of the recommended cocoyam technologies by respondents

4.3 Factors Influencing Adoption of Recommended Cocoyam Technologies

Result of the regression analysis presented in Table 4.3 revealed that the coefficient of determination (R^2) value was 0.7587. This implies that about 76% variation in the adoption of recommended cocoyam production technologies were explained by the independent variables included in the model, the remaining 24% unaccounted could be due to error or other variables not captured in the model. The F–statistic value of 12.94 was statistically significant at 0.01 probability level implying the perfect fit of the model and good at predicting the observed data. The result shows that out of fifteen (15) variables included in the model, thirteen (13) variables were statistically significant at $p < 0.01$, 0.05 and 0.10 probability levels respectively across the study areas. Eleven variables such as sex (3.5555), marital status (4.4631), education (0.2596), farm size (3.4864), farming experience (0.5158), extension contact (0.4243), membership of cooperatives (0.5181), output (0.0030), sources of information (2.5878), relative advantage (1.6125) and compatibility (1.7756) were positive and statistically significant, thus, have direct influenced on the adoption of recommended cocoyam production technologies in the study area while age (-

0.2513) and complexity (-1.7560) were negative and statistically significant, thus inversely influencing the adoption of recommended cocoyam production technologies in the study area.

Table 4.3: OLS estimates of the factors influencing adoption of recommended cocoyam production technologies

Variables	Coefficient	Standard error	t-values
Age	-0.2513	0.1021	-2.46**
Sex	3.5555	1.7266	2.06**
Marital status	4.4631	1.8547	2.41**
Household size	0.3351	0.3510	0.95
Education	0.2596	0.1436	1.81*
Farm size	3.4864	1.8279	1.91*
Farmingexperience	0.5158	0.1051	4.90***
Extension contact	0.4243	0.1735	2.44**
Cooperativemembership	0.5181	0.2210	2.34**
Access to credit	-2.87e-06	4.94e-06	-0.58
Output	0.0030	0.0011	2.75***
Sources of information	2.5878	0.7983	2.34**
Relative advantage	1.6125	0.8879	1.82*
Compatibility	1.7756	0.7412	2.40**
Complexity	-1.7560	0.6696	2.62***
Constant	65.6655	6.5451	10.03***
R-squared	0.7587		
Adjusted R-squared	0.7232		
F-stat	12.94***		

Source: Field survey, 2022
Note *, ** and * implies significant at 1%, 5% and 10% probability level, respectively**

The coefficient for age (-0.2513) was negative and statistically significant at 0.05 probability level. This implies that a unit increase in age will lead to 0.2513 decreases in adoption of recommended cocoyam production technologies. This has the expected a *priori,* although, older farmers may have wealth of experiences and probably the required impetus that may afford them the opportunity of trying new technology. Inversely, older farmers may be too weak to perform difficult farm operations without the help of labour-saving devices and maybe less likely to explore new sources of information on new innovation as they are less cosmopolitan. This is similar to the findings of Langat *et al*. (2011) who reported higher adoption of improved farming practice among mid-age farmers across the study areas.

The coefficient marital status (4.4631) was positive and statistically significant at 0.05 probability level. This implies that a unit increase in marital status will lead to 4.4631 increases in adoption of recommended cocoyam production technologies. Marriage tends to increase the house size which may probably signify availability of family labour for carrying out farming activities. The reason for this result could be attributed to the fact that the study areas are agrarian societies where members marry in order to have more household size to carryout farming activities, which can go a long way in boosting farm income and improving the livelihoods of rural farmers in the study area. Although, high household size increases the expenditure incurred by farmers

The coefficient for education (0.2596) was positive and statistically significant at 0.10 probability level. This implies that a unit increase in education will lead to 0.2596 increases in adoption of recommended cocoyam production technologies. This is similar to the study of Nwaobiala and Uchechi (2016) who found a positive relationship between education and use of new farming practices. Similarly, Simon *et al.* (2010) found education to be related to level of use of commercial practices in agricultural production. This has the expected *a priori* because education facilitates learning which in turn instil a favourable attitude towards the use of improved farm practices. Educated farmers can gather reliable information on improved agricultural practices through media such as newspapers, magazines, hand-outs, radio and television among others thus have better knowledge to efficiently analyse and use available information to make rational decision for adoption of the new innovation

The coefficient for farm size (3.4864) was positive and statistically significant at 0.10 probability level. This implies that a unit increase in farm size will lead to 3.4864 increases in adoption of recommended cocoyam production technologies. This is similar to the study of Bello *et al.* (2012) who found farm size to be related to use of recommended farming practices. This has the expected *a priori* because farmers with large expand of farm land is expected adopt sustainable farm practices which will invariably increase their income. Also, certain threshold farm size is necessary before the investment in a technology is worthwhile or more appropriate.

The coefficient for farming experience (0.5158) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in farming experiences will lead to 0.5158 increases in adoption of recommended cocoyam production technologies. This has the expected *a priori* because the number of years a farmer spent in farming will increase the experiential base which may likely assist in making adoption decisions. This finding is in line with the study of Nchuchuwe and Adejuwon (2012) who found a positive relationship between poultry farmers' experience and their adoption of labour-saving devices.

The coefficient for extension contacts (0.4243) was positive and statistically significant at 0.05 probability level. This implies that a unit increase in extension contact will lead to 0.4243 increases in adoption of recommended cocoyam production technologies. This has the expected *a priori* because extension contact plays a huge role in the dissemination of the improved farming practices. This is similar to the findings of Ukeje (2008) who reported a high significant and positive relationship between extension contact and adoption of improved goat management practices.

The coefficient for membership of cooperatives (0.5181) was positive and statistically significant at 0.05 probability level. This implies that a unit increase in extension contact will lead to 0.5181 increases in adoption of recommended cocoyam production technologies. This has the expected *a priori* because participation in cooperative have the potential of creating confidence between rural farmers and financial institutions thus allowing them to have access to farm credit from such institutions using their collective output in a community warehouse as collateral. This is similar to the study of Ogunbameru *et al.* (2008) who argued that cooperatives have positive influence on adoption new innovation.

The coefficient for output (0.0030) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in output of rural farmers will lead to 0.0030 increases in adoption of recommended cocoyam production technologies. This has the expected *a priori* because farmers with increasing output may likely adopt new innovation to increase their productivity.

The coefficient for sources of information (2.5878) was positive and statistically significant at 0.05 probability level. This implies that a unit increase in sources of information of rural farmers will lead to 2.5878 increases in adoption of recommended cocoyam production technologies. The study areas were homogenous society thus several sources of information on improved agricultural practices may then to increase the rate of diffusion of the innovation within the community.

The coefficient for relative advantage (1.6125) was positive and statistically significant at 0.10 probability level. This implies that a unit increase in relative advantage of the recommended cocoyam practices will lead to 1.6125 increases in their adoption. Most farmers are accustomed to the primitive cultural practices that are associated with drudgery and low yields. Thus, any innovations that have been demonstrated by Small Plot Adoption Technique (SPAT) to be superior to their cultural practices will facilitate higher adoption rates.

The coefficient for compatibility (1.7756) was positive and statistically significant at 0.05 probability level. This implies that a unit increase in compatibility will lead to 1.7756 increases in adoption of recommended cocoyam production technologies. The study areas were guided by predetermined norms, any innovation that contradicts those norms and values may be met with a lower rate of acceptance. Thus, the recommended cocoyam production technologies are in line with the norms and felt needs of the cocoyam farmers across the study areas. This is expected to increase the adoption of the technology.

The coefficient for complexity (-1.7560) was negative and statistically significant at 0.01 probability level. This implies that a unit increase in complexity will lead to 1.7560 decreases in adoption of recommended cocoyam production technologies. This has the expected *a priori*, this is because technology that is difficult to understand and use may have low adoption than technology that doesn't require special skills for its usage.

4.4 Effects of Adoption of Recommended Cocoyam Technologies on Respondents' Output

Result of the regression analysis as presented in Table 4.4 revealed coefficients of determination (R^2) value of 0.7728 which implies that about 77% variation in the output of the respondents were explained by the independent variables included in the model, while the remaining 23% unaccounted could be due to error or other variables not captured in the model. The F – statistic value of 16.84 was statistically significant at 0.01 probability levels implying perfect fit of the model and goodness at predicting the observed data. The result also revealed that out of eighteen (18) variables included in the model, thirteen (13) variables were statistically significant at 0.01 and 0.05 probability levels, respectively. Twelve variables such as farm size (0.1150), labour usage (0.0020), agrochemical (0.0644), timely planting (0.7086), planting method (0.2943), cocoyam inter-cropping (0.1300), cocoyam mini set (0.1209), weed control (0.2874), mulching (0.2129), extension contact (0.2158), membership of cooperative (0.1527) and access to credit (0.1601) were positive and statistically significant, therefore influences the output of cocoyam farmers directly, while fertilizer usage (-0.0001) was negative and statistically significant, thus inversely influences the output of cocoyam farmers.

Table 4.4: Regression estimates on effects of recommended cocoyam production technologies on output of the respondents

Variables	Coefficient	Standard error	t-values
Farm size	0.1150	0.0560	2.05**
Labour usage	0.0020	0.0009	2.39**
Seed rate	3.15e-07	5.99e-07	0.53
Inorganic fertilizer application	-0.0001	0.0002	-2.04**
Agrochemical application	0.0644	0.0206	3.13***
Timely planting	0.7086	0.1015	6.98***
Plantingspacing 1mx1m	-0.1393	0.0576	-2.42**
Planting method	0.2943	0.1399	2.10**
Cocoyam inter-cropping	0.1300	0.0610	2.13**
Cocoyam mini-sett 25g	0.1209	0.0592	2.04**
Organic fertilizer application	-0.1140	0.0989	-1.15
Weed control	0.2874	0.0717	4.01**
Mulching	0.2129	0.0643	3.31**
Pest control	0.0249	0.1356	0.18
Harvesting method	0.1466	0.1022	1.44
Extension contact	0.2158	0.0541	3.99***
Cooperativemembership	0.1527	0.0697	2.19**
Access to credit	0.1601	0.0761	2.10**
Constant	5.0223	0.2242	22.40***
R-squared	**0.7728**		
Adj R-squared	**0.7388**		
F-statistics	**16.84*** **		

Source: Field survey, 2022

Note *, ** and * implies significant at 1%, 5% and 10% probability level, respectively**

The coefficient for farm size (0.1150) was positive and statistically significant at 0.05 probability level. This implies that a unit increase in farm size as a result of adoption of recommended cocoyam production technologies will lead to 11.5% increase in the output of cocoyam farmers. This has the expected a priori because it is anticipated that complete adoption of the cocoyam recommended production technologies package will boost farmers' returns which will invariably lead to the expansion of farm land and thus an increase in the output of farmers.

The coefficient for labour usage (0.0020) was positive and statistically significant at 0.05 probability level. This implies that a unit increase in labour usage as a result of the adoption of recommended cocoyam production technologies will lead to 0.2% increase in the output of cocoyam farmers. This has expected a priori. As a result of the adoption of recommended cocoyam production technologies, it is envisaged that the farmer may likely increase the size of farm land to accommodate an increase in return. This will necessitate more labour, which if properly utilized, will increase farmers output.

The coefficient for timely planting (0.7086) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in timely planting will leads to 71% increase in the output of cocoyam farmers. The timing of Planting is a crucial cultural farming practice that can significantly affect crop performance and yield seriously. This has the expected *a priori* because timely planting is expected to improve cocoyam strong establishment, giving them plenty of time to grow to their full potential and lessen other environmental stress.

The coefficient for cocoyam mini-sett (0.1209) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in cocoyam mini-sett adoption will lead to 12%increase in the output of cocoyam farmers. This has the expected *a priori* because adopting the recommended cocoyam mini-sett techniques will help the farmer to produce large quantities of planting materials in the shortest possible time and lessen the competition for cocoyam corms as food and planting materials. This is expected to improve their productivity.

The coefficient for cocoyam inter-cropping (0.1300) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in cocoyam inter-cropping adoption will lead to 13% increase in the output of cocoyam farmers. Adoption of recommended intercropping practice will help the farmers to diversify their sources of income while maintaining same level of output per hectares.

The coefficient for weed control (0.2874) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in weed control will lead to 29% increase in the output of cocoyam farmers. This has the expected a *priori* because weeds compete with planted crop for nutrients, soil air and water as well as harbouring pests. Therefore, adoption of recommended weed control strategies by cocoyam farmers is expected to improve sanitary condition towards pests and diseases thereby improving the productivity of the farmers.

The coefficient for mulching (0.2129) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in mulching will leads to 21%increases in the output of cocoyam farmers. Mulch on cocoyam is expected to enhance the activity of soil organisms and reduce evaporation of water from the soil. Thus, the result is in line with the expected *a priori* because adoption of recommended mulching practices is expected to create favourable condition for cocoyam optimal growth.

The coefficient for extension contacts (0.2158) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in extension contact will leads to an increase of 22% in farmers' output. Extension agent facilitates the dissemination of recent innovation in agriculture to farmers in order to improve their productivity. As expected, increase in extension contact which can bring the result or method demonstration of cocoyam production technologies to farmers is expected to enhance the adoption of the technology which will invariably improve the output of farmers.

The coefficient for membership of cooperative (0.1527) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in membership of cooperative will lead to 15%increase in the output of cocoyam farmers.

The coefficient for access to credit (0.1601) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in access to credit will lead to 16% increase in the output of cocoyam farmers.

The coefficient for inorganic fertilizer usage (-0.0001) was negative and statistically significant at 0.01 probability level. This implies that a unit increase in inorganic fertilizer usage as recommended cocoyam production technologies will lead to 0.01% decrease in the output of cocoyam farmers.

4.5 Constraints Faced by the Respondents in Cocoyam Production

Distribution of the respondents according to constraints associated with cocoyam production is presented in Table 4.5. Although, there was no general consensus on the constraints perceived by the farmers to hinder cocoyam production, however, the severe constraints identified by the respondents in the study area include high cost of labour ($\bar{X}$= 2.85), problem of pests and diseases ($\bar{X}$= 2.84), lack of fund ($\bar{X}$= 2.80) and inadequate improved varieties ($\bar{X}$= 2.66) ranked 1st, 2nd, 3rd and 4th respectively. Labour as one of the important factors of production is usually in high demand especially where family labour is inadequate. Farmers therefore, need to pay wages for hired labour at every stage of farming activities which is often on high price. Also, the role of credit to agricultural development cannot be over-emphasized as it enables farmers to advantageously utilize recommended production inputs for increased output. This finding is in agreement with that of Ogada *et al.* (2014) who reported that paucity of funds and lack of credit access constraints the adoption of improved technologies. Loss of cocoyam productivity in the study area are mainly due to tuber rot infections and inadequate improved planting materials (propagules)

Other severe constraints as identified by the respondents were challenges of herdsmen ($\bar{X}$= 2.56), inadequate planting materials ($\bar{X}$= 2.40), high costs of technologies ($\bar{X}$= 2.22), poor extension services ($\bar{X}$= 2.13), complexity of cocoyam technologies ($\bar{X}$= 2.11) and inadequate farmland ($\bar{X}$= 2.66) ranked 5th, 6th, 7th, 8th, 9th and 10th respectively. These factors impede cocoyam production in one way or the other. This is in line with the work of Acheampong *et al.* (2015) who reported that challenges to optimal production of cocoyam include decreasing rainfall and soil condition, loss of forests, weak technical and institutional support as well as high cost of inputs.

Table 4.5: Distribution of the respondents based on constraints faced in cocoyam production

Constraints	SC	LSC	NC	WS	WM	Rank	Remark
High cost of labour	209	35	1	698	2.85	1st	Severe
Problems of pests and diseases	213	24	8	695	2.84	2nd	Severe
Lack of fund	200	41	4	686	2.80	3rd	Severe
Inadequate improved varieties	162	83	0	652	2.66	4th	Severe
Challenges of herdsmen	187	9	49	628	2.56	5th	Severe
Inadequate planting material	114	115	16	588	2.40	6th	Severe
High cost of technologies	75	149	21	544	2.22	7th	Severe
Poor extension services	75	128	42	523	2.13	8th	Severe
Complexity of cocoyam technologies	65	141	39	516	2.11	9th	Severe
Inadequate farmland	90	88	67	513	2.09	10th	Severe
Poor soil condition	47	130	68	469	1.91	11th	Not Severe
Cultural background of the people	28	78	139	379	1.55	12th	Not Severe
Lack of ready market	37	42	166	361	1.47	13th	Not Severe

Source: Field Survey, 2022

Note: SC=Severe Constraints (3), LSC=Less Severe Constraints (2), NC=Not a Constraints (1), WS=Weighted Sum, WM=Weighted Mean, Bench mean score is 2.0

4.6 Hypotheses Testing

4.6.1 Hypothesis I

The null hypothesis I which stated that there is no significant relationship between the selected socio-economic characteristics of the cocoyam farmers (age, sex, marital status, household size, education, farm size and farming experience) and their adoption of recommended cocoyam production technologies in the study area was tested using the t – values of the Ordinary Least Square (OLS) regression analysis at 5% level of probability. From the estimated t – values result presented in Table 4.6, sex (2.06), marital status (2.41), education (1.81), farm size (1.91) and farming experience (4.90) of the respondents were statistically significant at 5%, 10% and 1% level of probability respectively, hence, the null hypothesis was rejected based on the sex, marital status, education and farm size while age (-2.46) and household size (0.95) were not significant and the null hypothesis on age and household size was accepted that there is no significant relationship between the selected socio-economic characteristics of the cocoyam farmers and adoption of recommended cocoyam production technologies in the study area.

Table 4.6: Regression estimates of null hypothesis I

Variables	Coefficient	Standard error	t-values
Age	-0.2513	0.1021	-2.46**
Sex	3.5555	1.7266	2.06**
Marital status	4.4631	1.8547	2.41**
Household size	0.3351	0.3510	0.95
Education	0.2596	0.1436	1.81*
Farm size	3.4864	1.8279	1.91*
Farming experience	0.5158	0.1051	4.90***

Source: Field survey, 2022
Note *, ** and * implies significant at 1%, 5% and 10% probability level, respectively**

4.6.2 Hypothesis II

The null hypothesis which stated that adoption of recommended cocoyam production technologies had no significant effects on output of the farmers in the study area was tested using the t – values from multiple regression analysis at 5% level of probability and the result presented in Table 4.7. From the estimated t – values result, inorganic fertilizer application (-2.04), agrochemical application (3.13), timely planting (6.98), planting spacing (-2.42), planting method (2.10), cocoyam inter-cropping (2.13), cocoyam mini-sett (2.04), weed control (4.01) and mulching (3.31) were statistically significant at 1% and 5% level of probability respectively, implying that these recommended cocoyam production technologies had significant effects on cocoyam output of the farmers. Thus, the null hypothesis was rejected based on these recommended cocoyam production technologies while the alternative was accepted. However, seed rate (0.53), organic fertilizer application (-1.15) and pest control (1.44) were not significant implying that the null hypothesis based on these recommended cocoyam production technologies was accepted.

Table 4.7: Regression estimates of hypothesis II

Variables	Coefficient	Standard error	t-values
Seed rate	3.15e-07	5.99e-07	0.53
Inorganicfertilizer application	-0.0001	0.0002	-2.04**
Agrochemical application	0.0644	0.0206	3.13***
Timelyplanting	0.7086	0.1015	6.98***
Plantingspacing	-0.1393	0.0576	-2.42**
Planting method	0.2943	0.1399	2.10**
Cocoyam inter-cropping	0.1300	0.0610	2.13**
Cocoyam mini-sett	0.1209	0.0592	2.04**
Organicfertilizer application	-0.1140	0.0989	-1.15
Weed control	0.2874	0.0717	4.01**
Mulching	0.2129	0.0643	3.31**
Pest control	0.0249	0.1356	0.18
Harvesting	0.1466	0.1022	1.44

Source: Field survey, 2022

Note *, ** and * implies significant at 1%, 5% and 10% probability level, respectively**

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the findings of the study, it was concluded that the cocoyam farmers were aged but still active in production, married and educated with at least secondary education. However, there was poor access to credit, poor contact with extension agents as well as poor cooperative membership. The farmers adopted all the recommended cocoyam production technologies with little variation thus, adoption level was high. The recommended cocoyam production technologies have relative advantage and are compatible with farmers' practices but not complex. The major factors influencing the adoption of recommended cocoyam production technologies in the study area were sex, marital status, education, farm size, farming experience, extension contact, membership of cooperatives, output, sources of information, relative advantage and compatibility while farm size, labour usage, agrochemical, timely planting, planting method, cocoyam inter-cropping, cocoyam mini set, weed control, mulching, extension contact, membership of cooperative and access to credit were the major factors influencing the output of rural farmers. Major severe constraints were high cost of labour, problem of pests and diseases, and lack of fund.

5.2 Recommendations

From the findings of the study, the following recommendations were drawn:

i. Relevant stakeholders (Extension agents, State ministry of agricultural and other Non-Governmental Organization) should make an effort to sensitize and motivate youth to participate actively in cocoyam production, as their participation rate is low.

ii. The farmers should organize themselves into cooperative societies in order to harness the benefits accrued from cooperative participation such as access to credit, extension services and training in relation to cocoyam production.

iii. Access to credit improves the profitability of smallholder farms and improves the viability of the agricultural sector if it is efficiently utilized. It was therefore recommended that credit be made available for smallholder cocoyam farmers through the establishment of a microfinance bank with proximity to rural areas and given at a low interest rate to facilitate the adoption of cocoyam production technologies for increased efficiency and productivity.

iv. Several factors were found to influence the output of rural farmers and the adoption of recommended cocoyam production technologies by farmers in the study area. It is therefore recommended that farmer cooperative groups, the government, non-governmental agencies, community-based organizations, and other relevant stakeholders in agriculture should promote effective sensitization and social investment policies that will facilitate the adoption of modern technologies in agriculture.

v. Agriculture has always been heavily reliant on human labour, but due to the labour shortages and skyrocketing labour costs in the study area that have led to an increase in the cost of production, it is therefore recommended that, farmers adopt innovative products and technologies to supplement their reliance on traditional forms of labour.

5.3 Contributions of this work to knowledge

Contributions to knowledge of the study encompass the following:

i. The research provides technical, socio-economic and information such as age (mean =56), household (mean=6), educational status (mean=9), farming experience (mean=24), farm size (mean=0.82) on Cocoyam farmers in Enugu State that will serves as a guide to policy makers in respect to policy formulation. For instance, farmers' mean age of 56 indicates that majority of them are old and not within productive age. This study has made it possible to know that there is no gender bias in the production and consumption of cocoyam in Enugu state unlike some yam species which can only be produced by men while others by women only. Though, the population of women cocoyam farmers are more (51%) compared to men (45%). The findings will enable stakeholders formulate policies that will attract people within productive age to go into cocoyam production in order to increase production and availability of the crop.

ii. The differentiated adoption status of the recommended cocoyam technologies among the farmers shows the importance of the crop in Enugu State. The thesis was able to bring out adoption levels (high-71%, low-29%) of the improved technologies among the farmers. This is an indication that the farmers utilized the recommended technologies in cocoyam production. Thus, the technologies have relative advantages and were compatible with the existing norms of people in the study area.

iii. On the factors influencing adoption of cocoyam production technologies, age was -0.2513 and significant at 0.05 probability level. This implies further increase in age of the farmers will result to reduction in cocoyam production. Other factors (marital status, education, farm size, farming experience, extension contact, cooperative membership, sex) have positive coefficient and are significant at various probability levels. These findings are necessary guiding towards improvement.

iv. Based on the findings of this work, Cocoyam does not need fertilizer for its production. The crop requires proper weed control for optimal performance. Time of planting, spacing, intercropping, mini-set use and mulching are significant towards increased cocoyam productivity.

v. In production of cocoyam, numerous constraints exist as itemised therein, this thesis ranked the identified constraints in order of their severity. Some constraints (high cost of labour, problems of pests and diseases, lack of fund) were severe and ranked 1st, 2nd and 3rd respectively while problems (poor soil condition, cultural background of the farmers and lack of ready market) were we not severe and ranked 11th, 12th and 13th respectively. This will guide farmers towards overcoming such problems to enhance reduced hitch during production.

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