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Socio-Economic Determinants of Modern Agricultural Technology Adoption in Multiple Food Crops and Its Impact on Productivity and Food Availability at the Farm-Level: A Case Study from South-Eastern Nigeria

Chima, Chidiebere Daniel

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Socio-Economic Determinants of Modern Agricultural Technology Adoption in Multiple Food Crops and Its Impact on Productivity and Food Availability at the Farm-Level: A Case Study from South-Eastern Nigeria

By

Chidiebere Daniel Chima

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Faculty of Science and Environment, School Of Geography, Earth and Environmental Sciences, University Of Plymouth PL4 8AA, United Kingdom **March, 2015**

Copyright Statement

ABSTRACT

Chidiebere Daniel Chima

Socio-economic determinants of modern agricultural technology adoption in multiple food crops and its impact on productivity and food availability at the farm-level: A case study from South-eastern Nigeria

Farmers generally produce multiple crops while selectively adopting modern technologies to meet various needs. The main aim of this study is, therefore, to identify the range of socio-economic factors influencing the adoption of modern agricultural technology in multiple food crops and the corresponding impacts on productivity and food availability at the farm-level in South-eastern Nigeria. In this study, three major food crops (i.e., rice, yam and cassava) and two elements of modern technologies (i.e., HYV seeds and inorganic fertilizers) are considered. The hypotheses of the study are that inverse farm size – technology adoption, size – productivity, size- profitability and size – food availability relationships exist in Nigerian agriculture. The research is based on an in-depth farm-survey of 400 farmers from two states (251 from Ebonyi and 149 from Anambra states) of South-eastern Nigeria. Data has also been derived from surveys and interviews of ADP Program Managers and NGOs. A range of qualitative and quantitative methods including inferential statistics, bivariate probit model and regression analysis were used in order to achieve the specific objectives and test hypotheses. The results show that sample respondents are dominated by small scale farmers (81% of total) owning land less than 1 ha. The average farm size is small estimated at 1.27 ha. Farmers grow multiple crops instead of a single crop, i.e., 68% of the surveyed farmers grew at least two food crops. The level of modern technology adoption is low and mixed and farmers selectively adopt components of technologies as expected and use far less than recommended dose of fertilizers in crops. Only 29% of farmers adopted both HYV seeds and fertilizers as a package. The study clearly demonstrates that inverse farm size – technology adoption, farm size – productivity, and farm size – food availability relationships exist in agriculture in this region of Nigeria; but not inverse farm size – profitability. The bivariate probit model diagnostic reveals that the decision to adopt modern technologies are significantly correlated, implying that univariate analysis of such decisions are biased, thereby, justifying use of the bivariate approach. Overall, the most dominant determinants are the positive influence of farming experience and the negative influence of remoteness of extension services on modern technology adoption. The per capita per day level of mean food produced is 12322.74 calories from one ha of land and food available for consumption is 4693.34 calories which is higher than the daily requirement of 2000 calories. Yam is produced mainly for sale while cassava is produced for consumption. Regression analysis shows that farm size and share of cassava in the total crop portfolio significantly increases food availability. A host of constraints are affecting Nigerian agriculture, which includes lack of extension agents, credit facilities, farm inputs, irrigation, and value addition and corruption, lack of support for ADP staff and ineffective government policies. Policy implications include investment in extension credit services and other infrastructure (e.g., irrigation, ADP staff), training of small farmers in business skills, promotion of modern technology, as a package as well as special projects targeted for cassava (e.g., Cassava Plus project) in order to boost modern technology adoption in food crops, as well as improving productivity, profitability and food availability at the farm-level in Nigeria.

Dedication

This thesis is foremost dedicated to my late elder brother **Uchenna Augustine Chima** that gave everything to support my study. It is also dedicated to my lovely family and dear parents

Mrs Helen Ijeoma Chima

Master Uchechukwu Augustine-divine Chima-chidiebere

Master Chijindu Chimuanya Daniel Chima-chidiebere

And my dear parents

Chief Uthulor Chima (JP)

Mrs Beatrice Chima

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Author's Declaration

At no time during the registration of the Degree of Doctor of Philosophy has the author been registered for any other University award. Work submitted for this research degree at the Plymouth University has not formed part of any other degree either at Plymouth University or at another establishment.

This study was financed by self-sponsorship and help from my lovely family.

The following activities and programmes have been undertaken:

I. Attendance of research meetings with director of studies and project supervisors, during which research progress were discussed.
II. GTA and PGCAP600 Practical Teaching Training Course
III. Attendance of relevant courses and research skill trainings
IV. Oral and poster presentation at various conferences and symposium.
V. Private studies

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Signed: Chidiebere Daniel Chima

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Although this PhD bears the name of one author, a number of people have contributed to its completion. Over the academic years, I have been able to work with fellow research students, academic, ADP staff, ADP program managers and NGOs. Who all helped me develop the knowledge and skills required to complete this research.

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List of Abbreviation

ADP : Agricultural Development Program

AU : African Union

CAADP: Comprehensive African Agricultural Development Program

CAYS : Crop, Area and Yield Survey

DFID : Department for International Development

EU : European Union

FAO : Food and Agricultural Organisation

GDP : Gross Domestic Product

GR : Green Revolution

IFAD : International Fund for Agricultural Development

IFDC : International Fertilizer Development Centre

IITA : International Institute of Tropical Agriculture

LGA : Local Government Area

MDG : Millennium Development Goal

NAERLS: National Agricultural Extension and Research Liaison Services

NALAC: North America, Latin America and the Caribbean

NEPAD: New Partnership for African Development

NPAFS: National Program on Agricultural and Food Security

SSA : Sub-Sahara Africa

UN : United Nation

UNDP : United Nation Development Program

USAID : United States Agency for International Development

WTO : World Trade Organisation

Chapter One

1.0 Introduction

Agriculture has been the mainstay of the economy in Nigeria and many other African countries, providing employment and sources of livelihood for their rural and increasing population (Nwa, 2003). The recent mandate of Food and Agricultural Organisation (FAO) to reduce world hunger by half from its 1990 level by 2015 has made it even more important to look at ways of increasing agricultural productivity, especially in Africa where most of the agricultural producers are subsistence farmers (FAO, 2010). This chapter presents the background and rationale for this research, the research gaps, main aims and objectives of this study and research hypothesis of the study.

1.1 Background and Rationale

The importance of agriculture to the world cannot be over-emphasised. The need to feed the growing world population and make agricultural production more efficient is of utmost importance. Agriculture is the world’s largest economic sector, and on a worldwide basis more people are involved in agriculture than in all other occupations combined (EU, 2009). Whereas most parts of the world like Europe, America and parts of Asia are meeting food requirements for their own people or are in the process of doing so; other countries in Africa and parts of Asia are still struggling to feed their growing population (UN, 2008). Also UN (2008) report states that the world population is growing by 86 million per year and prediction is that it will reach 9 billion people by 2050.

Agriculture serves as a source of employment directly for most people, or indirectly by generating jobs outside the farm. Of poor people worldwide, those that live on less than one US dollar per day, 75% work and live in rural areas and projection suggests that over 60% will continue to do so in 2025 (IFAD, 2000). The right to food is one of the most consistently mentioned items in international human rights documents, but it is the one that is most frequently violated (Clover, 2003). Clover (2003) also states that the target set by the World Food Summit in the Rome conference of 1996, of reducing hunger by half of 1990 levels by 2015 has failed, despite world food production having grown faster than world population. Mason (2006) infers that increasing levels of poverty is a key factor in the hunger crisis or food insecurity in Africa; in some cases of food crisis, food may be available but simply unaffordable. The New Partnership for African Development (NEPAD) report states that it will require an investment of US$18 billion a year in rural infrastructures to achieve the 1996 WFS goal of cutting hunger by 50% partly, because African agriculture remains dependent on rain only; and irrigation schemes where they do exist are concentrated in large commercial farms (Boon, 2007). Concerns over food availability are driven by the need to feed an increasing population and one means of addressing these concerns is to increase food production and local food supply by improving agricultural productivity, and hence forming the basis and importance of conducting this study.

Decades of research have led to substantially improved understanding of the nature of world food insecurity. USAID (2009) report a decline in the percentage of the world population suffering from malnutrition from 20% in 1990/92 to 16% in 2006. Yet over one billion people still face both chronic and/or transitory food insecurity and poverty in Africa and parts of Asia. Ensuring adequate food security/availability for such a large share of the world's population is increasingly challenging, due to increasing world population pressure, poorly functioning input market, rapid urbanisation, outdated agricultural practices, climate change and recent global food, energy and financial crises (Adesina, 2009). Long before the recent crisis Africa was already in food crisis; one in three people and a third of all children are malnourished and half of all Africans live on less than one US dollar per day (Nambiro et al, 2007). Adesina (2009) also states that Africa is the only continent that increasingly depends on relief aid from abroad and had the highest projected gap in meeting the millennium development goal (MDG) of halving world hunger and poverty by 2015. The recent food, energy and financial crises have turned an already serious problem into a catastrophe. Binswanger and McCall (2008) observed that recent assessments show that the aggregate food price index has risen by an average of 60% and this increase in commodity price is not restricted to food grains only but also affects prices of vegetable oils, sugar, dairy and meat products. Adesina (2009) estimates that as a result of these price increases, an additional 100 million Africans are now being driven further into poverty. Therefore, the food crisis or insecurity in the continent reflects a long term structural problem, poor agricultural policies and non-performance of the agricultural sector, especially low agricultural productivity. Given the inherent problem associated with agriculture in Africa and the high level of food insecurity and poverty, there is urgent need to look at ways of increasing agricultural productivity and securing food availability; hence the importance of this study.

Also agriculture plays a major role in the economics of sub-Saharan Africa (SSA) countries; it contributes 70% of employment, 40% of exports and 37% of GDP (Nambiro et al, 2007). Since agriculture contributes 70% of employment but only 37% of GDP, it implies that food insecurity is concentrated in rural agricultural areas. Nambiro et al. (2007) inferred that agriculture has a comparative advantage in reducing poverty and food insecurity. It does this through its growth and participatory effect. Growth effects can be direct (through productivity effects on growth) or indirect growth (through linkages with non-agricultural sectors). Participatory effects occur because the poor participate more in agricultural growth, especially in low income countries. Babatunde (2009) suggests that the substantial differences in agricultural productivity between Asia and Africa can be explained by differences in the use of modern inputs. Evidence suggests that better access to infrastructures (such as roads and irrigation) and agricultural services has given Asian farmers significantly better access to modern inputs. Therefore, SSA farmers without such access are not able to fully exploit the benefit of modern agricultural technology.

Nigeria, like most African countries, faces similar difficulty in her agricultural sector. Nigeria is situated in the western region of Africa with a population of over 150 million people, meaning that one fifth of Africans live in Nigeria. The country has the largest economy in the continent with annual GDP of US$71 billion (DFID, 2005). Of the over 150 million people, over 75 million live in absolute poverty, only China and India have a larger number of poor living within their borders (DFID, 2006). Thomas and Canagarajah (2002) estimates that over half of Nigerians depend on agriculture for their livelihood and the economy of the country, just like those of other SSA countries, depended on agriculture in the early 1960s. With the oil boom of the 1970s, a lot has changed, with the economy now skewed towards crude oil exportation. Blessed with abundant land and water resources, Nigeria’s agriculture sector has a high potential for growth, but this potential is not being realised and productivity is low and basically stagnant (Aigbokhan, 2002). Ehui and Tsgas (2009) observed that farming systems are mostly small scale (subsistence farming) and depend on the vagaries of the weather.

Poverty amidst plenty is the world's greatest challenge, especially with SSA countries accounting for 17% of this population. Increasing the productivity of land under cultivation, increased use of labour saving technologies and improved variety are necessary and a panacea for food security, food availability and poverty alleviation in developing countries like Nigeria (Oni et al, 2009). Janvry and Sadoulet (2001) state the assumption that there are adequate profitable technologies on the shelf which farmers can use to increase productivity and income and hence reduce their food insecurity, and poverty level is not factual. But because agricultural research has been poorly organised for decades, the assessments of these technologies has not been sufficiently integrated with the process of agricultural technology development. Also most technologies that have been released are based on attributes like high yield, early maturity or taste rather than being based on economic benefits. Economic viability of technologies has in reality not been the concern of agricultural researchers, but remains a very important attribute that farmers continuously assess before deciding whether or not to adopt/use a particular technology (Omilola, 2009).

Given the level of food insecurity and the problems associated with agriculture in Africa (World Bank, 2008) and the fact that Nigeria is the most populous African country and has variation of weather (dry savannah, moist savannah and humid forest) like most African countries; the need for this study to be carried out in Nigeria cannot be over emphasised.

1.2 Research Gap

A review of most of the relevant literature, e.g., Nkonya et al, (2010), Omilola, (2009), Conley and Udry, (2000) and Munshi, (2004), show that most of the available literatures deal with only one main aspect of this study, i.e., adoption of agricultural technology, or agricultural productivity growth/increase or the linkage between agricultural adoption and productivity growth/increase. Other strands of available literature, e.g., Adesina (2009), FAO (2005), Akinyele (2009) and UN (2008), deal with issues to do with food security/availability in Africa and assessment of the challenges and food crisis issues in Africa. There is no relevant literature that links these three important aspects of agriculture (agricultural technology adoption, productivity and food availability) in Africa. Therefore this study attempts to bridge this gap by examining these three very important aspects of agriculture. Similarly, within the emerging body of information in this area of study, there seems to be a gap in understanding the fundamental issue of food availability among subsistence farmers in Africa; given that they are the main agricultural producers and how it relates to food security.

Also notwithstanding many studies, e.g., Flores, (2004), Scialabba, (2007), FAO, (2005), Asfaw and Admassie, (2004), Marra et al (2003) and Mendola, (2007), and numerous international conferences and national policies like World Food Summit in Rome (2009); Millennium Development Goal (1996), New Partnership for African Development (2001) and Food and Nutrition Policy for Nigeria on the issue of agricultural technology adoption and food security in Africa, the problem of hunger, poverty and food insecurity still prevails in Africa. Therefore, there is the need to address this gap in understanding the nature and fundamentals of food availability and the dynamics of adoption of agricultural technologies in Africa.

A review of great intervention policies in agriculture like the Green Revolution (GR) in Asia in the 1960s and literature in this area such as (Holloway et al., 2002, Cameron, 1999, Leathers and Smale, 1991, Olwande et al 2009, Minten and Barrett 2008, Munshi 2004, Bandiera and Rasul 2002 and Oni et al. 2009) show the importance of adoption of agricultural technologies as a package which has not been fully exploited in Africa. This study will tend to bridge this gap by looking at the adoption of agricultural as a package with respect to farming categories (small, medium and large scale farms) of the farmers. It will also identify which element of the technology is being adopted most and by whom. Given the difficulty of obtaining reliable panel data in Africa, this study relies on a cross-section of information regarding modern agricultural technology adoption and food availability from home production and the range of socio-economic factors that influence these issues at the farm level. The key assumption is that state of variation in the levels of modern technology adoption and food availability across varying demographic and socio-economic characteristics of individual farmers will closely approximate a long-run relationship that could have been achieved otherwise by following a set of cohort farmers over time.

1.3 Aim and Objectives of the Study

The broad aim of this study is to identify the range of socio-economic factors influencing adoption of modern agricultural technology in multiple food crops and its corresponding impact on productivity and food availability from farm production in South-eastern Nigeria. The economic benefit of agricultural technologies is one factor that influences adoption of these technologies. In numerous occasions, the adoption of these technologies may have been difficult either because the technology proposed is not sufficiently adopted or it presents economic risk or contradicts local culture. In pursuing the main aim of this study, this research will focus on agricultural technology adoption, production increase and partial food availability at the farm level. The following specific objectives are:

- To identify the types of modern agricultural technology currently utilized at the farm-level.
- To identify whether modern agricultural technology is being adopted as a package, and if not, which elements of the modern technology package are being adopted most.
- To identify the socio-economic determinants of modern technology adoption in multiple food crop production at the farm-level
- To measure the level of food produced by farmers and available for consumption at the farm-level in one crop calendar year.
- To identify the socio-economic determinants of food availability from farm production.
- To identify various constraints affecting modern agricultural technology adoption, productivity of food crops and food available for consumption from farm production at the farm-level.

This study will evaluate the above objectives through the use of structured questionnaires for both farmers and Agricultural Development Program (ADP) staff in the study area and selected interviews with key stakeholders. The agricultural technologies that are considered in this study are inorganic fertilizer usage, High Yielding Variety (HYV) usage, use of farm machineries and use of pesticide/herbicide identified by the farmers. The study will evaluate the sequence of adoption of different technology in the study area and identify the components (technology) that are being adopted. The use of inorganic fertilizer was regarded as agricultural technology rather than intensive input usage, because they are chemical compounds that are made outside the farm for the sole purpose of improving the nutrient content of the soil and enhancing the growth of plants leading to increase in their productivity (yield) (Nambiro and Okoth, 2013; Ogada et al.; 2014 and The Fertilizer Institution, 2014).

It is very important to note that the food availability aspect of the study only refers to Partial Food Availability (PFA) at the farm level (subsistence level) from home production excluding food purchases and food transfer from other households. Finally, the analysis and evaluation of the aim and specific objectives of this study will be at farm level, using cross sectional data.

1.4 Hypothesis

According to Kerlinger (1986), ‘A hypothesis is a conjectural statement of the relationship between two or more variables’. Also Grinnell and Stothers (1988), states that a hypothesis is written in such a way that it can be proven or disproven by valid and reliable data; it is in order to obtain such data that we perform our study (Kumar, 2005). From the above, it could be said that a good hypothesis should have the following characteristics:

- Its validity is unknown
- It is a tentative proposition and
- In most cases, it specifies a relationship between two or more variables (Kumar, 2005)

An important factor that affects productivity in developing country agriculture is farm operation size. The debate on size-productivity relationship is mixed in the literature. An inverse relationship between farm size and productivity is prominent in areas where farming practice is labour intensive because, for the large farms, high level of labour costs deters them from using hired labour to optimal levels (Niroula and Thapa, 2005). However, with increased use of modern technology and inputs, the inverse size-productivity relationship has been weakened in recent times (ibid). Nigerian farming is characterized by small scale and labour intensive farming but large farmers are also featured to some extent. For example, Apata *et al*. (2011) noted that three percent of farm holdings are owned by large farmers with an average farm size of 13.51 ha. Therefore, it is important to test the size-technology adoption, size-productivity, size-profitability and size-partial food availability relationships in Nigeria using recent evidence. Given this backdrop, this study focuses on the role of farm size in adoption of modern technologies as a package or elements of the package, productivity of food crops as well as food availability from farm production. Therefore, for the purpose of this study, the following four research hypotheses will be tested:

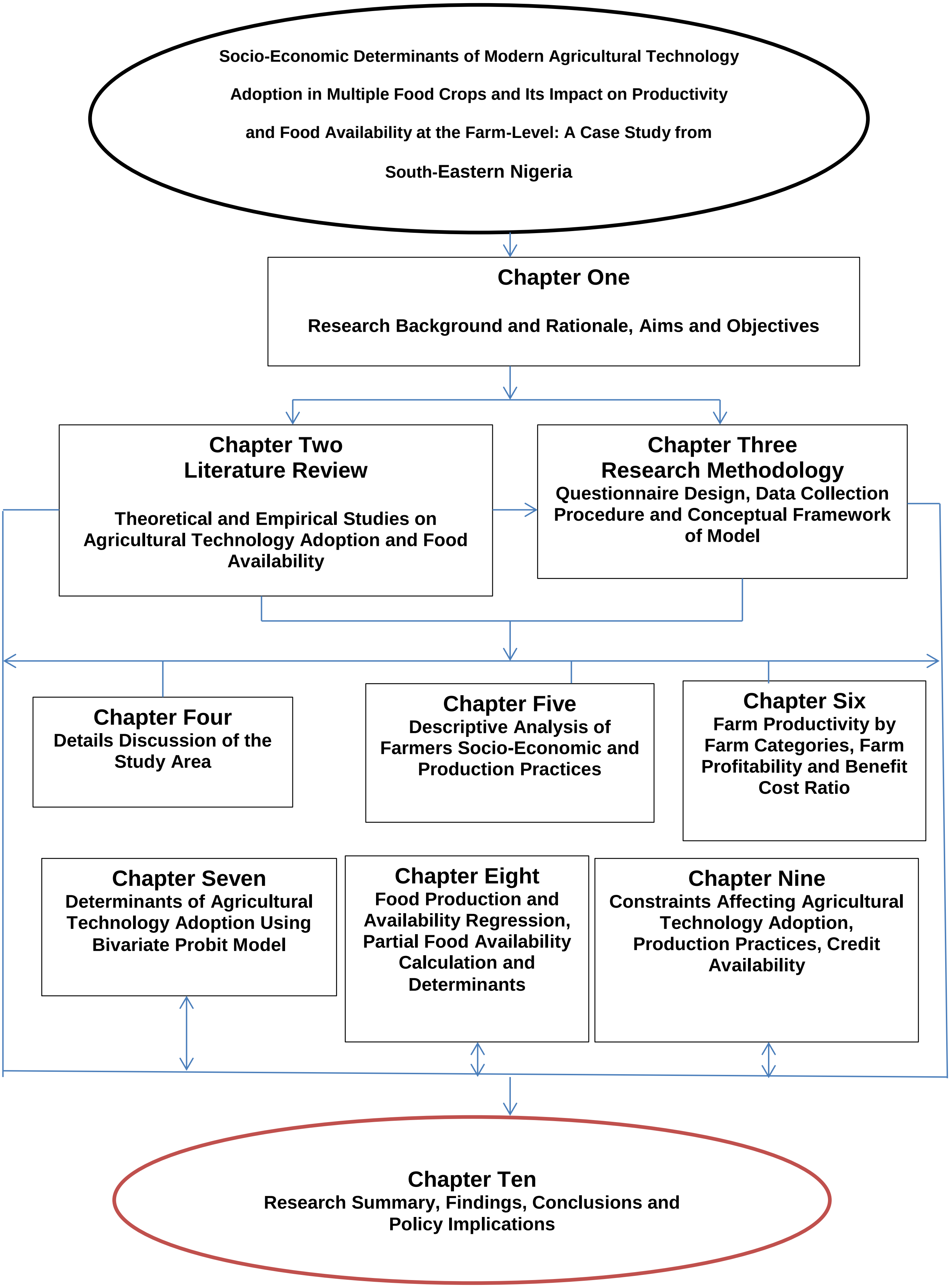
- Farm size does not play any role in decision to adopt modern agricultural technologies in major food crop production at the farm level
- Farm size does not have any impact on productivity of food crops at the farm level
- Farm size does not have any impact on profitability of food crops at the farm level
- Farm size does not have any impact on food availability from farm production at the farm level

Appropriate statistical tests will be conducted to validate these four broad research hypotheses by specifying appropriate null and alternative hypotheses.

1.5 Overall Description of Research Plan

Chapter One introduces the background and rationale behind the study and the research gap the study aims to address. It also discusses the main and specific objectives of the study and the hypothesis that will be tested. Chapter Two presents the review of literature focusing on the state of agriculture in Africa and Nigeria, Green revolution and its limitations, modern agricultural technology adoption and food security/availability issues in Africa and Nigeria. Chapter Three describes the research methodology, data collection procedure and limitations and outcome of the data collection process. In addition, the chapter outlines the conceptual framework behind the econometric analysis, partial food availability calculation and farm profitability and profitability index. Chapter Four describes the study area in detail and discusses agricultural production trends in Nigeria and the study area. Chapter Five presents descriptive analysis of the farmers/respondents, paying attention to the socio-economic characteristics of the farmers and their farm production practices. Chapter Six measures farm productivity of major food crops by farm categories, farm profitability and profitability index. The determinants of agricultural technology adoption by farmers using bivariate probit model is presented in Chapter Seven. Chapter Eight concentrates on food production and food availability of major staple food crops, and identifies determinants of food availability at the farm level. Chapter Nine discusses the constraints affecting agricultural technology adoption, production practices, and credit availability. Chapter Ten summarises key findings, draws conclusions, policy implications and direction for future research.

Figure 1.1: Structure of the Research Thesis



Chapter Two

Agricultural Technology Adoption and Food Availability

Literature Review

2.0 Introduction

Food is one of the most important human needs, necessary for health, survival and productivity. It is the foundation for all human and economic development. Ensuring food security/availability for today's population and generations to come is one of the greatest challenges facing the world community. Food security refers to the ability of people to meet their required level of food consumption at all times. It is considered by many to be a basic human right. However, about 1.1 billion people in low-income, food deficient developing countries cannot meet this basic need (FAO, 2005a).

Africa entered the 21st century as the world's poorest continent, with economies growing slowly or declining and per capital incomes low or falling. Although the continent's GDP has improved over recent years, the proportion of people living in absolute poverty remains higher now compared to what it was in the 1980s and 1990s (FAO, 2010). Juma and Serageldin (2007) state that Africa like other parts of the developing world faces perennial challenges in the area of food security/availability and agricultural productivity increase. Given the recent enormous economic growth and development in China and other emerging economies, the demand for food in these areas has increased tremendously and the increase in the amount of food grains used for bio-fuel production is not helping matters.

The challenge for developing countries agriculture in the next 25 years is enormous, particularly if it is not only to satisfy the growing effective demand for food but also help reduce poverty and malnutrition and to do it in an environmentally sustainable fashion. Due to population growth and rising incomes, demand in the developing countries is predicted to increase by 59% for cereals, 60% for roots and tubers and 120% for meat over this period (FAO, 2005a). This increased supply cannot come from area expansion, since that has already become a minimal source of output growth on a world scale and a negative source in Asia and Latin America. Neither can it come from any significant expansion in irrigated area due to competition for water with urban demand and raising environmental problems associated with chemical run-off (Delgado, 1995). The above underline the need for this study and the need to exploit other ways of increasing productivity, such as the adoption of agricultural technology as a package, especially in developing countries.

This chapter reviews all the relevant literature that covers the different aspects of this study as they relate to the core objectives of the study. Therefore, this chapter explores the following broad sections: review of differential development in agriculture across the world; the green revolution, the experience of Asia, Latin America and Africa; agricultural development and the state of agriculture in Africa and Nigeria; the concept of agricultural technology adoption and current trends in adoption literature; the concept of food security and the linkage between agricultural technology and food availability. Finally, the review of literature will highlight the gaps in knowledge and indicate which of the gaps will be addressed by this study.

2.1 Differential Development in Agriculture across the World

The UNDP (2007) maintains that agriculture is the backbone of Less Developed Countries (LDCs); it accounts for 30 to 60 percent of the gross domestic product. This sector employs more people than any other sector and represents a major source of foreign exchange and supplies the bulk of basic food materials. Yet agriculture in LDCs faces many difficulties both internally and externally in their efforts to meet the MDG of reducing hunger by half by 2015 (ibid). The internal difficulties include low productivity, low skill capacity, poor infrastructure, and low life expectancy among others. The external difficulties are the fluctuation in the prices of most export crops and the over dependency of LDCs agriculture on weather conditions. Therefore, LDCs agricultural supplies often vary along with the weather; LDCs can rapidly move from a surplus to a deficit situation very easily (ibid).

Agricultural production per capita has been steadily increasing in line with the world average in developing countries like China. Since the early 1980s, it has grown at an average rate of 0.5%, a higher rate than that of industrialized countries (0.2%). The pattern of agricultural production in developing countries is not uniform across the regions; Asia increased agricultural production in the 1980s and parts of the 1990s but this promising performance was interrupted by the severe Asian financial crisis of 1997. Production per capita in Africa was stagnant during the 1960s and the first half of the 1970s but still above the Asian average. This decreased from 1975 until 1985 when it recovered slightly but remained below that of Asia.

Latin America and Caribbean countries' (LAC) agricultural production trend has been increasing on average, particularly in the second half of the 1970s and in the early 1990s. In spite of the financial crises of 1994 and 1997, LAC countries have maintained a level of production per capita above both the world and developing countries (DC) average (Diaz-Bonilla et al., 2002). Also according to the World Trade Organization (WTO) international trade statistics (2003), Western Europe had a share of 42.7% of the world total agricultural exports during the year 2002. The report states that Latin America had 0.6% while African countries dependent on agriculture as a source of revenue generation had a miniscule share of 1.4%. Also within the European Union (EU), agricultural products originating from Africa, Caribbean and Pacific Group of States only represents 4% of EU imports.

There are distinctive differences in trade across North America and Latin America and the Caribbean (NALAC), Asia, Africa, the EU and the transitional economies. In NALAC, the overall trend has been increasing since the early 1970s; they have increased at a relatively more stable rate in LAC. The trends in Asia for both developed and developing countries are almost the exact opposite of NALAC. Both groups are net importers of food and their net import has increased since the 1970s. In less developed countries of Africa, the net export of both agricultural and food products have declined since the mid-1970s. Africa has experienced a dramatic decline in net export values for both agricultural and food products, with the exception of South Africa and some North African countries. The trend in the EU is the opposite of that of Asia and Africa. The EU is now a net exporter of food products and this trend looks set to continue (Diaz-Bonilla et al, 2002).

It has been argued that trade and economic policies appear to have been generally more supportive of agricultural production and export in Asia, uneven record in LAC and it seems to have been just one component in a larger array of forces inhibiting economic development in Africa (Diaz-Bonilla and Reca, 2000). The problems of developing countries are lack of financial and human resources and institutional capabilities. The differential in development with developing countries arises from the differences in the climatic conditions of the different regions, financial and human resources and institutional capabilities, together with policy implementation ability and corruption among others.

2.2 The Green Revolution, the Experience of Asia, Latin America and Africa

The Green Revolution (GR) was just one aspect of a much larger transformation of global agriculture in the 20th century. The story of English wheat is typical; it took nearly 1000 years for wheat yields to increase from 0.5 to 2.0 tons per hectare, but this has climbed to over 7 tons per hectare during the 20th century (Hazell, 2009). These advances were fuelled by modern plant breeding, improved agronomy and the development of inorganic fertilizers and modern pesticides and have helped developed countries to achieve sustained food surpluses and abolish the threat of food shortage (Hazell, 2009).

These advances were much slower in reaching developing countries. Although the colonial powers had invested in improving the production of tropical export crops, they invested little in the food production system of their colonies. This neglect together with rapidly growing populations led to widespread hunger and malnutrition by the 1960s, especially in developing countries of Asia, Africa and Latin America (Evans, 1998).

The term ‘’Green Revolution’’ (GR) originally described the development of improved varieties for rice and wheat but it now refers to the development of high yielding varieties for a number of other major crops important to developing countries. GR is a continuing process of change rather than a single event;

continuing improvements of cereal varieties and management practices helped support the high level of productivity that was initially attained. Although the main thrust of GR occurred during the period 1965 – 1990 in Asia, it has many technological and policy antecedents in the rice revolution that began in Japan in the latter part of the 19^{th} century and spread to Taiwan and Korea during the late 1920s and 1930s (Jirstrom,2005). GR spread rapidly across developing Asia and the resultant increase in food production pulled the region back from the edge of an abyss of famine and led to regional food surpluses within 25 years, according to Hazell, (2009). The author further maintains that it lifted many people out of poverty, made an important contribution to economic growth and saved large areas of forest, wetlands and fragile lands.

The concept of GR was driven by a technology revolution based on the adoption of agricultural innovation as a package. The GR package includes irrigation, improved seeds, fertilizers and pesticides. Its implementation depends on strong public support for developing the technology, building up the required infrastructure, ensuring that markets, finance and input systems work and also ensuring that farmers have adequate knowledge and economic incentive to adopt the technology package. Public interventions were especially crucial for ensuring that small farmers were included, without which the GR would not have been as pro-poor as it was.

Attempts have been made to separate the contributions of the different components of the GR package, but in practice it was the combined impact of interventions and their powerful interactions that made the difference (Jhamtani, 2010). This principle of GR that is the adoption of agricultural technology as a package has not being fully exploited in Africa and is one of the major aspects of this study. The fact that the GR worked very well in Asia despite some of its short comings underscores the importance of exploiting the key principle behind it.

The GR was not confined to Asia; it successfully spread to large parts of Latin America, the Middle East, and North Africa. But despite several attempts to bring the GR to SSA, it has not yet happened on the scale that is needed. Moreover, many promising starts failed to sustain themselves over time. The experience with hybrid maize in Eastern and Southern Africa is salutary; initial success was based on the Asian model with improved varieties that originated from regional plant breeding efforts, subsidized inputs and a grain marketing board that bought up maize at guaranteed minimum prices.

Several factors such as an inefficient and corrupt marketing board, escalating fiscal cost that could not be sustained and soil degradation due to specialized maize cultivation on fragile land led to the collapse of the system (Smale and Jayne 2003). By missing out on the GR, average cereal yield in Africa has changed little since 1960 while that in Asia and other developing regions has tripled. This has been a major factor underlying the trend decline in per capita food availability in Africa and the worsening poverty and malnutrition in Africa (World Bank 2007).

2.2.1 Limitations and Criticism of the Green Revolution

Asia was able to break out of its food production constraint by bringing the force of the 20th century scientific revolution in agriculture to its farmers. Governments and international organisations invested heavily in agricultural research and development, extension, irrigation, and fertilizer supplies and farmers also made major changes to their traditional farming systems. The switch from low input, low output farming to high input, high output farming was not without its problems, but it was supposed to provide the needed productivity breakthroughs that had otherwise failed to materialize (Hazell, 2009). The initial GR technology package worked best for wheat and rice in the best irrigated areas. The technology has now evolved to accommodate the challenges of many poorer regions growing a wider range of food crops; continuing advances in agricultural sciences have increased the range of areas and food crops that can benefit from GR technologies. In addition, market forces alone are insufficient for launching GR in poor developing countries where market chains for food staples are typically characterized by numerous failures and coordination problems (Dorward, Kydd and Poulton 1998).

More than a single technology fix, a set of policy initiatives and preconditions came together in Asia to create an enabling and sustained economic environment that ensured all sized farms could participate in a fully functional market chain for food staples. These include access to a changing technology package; threshold levels of infrastructure and market. Given the above, the time is now right for African countries to adopt, if only in parts, the key principle behind the GR which is the adoption of agricultural technology as a package, and hence the importance of this study.

Despite all the gains of GR, it is not without its own limitations; the use of fertilizers and pesticides is one of the key components of the GR package. This increased use of agrochemicals not only increases production cost but also has health and environmental impacts, whose costs have not been properly internalised. For example, the cost associated with agrochemical pollution of the water systems and soils has never been taken into account (Jhamtani, 2010). Accidents and even deaths of farmers and agrochemical labourers due to lack of knowledge on safe use of chemicals have been underreported. Most farmers are not well educated on the use of chemicals and enough information has not been given to them on the safe handling of chemicals. Also, easy access to pesticides has meant that these chemicals have becomes a common means of committing suicide when farmers go bankrupt or become embroiled in debts (Jeyaratnam, 1993). Jhamtani, (2008) reported the increasing cases of food contamination by pesticides, as was the case of DDT residue found in mother's milk in Indonesia. The price paid for chemical contamination thus goes beyond the agricultural fields to our daily diet.

The intensive double or triple mono-cropping of rice caused the degradation of the paddy micro-environment and a reduction in yield growth in many irrigated areas in Asia. This led to increased pest infestation, mining of soil micro-nutrients, and reductions in nutrient-carrying capacity of the soil, together with build-up of soil toxicity, salinity and water-logging (Pingali and Rosegrant, 1994). Consequent on this, crop yields are declining rapidly and many farmers are heavily in debt from their investment in new equipment and cost of chemicals; this has an ominous effect on the farm economy.

The main lesson to learn from GR is that it is not only about the adoption of agricultural technology but the whole package. GR in Asia can be used by Africa as inputs for considering strategies and approaches to food availability. The most vital consideration is the local agro-ecosystem rather than applying technologies that are developed detached from the local systems. The world has changed compared to the 1960s when GR was adopted in Asia. We now face crises of natural resource erosion, climate change, globalisation and most recently, the financial crises. Africa not only needs to learn from the experience of Asia but build its own GR to suit its strengths.

2.3 Agricultural Developments and the State of Agriculture in Africa and Nigeria

The region known as Africa is a very heterogeneous area with varying climatic and weather conditions from North to South and from East to West. The outside world tends to have a fairly definite view about Africa or a preconceived view of Africa as an entity. African agricultural development is not an exception but has come a long way from the colonial era, through the independent era of the 1960s to where it is now in the 21st century (Delgado, 1995).

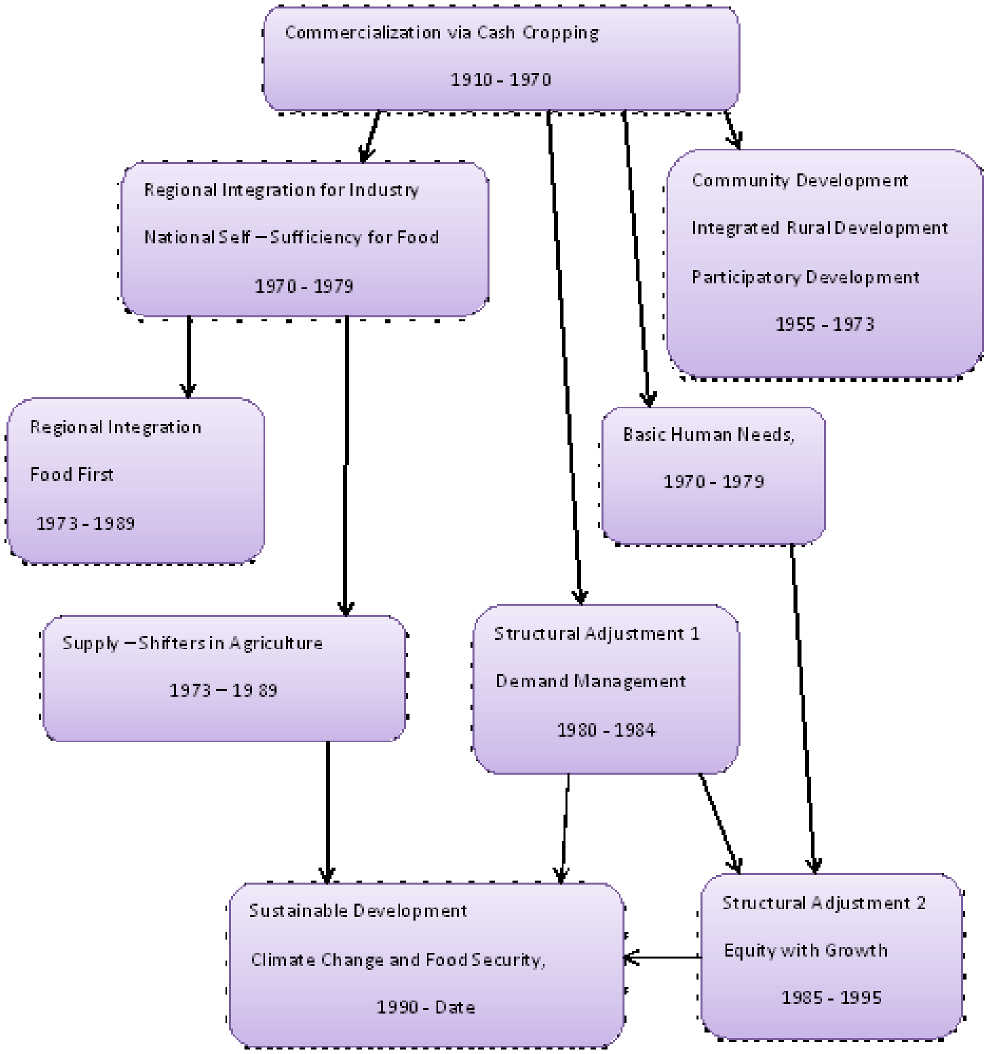
During the last 25 years, African policymakers have been bombarded with advice on agricultural development strategies, often conflicting or motivated by divergent theoretical views. Over the years, different types of paradigms have been proposed and adopted by policymakers in Africa (Cornia and Helleiner, 1994). There is (Paradigms) an underlying body of beliefs on how the process of agricultural development works and how it can best be promoted. Despite the diversity of Africa, it can be argued that there are key similarities across the countries of the region that permit a schematic overview of agricultural development strategies.

The dominant paradigms of agricultural development strategies in Africa are presented in the flow chart in Figure 2.1 and the approximate time frame for the dominance of each paradigm and the intellectual link between them are also shown. These paradigms have at least five characteristics in common. First, they have developed in Africa in roughly chronological order since the late colonial era and some overlap each other. Second, it is incorrect to ascribe any of these paradigms to a specific geopolitical or intellectual interest. Each has its champion both within and outside Africa, like the World Bank championing of the structural adjustment program in the 1980s. A third characteristic of the paradigms is that both their nature and their common application across countries of Sub-Saharan Africa were largely the result of changes in world economy and political events. A fourth characteristic is that there exists a tension within each paradigm between the will to focus on a precise well defined actionable instrument and the desire to offer a broad vision of how development occurs. Lastly, the fifth characteristic in common is that the basic design and mode of implementation of all these paradigms comes from outside Africa, even though each paradigm undoubtedly has had a genuine African adherent. It is very hard to think of other significant regions of the world in modern times where outside influences on basic development strategy issues have been so pervasive (Delgado, 1995).

Figure 2.1 shows the different paradigms of agricultural development in Africa, the commercialization via cash cropping shows the era during the colonial period when emphasis was on the production of export crops for the colonial masters. Development in this era is documented by Suret-Canale, (1977) and shows an era where emphasis was on community development, integrated rural development all geared towards producing export crops. There are other paradigms, but now emphasis is on sustainable agricultural production, climatic change and food security/availability.

According to the Bill and Melinda Gates foundation 2010, agriculture in Africa now provides 70 percent of employment and 30 percent of gross domestic product (GDP) of most Sub-Saharan African countries. It plays a major role as a source of foreign exchange and in some countries it is the main source of foreign exchange. Given the importance of agriculture to the economy of sub-Saharan African countries, there is a need to find other ways of increasing the productivity in the region which this study is expected to show.

Figure 2.1 Paradigms of agricultural development in Africa



Source: Delgado,1995

Agriculture dominates the economies of most African countries, providing jobs, income and exports. Therefore, a stronger performing agricultural sector is fundamental for Africa's overall economic growth. A constantly growing agricultural sector is crucial for addressing hunger, poverty and inequality in the region (FAO, 2005). Despite the importance of the agricultural sector to the economies of sub-Saharan countries, agriculture in Africa is still relatively weak and faces problems such as a high degree of production variability, relatively low crop yields, over dependency on the weather for rainfall, with low income elasticity and high price volatility in relation to other regions of the world (AU, 2003). In general, agriculture in Sub-Sahara Africa is still very undercapitalized, uncompetitive and underperforming, hence the need to find ways of increasing productivity and the need for this study.

Appendix 1, Table: 4; shows agricultural indicators in different regions in the world; it highlights the state of agriculture in Sub-Saharan Africa and shows how agriculture in SSA compares with other regions of the world against some key indicators. This reveals how SSA falls well below other developing regions of the world in the proportion of area irrigated, value added by workers, fertilizer levels and productivity growth in both crops and livestock activities. In SSA less than 4 percent of the cropped area is irrigated; value added per worker in agriculture has to be doubled to equal those in Latin America, and cereal yields would have to more than double to match those in South Asia.

The consequence of this poor state of agriculture in SSA is reflected in the level of poverty and food insecurity in the region. About 300 million people live on less than US$1 per day and it is the only continent that is increasingly dependent on relief aid from international agencies; in addition it has the highest projected gap in meeting the MDG goal of halving hunger and poverty by 2015 (Adesina, 2009).

Agricultural development in Nigeria like in other SSA countries followed a similar pattern as that in Figure 2.1. The history of agricultural development in Nigeria is intertwined with the political history of the country and can be accessed from the pre-colonial, colonial and post-colonial eras. During the pre-colonial era, agriculture was the mainstay of the traditional economy and the period of colonial administration brought a great impact on agricultural development with emphasis placed on export crops, research and extension services (Nwa, 2003).

Also, agriculture in Nigeria like that in other countries in Africa still faces numerous problems. Despite the discovery and exploration of crude oil from the 1960s, agriculture still remains a major hub of the economy providing employment for over 90 percent of rural dwellers, who constitute 70 percent of the total population. The country is blessed with abundant land, labour and natural resources with an estimated agricultural land area of 71.2 million hectares (Akinyele, 2009). The agricultural sector GDP is made up of crops (85 percent), livestock (10 percent), fisheries (4 percent) and forestry (1 percent). More than 90 percent of the agricultural output is accounted for by small-scale farmers with less than 2 hectares under cultivation (Akinyele, 2009). With an estimated 71.2 million hectares of cultivatable land and about 70 percent of the population labour force engaged in the sector, the output of the sector is adjudged to be low and labour intensive (FAO, 2002; Ukeje, 2000).

In recent years, the agricultural sector in Nigeria has suffered a relative decline since independence due to the dominance of the oil sector in the economy and in the aggregate GDP share, but it still accounts for 33 percent of the nation's GDP (Aigbokhan, 2001). While agriculture holds immense potential for enhancing and stabilising the country's foreign exchange earnings and guaranteeing food security/availability in the country and beyond, the past three decades have witnessed a steady decline in this role. Nigeria which was once a large net agricultural produce exporter now imports food and past attempts to revive the agricultural sector have been unsuccessful. With the increasing human population in the country and increase in demand for food, there are needs for the development of the sector by boosting/increasing the volume of food production to meet the increase in food demand and to guarantee the food security/availability of the country, which this study hopes to show.

Irrigation schemes and projects in Nigeria consist of three categories, namely, the public irrigation schemes which are government executed schemes, the farmer owned irrigation projects and the residual fadama or floodplains. The large scale and medium scale irrigation schemes in the country are controlled by the River Basin Development Authority with a current estimate of 119,350 hectares under the two schemes. The land area irrigated in Nigeria is shown in Appendix 1, Table: 2 and it reveals that the combined area equipped for irrigation in the country stands at 293,117 hectares together. With an additional 681,914 hectares non-equipped flood recession cropping area, making a total of 975,031 hectares water managed area (Aquasat, 2005). However, while the irrigation potential of the country stands at 2,330,510 hectares, the actual irrigated land is less than 1 percent of the cultivated land thus making the contribution of irrigated agriculture to crop production very small and an important factor if we are to increase agricultural production (ibid).

In comparison with developed countries and the developing countries like Nigeria, Bhaduri and Skarstein (1997) noted that in the 1950s, the agricultural labour productivity of developed countries was seven times that of the developing countries but by 1990, the agricultural labour productivity in developed countries was already thirty seven times higher than that of the developing countries, relating to higher labour cost for the developing countries and lower production cost for developed countries. This is reflected in the huge increase of food imports by developing countries, as this made them net importers of food, and there was also a sharp reduction of their export commodities. Given the state of agriculture in Africa, there is the need to look at barriers to agricultural development in Africa.

2.3.1 Barriers to Agricultural Development in Africa

The several factors affecting the development of agriculture in Africa include:

(**a) Poorly developed market and low price of agricultural products: -** Output prices play a significant role as well as the ratio between output and input prices in determining the level of development of agriculture. Unfortunately because of the poorly developed markets and high transport cost in Africa, output prices have remained low and variable with a more rapid increase in prices of agricultural inputs. High tariff and non-tariff barriers reduce intra-regional trade flows leading to greater price volatility. Also, open intra-regional trade between African countries offers important opportunities to exploit differences in comparative advantages. Expanding regional markets can serve as a vent for surpluses and help in stabilizing food prices (Diao et al, 2008). Another factor is the bulky nature and perishability of many of Africa's staple crops. Processing and value adding will be needed to transform several of these crops into a wider range of products for which there is high demand.

(b) Weak political environment to support agriculture: - Underlying this negative factor is the lack of political will amongst Africa's leaders, senior policy makers and donors towards agricultural development. Given the adoption of the Comprehensive Africa Agricultural Development Program (CAADP) by African leaders, in which countries committed themselves to invest at least 10 percent of their national budgets into agriculture, this pledge is yet to be realised since most African countries are yet to live up to their pledge (AU, 2010)

(c) Climate change and vulnerable weather conditions: - Climate change is expected to dramatically change the face of agriculture and increase the vulnerability of hundreds of millions of poor farmers in rural and urban populations of Africa. It is expected that severe drought will occur more frequently, especially in the dry semi-arid regions and flood is expected to increase in the rain forest regions (Fleshman, 2007). While Africa contributes less than 3 percent of the global greenhouse emissions, compared to 40 percent from the G-8 countries, it now bears a disproportionate burden of economic losses as well as the human, health and social consequences of its effects. The net loss due to climate change in Africa could be as high as US$133 billion, with agriculture bearing the brunt of it, an estimated loss of about US$132 billion (ibid).

(d) Poor state of infrastructures: - The state of infrastructures (road, electricity, hospital etc.) in Africa is the poorest in relation to other developing regions. This affects the movement of agricultural products and the prices that farmers are able to get for their crops, since they may not be able to move them to the nearest city where they may get better prices for the crops.

(**e) Lack of access to modern mechanised equipment and irrigation facilities: -** Agriculture in Africa is still being carried out with crude equipment like hoes and cutlasses and this is hindering the productivity of farmers (Afua et al. 2009).

(f) Access to credit facilities: - Access to credit is one of the biggest problems facing agricultural development in Africa. Due to the nature of agriculture in Africa, it is always difficult for poor farmers without collateral to get access to credit from the banks (Thomas and Canagarajah, 2002).

(g) Land ownership system: - Access to land is a big problem in Africa, and where lands are available they may be fragmented into small portions, making large farms or commercial farming difficult in most parts of Africa (Ukeje, 2000).

2.3.2 Agricultural Technology Promotion in Africa

Technological changes have been one of the most rapidly growing areas of study within the discipline of agricultural economics. The agricultural productivity gap between developed and developing countries has widened since after World War II due to rapid development in agricultural technology in developed countries (Rahman, 1996). Morroni (1992) defines technological change as a variation in the method of production and/or quality of goods and services produced. He emphasised that the distinctions between changes in the processes and changes in the product are very important.

They are intricately linked with each other in the sense that a change in the product leads to a change in the process and vice versa. Cyert and Mowry (1987) indicate that technological changes have two major effects: (a) they transform the process by which inputs are transformed to outputs and (b) they enable the production of entirely new product/outputs. They distinguish between process innovation and product innovation. Process innovation is referred to as the technological change that improves the efficiency with which inputs are transformed into outputs, whereas product innovation leads to the production of a new product.

The challenge for developing countries' agriculture in the next 25 years is enormous, particularly if it is not only to satisfy the growing effective demand for food but also to help reduce poverty and malnutrition and do it in an environmentally sustainable fashion. This increased supply cannot come from area expansion, since that has already become a minimal source of output growth on a world scale and a negative source in Asia and Latin America. Neither can it come from any significant expansion in irrigated area due to competition for water with urban demand, nor the raising of environmental problems associated with chemical run-offs.

Therefore it needs to come from growth in yields, the growth rate in cereals over the next 25 years. Consequently the growth in yields cannot be left to fall below this rate in developing countries without increasing the share of food consumption that is imported. With about 1.3 billion people in absolute poverty (earning less than US$1 per day) and 800 million underfed in developing countries (World bank, 2008), agriculture has a major role to play in poverty reduction, particularly since three quarters of these poor and underfed live in the rural areas where they derive part if not all of their livelihoods from agriculture as producers, or as workers in agriculture and related industries.

The above underlines the need for this study and the need to exploit fully the adoption of agricultural technology as a package in developing countries. The real income of poor consumers also importantly depends on the price of food if poverty is to fall and the nutritional status of the poor is to improve. At the current levels of food dependency, the decline in growth rate in yields will have to be stopped, and yield increases compared to current trends will have to occur in part in the fields of poor farmers and will have to generate employment opportunities for the rural poor. Since the growth rate in yields achieved with traditional plant breeding and agronomic practices has been declining, the next phase of yield increases in agriculture will have to rely on the adoption of new agricultural technologies.

There have been attempts to promote one kind of technology or the other in the past, as reflected in past agricultural development strategies as shown in Figure 2.1 both in Africa and Nigeria. Duflo et al. (2004), state that rapid population growth has caused Africa not to be viewed as a land abundant region, where food crop supply could be increased by expansion of the area of land used for agriculture. Large areas in Africa are increasingly becoming marginal for agriculture and arable lands have become scarce in many African countries. This marks the need for intensification of land use through use of productivity enhancing technologies for food security/availability in Africa (Olwande et al, 2009).

Achieving and maintaining economic development has been the main challenge facing African countries during the last forty years. This has been exacerbated by the inability of African nations to harness and utilize their natural resources in a sustainable manner, together with their inability to promote and apply science and technology to generate agricultural production technologies that can circumvent unpredictable rainfall and drought, as well as reduce the impact of natural disasters.

However, science and technology are not a panacea for economic development and by themselves they will not solve Africa's stubborn legacies of underdevelopment; but they can contribute positively and improve current conditions. African countries must follow a multifaceted approach of strengthening their national agricultural research systems and their networks at the intraregional as well as at the global level (FAO, 2005b). The challenge for Africa is to provide an enabling environment for sustainably increasing the output of smallholder famers.

In order to meet the United Nations Millennium Development Goals (MDG) of reducing or halving hunger by 2015, the African Union (AU) through the New Partnership for African's Development (NEPAD) in 2003 established the Comprehensive African Agriculture Development Programme (CAADP) which identified agricultural research, technology dissemination and adoption as the pillar for African's development.

NEPAD aims to achieve an increase in food productivity through an increased rate of adoption for the most promising technologies and efficient linkages of research and extension systems. A shift is needed from a single commodity and mono-disciplinary base to a farming system and a multi-disciplinary based approach together with a change from a top down extension model to a participatory approach to technology assessment and adoption (AU, 2010).

2.3.3 The Concept of Agricultural Technology Adoption

According to Harper Collins English dictionary (2003), the term 'Adopt' means among other things to choose; that is to choose a plan or method of doing something. In other words it means to accept a system as the best way of carrying out an event. Over the years, researchers have worked to answer the question why farmers choose a particular farming system or input over any other. They have tried to answer the question, what makes a farmer choose a particular agricultural technology. Initially, policy makers and researchers sought to use simple descriptive statistics to explain the diffusion of new seed varieties and associated technologies such as fertilizer and irrigation. But concerns arose about the impact of technology adoption on commodity production, poverty and malnutrition, farm size and input use, genetic diversity and a variety of social issues (Doss, 2006).

Numerous researchers have now developed innovative methodologies for addressing such concerns. They have collected and carried out surveys with enormous amounts of data to describe and document the adoption of new agricultural technologies. Yet many questions remain. We still have considerable gaps in our knowledge of which technologies are being used, where and by whom. Bigger questions have also arisen about the roles of policy, institutions, infrastructure and agricultural technologies in increasing agricultural productivity. To understand this better we need to define some of the key terminology used in adoption:

Innovation: - This is defined as a new technical product or procedure that is created in a research facility (Leeuwis, 2004). However, it is well known that many of the ideas, products and processes developed in the laboratory never reach the stage of being applied in everyday practice (Little et al., 2002). Therefore for extension purposes we need a more pragmatic conception of innovation; in other words, it has to be a new way of doing things or even doing new things, but it can only be considered an innovation if it actually works in everyday practice (Leeuwis, 2004).

Diffusion: - This is the process of the spreading of innovation from the research centre to the farmers/community. Communication is the key way of diffusion of innovations, and researchers have observed that specific people within the community play an important role in stimulating or preventing the spread of innovation (ibid).

Adoption: - This refers to the acceptance or uptake of innovation by individuals, not something that happens overnight; rather it is the final step in a sequence of stages. The most widely used characterisation of stages in connection with the adoption of innovation are the knowledge stage, persuasion stage, decision stage, implementation stage and confirmation stage. In addition, people adopting innovation are classified into the following categories: innovators, early adopters, early majority, late majority and laggards (ibid).

2.3.4 Current Trends in Adoption

Some strands of literature looked at the issue of methodology and different policies that have been used to tackle the issues of hunger, poverty and food insecurity in Africa. For example, Adesina, (2009), Scialabba, (2007), Flores, (2004), Nambiro, (2007) and FAO, (2005a) all examined the nature, factors and problem of food availability/security in Africa. Other strands of literature like UN, (2008), FAO, (2005), Akinyele, (2009) and Thirtle et al (2001) looked at the different policies and programs by various Government and NGOs in addressing the issue of food availability/security in Africa. Despite all these policies, programs and investments by various Government and NGOs operating in Africa, food availability/security and the nutritional situation are worsening (FEWSNET, 2007).

Having reviewed different literature on food availability in Africa and briefs from different NGOs like Gill (2002), Overseas Development Institutes (ODI) briefing on the application of appropriate agricultural technology and practices and their impact on food security), there exists a gap in the literature which has been discussed in this study under the heading ‘Research Gap’. Also, the review of literature emphasises the need for this study and efforts in the co-ordination of programs to tackle the issue of food availability and adoption of agricultural technology.

Another aspect of this study deals with the issue of adoption of agricultural technology and productivity increase in Africa. Within the emerging body of information, some strands of literature focus on the learning and social networks involved in agricultural technology adoption. This broader literature is not necessarily focused on agricultural development, but some papers have used episodes of agricultural adoption as examples of social learning.

Feder et al. (1985) reviewed the literature on technology adoption in developing countries, which forms the bases for most studies in the area. For example, Leathers and Smale (1991) used a Bayesian approach to examine the sequential decisions of adoption among farmers as a learning process; they suggest that farmers adopt a part of the package to learn more about the innovation as a whole.

Asfaw and Adamassie (2004) examined the role of education in the adoption of chemical fertilizer under different socioeconomic environments in Ethiopia and found that there is a substantial and statistically significant intra-household spill-over effect of education on the adoption decision of households. Conley and Udry (2000) modelled the adoption of pineapple production practiced in Ghana and found that social learning is important in the spread of the new technology.

Cameron (1999) looked at the impact of learning on the adoption of high yielding varieties in India, taking advantage of panel data. Munshi (2004) compares wheat and rice growing villages in India to demonstrate that adoption based on observing neighbours is less likely in areas with heterogeneous populations where a farmer may not be able to control the differences in neighbours' characteristics. Holloway et al. (2002) used the Bayesian spatial probit estimation and found strong positive neighbourhood effects with regard to the adoption of high yielding rice varieties in Bangladesh. Olwande et al (2009) examined a panel analysis of smallholder farmers' fertilizer use in Kenya and observed that the proportion of households using fertilizer dramatically rose in the last decade while fertilizer application rates increased marginally.

All these studies help us to move beyond the static analyses that look at the characteristic farmers, plots and technology, to an understanding of different aspects of the adoption process. Of all these studies, only Olwande et al (2009) and Cameron (1999) have access to panel data that allows them to address the dynamic component of data over time on the same farmers; others infer by looking at cross-sectional data.

Other sets of literature focus on the issue of methodology. They deal with the issue of endogeneity and simultaneity of decision making. Econometric techniques have become increasingly sophisticated in ways that could not have been imagined 20 years ago, compensating for the fact that researchers are generally using cross-sectional data to address issues that are inherently dynamic. Byerlee and de Polanco (1986) demonstrated that farmers adopt improved varieties, fertilizers and herbicides in a step wise manner, rather than as a package in the Mexican altiplano. Dimara and Skuras (2003) modelled the adoption decision as a partial observation process, which allows adoption to be modelled as a two stage process, even if only one stage is observed.

Khanna (2001) used a double selectivity model to look at two site-specific technologies, soil testing and variable rate technology. This model is designed to compensate for sample selection bias. Also Smale et al (2001) modelled adoption as three simultaneous choices; the choice of whether to adopt the component of the recommended package, the decision of how much of some input, such as fertilizer, to use, and the decision of how to allocate different technologies across the land area.

Mendola (2007) and Marra et al (2003) looked at the propensity-score matching analysis of agricultural technology in Bangladesh and the risks and uncertainties of adoption of new agricultural technologies. Barrett et al. (2004) also took advantage of the fact that many farmers in Madagascar have introduced an improved rice management technology on some but not all of their plots. Thus, they can control for productivity differences across plots while holding constant farming characteristics, including unobserved farming characteristics.

A third strand of literature looks primarily at agricultural technology policy, asking about a particular technology and why it is not being adopted in a given location. For example, the International Centre for Wheat and Maize Improvement (CIMMYT) collaborated with national research institutions in East Africa to conduct 22 micro-level studies of wheat and maize as well as adoption of chemical fertilizer (Doss, 2006). They provided useful descriptive information on who is using improved seeds and fertilizers in some areas of East Africa.

Several other studies have been conducted across different regions. For example, Mather et al. (2003) examined the adoption of disease resistant bean varieties in Honduras, and Hintze et al. (2003) examined the factors, including varietal characteristics, affecting the low levels of adoption of improved maize varieties in Honduras. Ransom et al. (2003) investigated the adoption of maize varieties in the hills of Nepal. Increasingly, attention has shifted from the adoption of new crop varieties to the adoption of new management practice, new crops and ecological friendly farming method/practice. Many other studies in this area like Omilola, (2009), Oni et al (2009) and Nambiro et al (2007) all looked at the impact of agricultural technology, trends and drivers of agricultural productivity and agricultural growth and poverty reduction in Africa and Nigeria.

Other bodies of literature are published as working papers or briefs because they do not make a substantial methodological contribution to the field. For example, Dayo et al. (2008) and Afua et al. (2009) examined constraints to increasing agricultural productivity in Nigeria and constraints to fertilizer use in Nigeria: perspective and insights from the agricultural extension service respectively. Although some of these studies make methodological contributions, others contribute primarily by providing information on localized situations of interest to policy makers.

All the above literatures are yet to fully exploit the idea of adoption of agricultural technology as a package in Africa and how each component of the package interacts with each other. The entire above mentioned gap in the literature has already been dealt with in this study under the heading ‘Research gap’. Given the difficulty of getting reliable panel agricultural data in Africa, this study relies on the agricultural history of respondents or farmers on adoption of new technologies, and it will examine these issues at the farm level.

2.4 Agricultural Policies in Nigeria

Agricultural policies and programs have evolved over the years in Nigeria from the colonial era to the present day. Nigeria’s government has over the years put in place policies and programs to address the issues of agricultural production and food availability. The history of government agricultural development initiatives in Nigeria dates back to 1935 when the Nigerian cooperatives ordinance was promulgated to regulate cooperative activities in the country. In

1947, a law was enacted establishing the department of cooperatives. Since that period, until today, there has been several government programmes ranging from Commodity Boards (1947 – 1986) to agricultural research, national accelerated food production program (1970s), Nigerian Agricultural Cooperative Bank (1973) and Agricultural Development Project (1975).

Other government schemes include, River Basin Development Authorities (1977), Operation Feed the Nation (1976 – 1979), Green Revolution (1979 – 1983), Directorate of Food and Road and Rural Infrastructure (1986 – 1993), National Agricultural Land Development Authority (1991 – 1999) and Presidential initiatives on cocoa, cassava, rice, livestock, fisheries and vegetables (1999 – 2007).

A full description of the past government programs/projects is summarized in Appendix 1, Table: 5. It is clear that most of these programs failed to achieve the main objectives of establishing them and some of them have been scraped, although many are still being implemented. The major issues that hindered the success of the programs are inadequate planning and funding, political/regime instability, ineffective management and corruption, among others. Agricultural research in Nigeria has failed to provide the much desired agricultural development and change; hence, the importance of this study.

2.4.1 Agricultural Development Project/Program (ADP) In Nigeria

As shown in Appendix 1 Table: 5, agricultural policies in Nigeria have come a long way from the pre-colonial era to present day, but one of the policies that has remained over the years and evolved with time is the agricultural development project, with emphasis on agricultural extension services. This section will discuss briefly the history, evolution, objectives and organisational structure of ADP at the state level.

At its inception it was known as Agricultural Development Project but the project aspect of it was later substituted to program when it went nation-wide in 1984. The program was conceived in 1972 and was World Bank Funded at inception; it was set up to provide extension services, technical input supports and rural infrastructure services. The program effectively commenced in 1975 in Northern Nigeria, in the enclave (experiment) areas of Funtua, Guzau and Gombe (Abah, 2001). The success of these experiments led to the establishment of state wide projects in Kaduna, Sokoto and Bauchi states as off-shoot; a multi-state ADPs was later designed by the Federal Government Agricultural Co-ordinating Unit (FACU) to cover some states in the Middle Belt and Southern Nigeria (Chukwuemeka, 2004).

What we have today as ADP is the joint efforts of the World Bank and International Fund for Agricultural Development (IFAD) which culminated in the granting of a #162 million (#Naira) loan in 1984 that helped and led to the expansion of the project to program to cover all the states in Nigeria (ADP Monitor, 1994). The approved ADP programme was funded by the World Bank, providing 66% of total project cost contributed in civil works, plants, vehicles, equipment, spare parts, training and consultancy.

The Federal Government provided 19% in input procurements, chemicals and pesticides. The State Government provided 15% in salaries and general services. ADP has now assumed a permanent status and is now recognized as a major agricultural development institution in the country. They do not engage in direct food production but rather provide extension and infrastructure services to enable the farmers do their farming. The main objective of the programme at inception includes the following:

- To improve the farm income of small holder farmers through integrated rural development programmes.
- To support the Federal Government objective in food production through the improved production of cassava, yam, maize and rice.
- To raise the living standards of the rural population.
- To revitalize and re-organize agricultural extension services through training and visiting system.
- To commercialize and improve the existing farm input distribution system.
- To provide all season access roads to rural farming communities by establishing and maintaining rural feeder roads.
- To establish On-farm Adaptive Research (OFAR) as a means of developing and disseminating information.
- To sponsor and encourage the processing, storage and marketing of primary farm inputs (Chukwuemeka and Nzewi, 2011).

These objectives were to be achieved through the following sub-programmes: Crop and farm development, Agricultural research and extension and Commercial services (Eze, Chukwuemeka and Abah, 1998).

The organisational structure of ADP in Nigeria is more or less the decentralized type where the federal government coordinates and the states carry out extension programmes, and manage and control activities and resources. Figure 2.2 presents a typical ADP state level organogram.

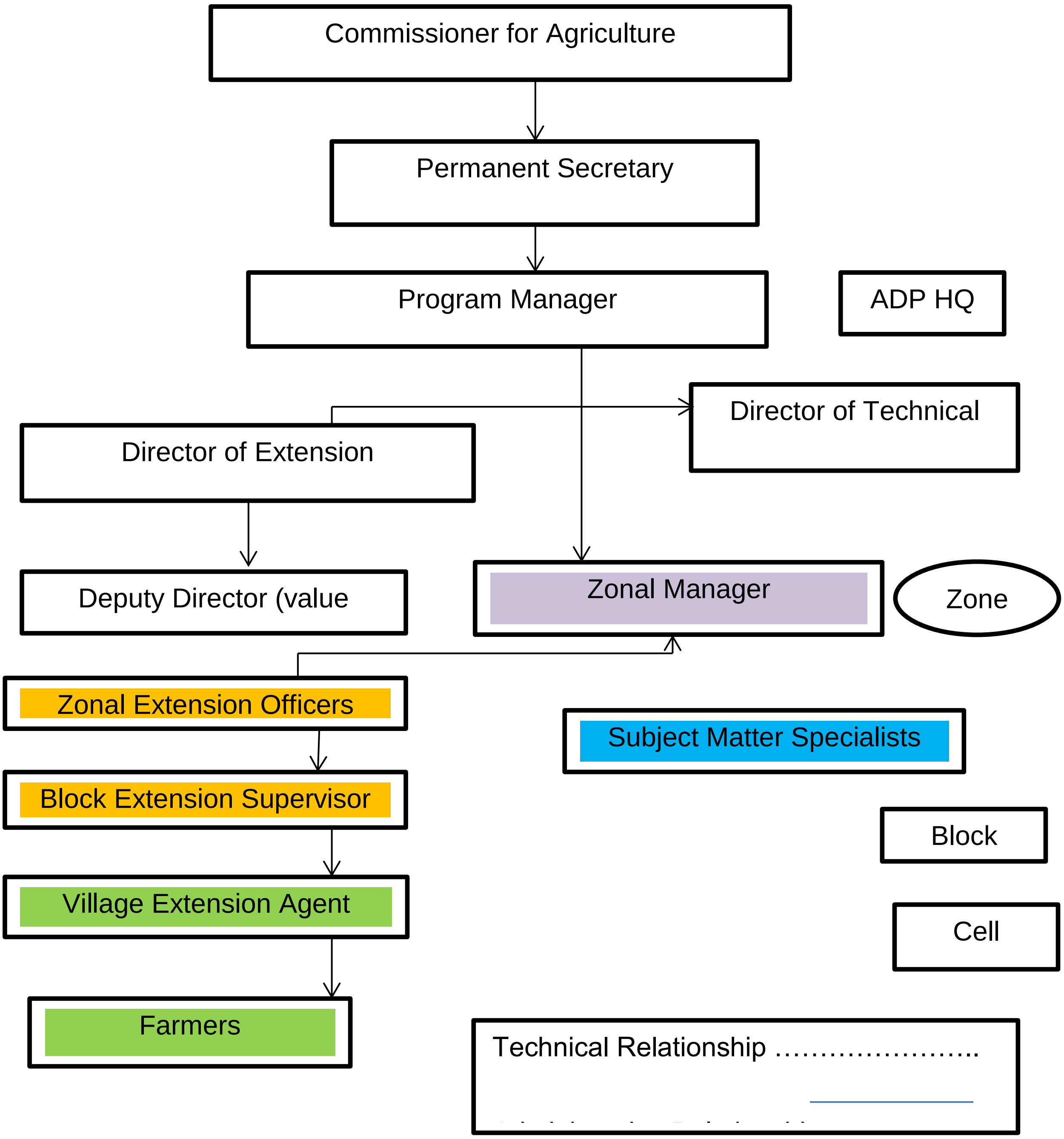
Village Extension Agent Level: - This is the primary level of ADP/ extension services and is composed of mainly extension agents and other extension service providers. They interact with farmers and farmers groups at field/farm level, exchanging information, experience and getting feedback to block extension supervisors from the farmers.

Block Extension Supervisor: - Local management committee with members from the wards, extension staffs and subject matter specialists.

Zonal level: - Zonal manager responsible for program implementation in the zone with his management team.

State level: - Program manager and his management team in coordination with the state commissioner for agriculture and relevant ministries and departments.

Figure 2.2: Organogram of State Agricultural Development Program (ADP)



Source: FMARD report, 2011

The importance of ADP to agricultural technology adoption in Nigeria needs not to be over-emphasised since they are the main agricultural extension service agency in the country. In the course of this study, questionnaires were distributed to ADP staffs in the study area and the result is presented in Chapter Nine. Some of the limitations of ADP have already been mentioned in Appendix 1, Table: 5 and some of their constraints were discussed in Chapter Nine.

2.5 The Concept of Food Security/Availability

The concept of food availability/security has evolved in the last thirty years to reflect changes in official policy thinking (Clay, 2002 and Heidhues, et al. 2004). The term first originated in the mid-1970s when the world food conference (1974) defined food security in terms of food supply – assuring the availability and price stability of basic foodstuffs at international and national level. In 1983, FAO analysis focused on food access, leading to a definition based on the balance between the demand and supply side of the food security equation (FAO;2006).

The definition was revised to include the individual and household level, in addition to the regional and national level of aggregation in food supply analysis. In 1986 the highly influential World Bank Report on poverty and hunger (World Bank, 1986) focused on temporal dynamics of food insecurity (Clay, 2002). The report introduced the distinction between chronic food insecurity associated with problems of continuing or structural poverty and low incomes, and transitory food insecurity. These involved periods of intensified pressure caused by natural disasters, economic collapse or conflict. This report was complemented by the Sen (1982) theory of famine which highlighted the effect of personal entitlements on food access i.e. production, labour, trade and transfer based resources.

The widely accepted World Food Summit (1996) definition reinforces the multi-dimensional nature of food security and includes food access, availability and food use stability. It has enabled policy responses focused on the promotion and recovery of livelihood options, initially made popular by academics such as Chambers and Conway (1992). Livelihood approaches are now fundamental to international organizations' development programmes. They are increasingly applied in emergency contexts and include the concepts of vulnerability, risk coping and risk management.

As the link between food security, starvation and crop failure becomes a thing of the past, the analysis of food insecurity as a social and political construct has emerged (Devereux 2000). More recently the ethical and human rights dimension of food security has come into focus. The right to food is not a new concept and was first recognized in the UN Declaration of Human Rights in 1948. In 1996 the formal adoption of the Right to Adequate Food marked a milestone achievement by World Food Summit delegates. It pointed the way towards the possibility of a rights based approach to food security. Currently, countries have the right to food enshrined in their constitution and FAO estimates that the right to food could be judicial in some 54 countries (McClain-Nhlapo, 2004). In 2004 a set of voluntary guidelines supporting the progressive realization of the right to adequate food in the context of national food security were elaborated by an Intergovernmental Working Group under the auspices of the FAO Council.

Food security therefore implies the provision of safe, nutritious and quantitatively and qualitatively adequate food, as well as access to it by all people. Food security has three dimensions (UN, 2008), availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports. It is also access by households and individuals to appropriate foods for nutritious diet and optimal uptake of nourishment, thanks to a sustaining diet, clean water and adequate sanitation together with healthcare.

Access to food: - It is important to emphasise that more food production does not necessarily mean more food for those who need it. Most experts would agree that the largest part of the production increase has to come from yield increases. Current levels of agricultural productivity and production say little about potential levels because they are simply a response to present levels of demand and price/market conditions (Boon, 2007).

It is however important to note that food production is not the same as food availability (production minus exports plus imports) and that aggregate availability and the ability to acquire food (food entitlements) are very different things. McGranahm et al (1999:104), states that while food production undoubtedly influences food entitlements the connections are complex and there are also other matters involved.

People's access to food depends both on the purchasing power of their income and on their non-market entitlements such as rights to land for subsistence farming and foraging purposes. Households seeking to preserve food security/food availability levels may resort to a number of strategies to gain access to food. These include: managing normal income generating patterns; adaption by means of innovative use of available resources or some divestment of liquid assets; divestment of productive assets such as stock or land; and out-migration and destitution.

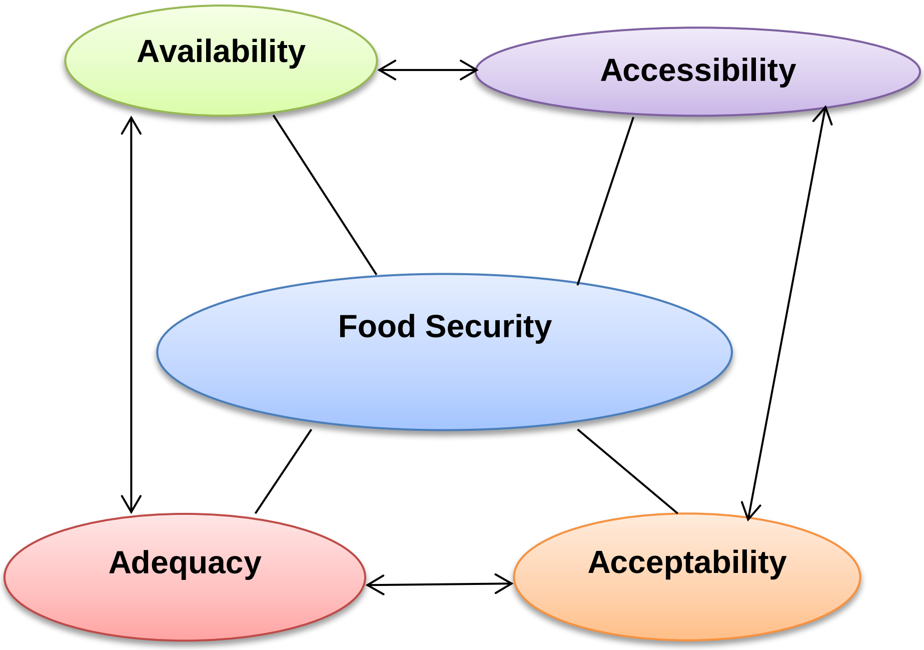
The market economy is not expected to grow rapidly and many non-market entitlements are in danger of decline. Food entitlements for urban dwellers are most often mediated through the market, whereas for rural dwellers in general and subsistence farmers in particular these entitlements tend to depend more on the local production. Clearly food insecurity is basically a problem of poverty affecting those social groups with the weakest or most fragile food entitlements both in terms of access to social networks and safety nets or productive assets (capital, land, agricultural inputs).

2.5.1 Determinants of Food Security

These determinants (factors) are directly and indirectly interrelated (Figure 2.3). Available food must be accessible to all members of the populace. What is available must also be adequate and the populace must be willing to eat that which is available, which must also be accepted as a preferred food.

Figure 2.3 shows the interactions between factors that affect food security. Practically a food glut in the rural communities may not necessarily be reflected on the market due to problems relating to accessibility – road and transportation networks. More market distributors are not willing to move into the hinterland to cart food to the urban centres. Similarly a glut of cassava and plantain may not necessarily be that important for example to the Ghanaian non Akon ethnic groups who do not necessarily accept or prefer to eat ‘‘Fufu’’ or ‘‘Ampesi’’.

Figure 2.3: Factors affecting food security



Source: FAO, 2009

2.5.2 The State of Food Security/Food Availability in the World

FAO (2009c) estimates that 915 million people worldwide were malnourished in 2000 – 2002: 815 million in developing countries, 28 million in the countries in transition and 9 million in the industrialized countries (Appendix 1, Table: 3), South Asia and Sub-Saharan Africa have a disproportionate share of the world's hungry. The number of malnourished people in developing countries decreased by only 9 million during the decade; the number of chronically hungry in developing countries increased at a rate of almost 4 million per year, wiping out two thirds of the reduction of 27 million achieved during the previous five years.

Agricultural output in Africa has been lagging behind population growth since the 1960s. Between 1965 and 1990, agricultural production grew at an annual rate of 1.7 percent while there was an annual population growth average of 2.8 percent. Food imports including food aid in the African region have increased substantially to offset the deficiencies and in early 1994 represented about 10 percent of food consumed. At current growth rates, the food gap is projected to increase to more than nine times the present gap by 2020.

As we near the year 2015, set by the world food summit in 1996 and reinforced by the millennium development summit (MDG) in 2000 of reducing or halving world hunger, we are almost certain to miss this target of cutting the number of malnourished people in the world by a half by 2015, if the current trend persists (FAO, 2005). However, while it is still possible to meet this goal in most regions, it is now believed that this target may never be met in Africa, especially in sub-Saharan Africa (ibid).

However, changes due to economic failures and human induced as well as natural disasters create food shortages that affect temporally all or part of a country's population. Although there is no direct estimates of the extent of transitory hunger it is assumed that it may affect around 5% to 10% of the developing world population annually. Chronic food insecurity implies a persistent inability on the part of the household to provide itself adequately with food; this can persist for years if not a lifetime. Chronic food insecurity generally arises through inadequate access to resources and is therefore structural in character. Chronic and transitory food insecurity may both have different causes and require different responses or programme solutions.

Often governments are faced with the task of preventing a transitory problem from becoming permanent, as households are unable to replenish their resources. In addition, even in the absence of chronic and transitory hunger the population may suffer from a lack of essential micronutrients. This is often referred to as hidden hunger. As many as a third of the world's people do not meet their physical and intellectual potential because of vitamin and mineral deficiencies, according to a report released by UNICEF and The Micronutrient Initiative. Although this issue is not within the scope of this study, its importance should not be underestimated.

As of March 2005, the number of countries facing serious food shortage throughout the world stood at 36, with 23 in Africa, 7 in Asia/Near East, 5 in Latin America and 1 in Europe. The causes are varied but civil strife and adverse weather predominate, the outbreak of desert locusts in western Africa, the recent tsunami disaster in South East Asia and the recent food and financial crisis. Modern agricultural methods have resulted in spectacular increases in productivity: more cereals and animals per hectare, more meat and milk per animal, more food output per person employed. However the majority of the chronically hungry are small farmers in developing countries who produce much of what they eat, are often too poor to purchase inputs and are marginalized from product markets.

In the last 10 years, progress in the drive to reduce hunger has been slow and has varied around the world; in Sub-Saharan Africa the number of hungry people has in fact increased by 20 percent since 1990. In the period 2000 – 2002, the proportion of malnourished people in the total population of Kenya was 33 percent, in Uganda 19 percent and the republic of Tanzania 44 percent. The number of underweight children has also increased in Central Western and Eastern Africa compared to an overall decline in other developing regions such as Asia, South America and North Africa (ibid).

As a result of its agro-ecology, trade history and position, most African countries have diverse diets in terms of staple foods. This is a great advantage in terms of food availability because many consumers will substitute among the five broad categories of staple food – cassava, yams and tubers, millet, maize and rice – according to national and also tribal taste preferences and changing relative prices. Women have distinctive roles to play in determining the acceptability of food, basically because of their traditional role as wives and mothers who cook for their families. Transforming food from its raw state into processed or cooked food has long been the preserve of women (FAO, 2005).

FAO, 2006b states that the food security of any region is not simply a question of producing enough food to meet demand; it is also influenced by a multitude of factors both natural and caused by humans. Increased food supply does not automatically mean increased food security for all. What is important is who produces the food, who has access to the technology and knowledge to produce it and who has the purchasing power to acquire it. Furthermore many of the causes of food insecurity are also symptoms, thus creating a cyclical effect that can result in further food insecurity.

For Africa to be able to feed its growing population there is a need to review the way agriculture is being done in Africa. Given other great intervention in agriculture like the Green Revolution, there is the need to exploit other means of increasing productivity and hence the need for this study. The idea of the adoption of agricultural technology as a package has not been fully exploited in Africa and this idea is what propagated the success of the Green Revolution in the 1960s in Asia.

2.5.3 Subsistence Farm Production and Food Security: An Overview

Generally, households access food mainly through three sources; these are through subsistence production, purchases from the market and transfer from public programmes or other households (Ruel et al. 1998). According to Sen (1982), these sources are often referred to as entitlements categories, which are production, exchange (Barter or Purchase) and transfers. Rural households mainly produce most of their food, whereas urban households purchase most of their food (ibid). Recent studies such as Ruel, (1998), Frayne and Pendleton, (2009), Bryceson, (2000; 2002); Apata et al. (2011b) and Adeniyi (2012) shows that food expenditure accounts for 60-80% of income expenditures of low-income households. Therefore, increasing subsistence production has the potential to improve food security/availability of farming households in both rural and urban areas by increasing food supply and by reducing high food price inflation.

In most of sub-Saharan African countries, food insecurity affects the urban poor more severely as they are mostly dependent on market purchases, unlike their rural counterparts who have access to farm land (Frayne and Pendleton, 2009). Ability to earn cash and high food prices are the two crucial components affecting urban household food security. The efficiency of distribution and marketing system, access to public transfers (food subsidies or food aid) or private transfers (exchange with rural relatives) are some of the most important factors affecting the cost of food, especially for urban households.

Rural economy in most sub-Saharan African countries has changed over the years, with more farmers diversifying and seeking off-farm income to supplement their dwindling farm income (Igwe, 2013; Chapman and Tripp, 2004). This implies that rural agriculture is becoming more subsistence in nature and highlights the importance of this group of farmers to the overall food security of developing countries. Understanding the food availability of subsistence farmers from their farm production will help in the better understanding of the overall food security of most sub-Saharan African countries.

Agricultural production in Nigeria like most sub-Saharan African countries is dominated by small scale farmers (subsistence farmers) that account for 90% of the food production in the country, on land ranging from 0.1-2.0 ha with crude farm implements, and depends on rainfall rather than irrigation (Fabusoro et al. 2010). This highlights the importance of this group of farmers to the food security/availability of the country. The debate on the relationship between subsistence agriculture, poverty and rural development in Nigeria has gone through a complete circle, with studies like Spencer, (2002); Poulton et al. (2005) and Lipton, (2005). However, subsistence farmers play a very important role for food security of sub-Saharan African countries and this study intends to evaluate their contribution to food availability/security of developing countries.

According to Bryceson, (2002); recent studies indicate that subsistence food production is increasing in importance in most developing countries; mainly as a fall-back against a backdrop of inflation and high food prices. In the context of rising food prices, and given the constraints and opportunities available to subsistence farmers, rural farm families in sub-Saharan African countries continue to value pursuing farming activities for home consumption (Smale et al. 2009). In addition, there is a need to increase access to assets, as household assets are major determinants of subsistence farmers' ability to participate in agricultural production and markets and to secure livelihoods through subsistence agriculture (Rockefeller Foundation, 2006 and World Bank, 2007).

2.6 Agricultural Technology – Poverty Linkage

For several decades, the linkages between agricultural technology and poverty have often been indirect and arising from the impact of technical changes in agriculture or agricultural productivity growth (Freebairn 1995; Fan and Hazell 2000; Datt and Ravallion 1998). For instance, literature on the poverty linkage effects of agricultural growth during the 1970s tends to show that technical change in agriculture leads to more production, which in turn leads to increased income for households with land. The latter are believed to use most of the income they make from agricultural production in the purchasing of labour intensive goods and services, thereby leading to second- and third- round effects of providing food security and more employment opportunity for the poor (Mellor 1976,).

Many of the studies on the effects of agricultural technology on poverty tend to show that there are strong complementary bonds between physical infrastructure and human capital for instance, Canning and Bennathan (2000); Datt and Ravallion (1998, 2001). But it was not until recently that the explicit mention of the relationship between agricultural technologies and other complementary ideas began to feature in most literature. For instance, Shah et al. (2002) illustrates how small investment in agricultural technology can benefit landless households directly through production of vegetables and fruits and indirectly through employment generation. Most other studies indicate that agricultural technology may reduce poverty through direct effects on output levels, employment, food availability, food prices, incomes and overall socioeconomic welfare. The type of technology adopted tends to be responsible for the type of poverty – reducing impacts that can be expected from agricultural technology (Litchfield et al. 2002; Lipton et al. 2003; Hussain et al.2002; Hussain and Hanjra 2003, 2004).

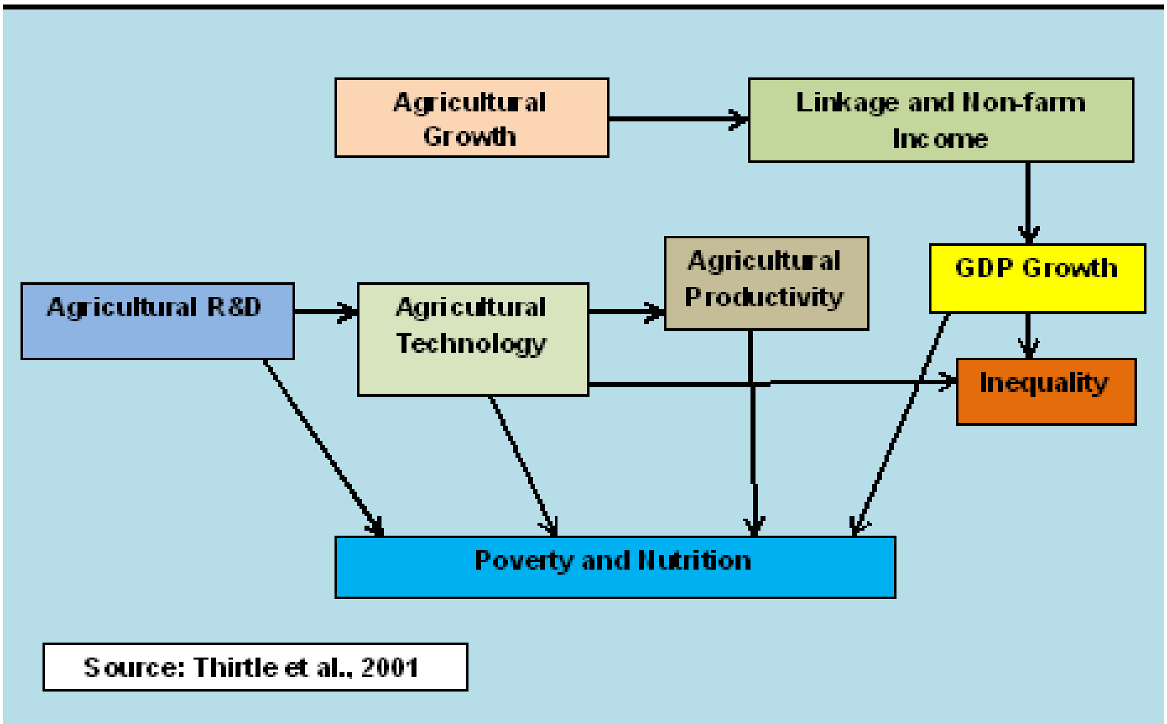
De Janvry et al. (2001), state the assumption that agricultural technology automatically reduces poverty. Antipoverty impacts have often been developed mostly for their adopters and focused exclusively on them. This approach obscures the significance of agricultural technology as a poverty–alleviation weapon without comparing adopters to non-adopters. Put differently, can the conceptualization of agricultural technology-poverty linkage be structured in such a way as to allow comparability between adopters and non-adopters? This fundamental question and others like it have been answered in the literature, but the idea of adoption of agricultural technology as a package have not been fully exploited in developing countries. Here farmers tend to adopt one aspect of the technology available due to one problem or the other, and this is the main question this study would like to answer.

2.6.1 Linkages between Research & Development, Technology, Growth, Productivity and Poverty

According to Thirtle et al. (2001), research-led technological change has propelled famine-plagued, food insecure Asian countries into food self-sufficiency. A large supply of food keeps food prices down, which is critically important to the poorest people who spend up to three quarters of their income on food, but population growth has masked many of the gains, keeping food prices up and rural wages down. Technology adoption has been uneven, due to costs and unsuitability for resource-poor regions. So alongside economic growth, poverty alleviation requires special programs targeted at the poor. Technology alone is not enough without infrastructure and education and will be ineffective in situations where inequalities in land ownership are too great, which raises the land reform issue, in addition to the need for investment and institutional change.

Improved technology produces agricultural productivity growth/increase that drives a rural growth process that can be inherently pro-poor. It can benefit poor farmers directly by increasing their production; benefit small farmers and landless labourers through greater employment; lead to access to crops that are high in nutrients; and empower the poor by increasing their access to decision making processes, increasing their capacity for collective action and reducing their vulnerability to sudden changes via asset accumulation (FAO, 2009).

Figure 2.4 Research and development, growth, productivity increase and poverty linkage



As shown in Figure 2.4, agricultural research generates new technologies that increase agricultural productivity. Agricultural productivity growth/increase has an impact on GDP growth, both directly and through agriculture's linkages with the broader economy that generate increases in non-farm incomes. Both agricultural growth and GDP growth have impacts on inequality, poverty and nutrition. There is a considerable literature on the link from agricultural research directly to poverty, from R&D to productivity, on the effect of new technologies on the incomes of the poor and on the relationship between productivity and growth.

There are no estimates of the direct effect of agricultural productivity growth and either poverty or nutrition. Thus a major finding is that the empirical estimates of this relationship appear to be robust. Regardless of differences in data and formulation the results show that a 1% increase in yields leads to a reduction in the percentage of people living on less than US$1 per day of between 0.6% and 1.2%. This is a very tangible result since the R&D cost of generating a 1% yield gain can be calculated. Our guess is that since agricultural R&D expenditures are relatively small, this may be a cost effective means of poverty reduction (Thirtle et al 2001).

2.7 Synthesis

According to FAO 2009, in order for Africa like other developing countries to meet the MDG of reducing hunger by half by 2015 and to pull the continent from its present state of dependency on food importation and food aid, there is need for more efforts and studies on ways of increasing agricultural production in the continent and hence the importance of this study.

There is no magic solution to the problem facing agricultural development and productivity in Africa; rather there is the need for an improvement in sequence of events (political will, irrigation facilities, improved varieties, research and development, improved infrastructure, trade policies, modern equipment etc.)

that will lead to an increase in agricultural productivity and food security in Africa (Meijerink and Roza, 2007). Also there is need for African countries to fulfil and extend their 2003 Maputo declaration of allocating at least 10 percent of national budgetary resources to agriculture and rural development policies beyond the initial five years (AU, 2010).

Having reviewed the literature within the scope of this study, the following gaps in knowledge were identified.

- More knowledge on what needs to be done to improve the present disadvantage developing countries has on international trade agreements.
- More understanding on how past history and development in agriculture is affecting the present agricultural development in LDCs.
- Given the nature of Africa, a good understanding of all the barriers affecting agricultural development in Africa.
- Given the advantages and limitations of GR, how best to articulate and exploit the advantages of GR and implement it in Africa.
- More understanding on the best ways of making agricultural technology promotion more Africa oriented and in line with the needs of African farmers.
- More understanding on what makes a farmer adopt a new technology and factors affecting the dissemination of R&D information in Africa.
- More understanding of the linkage between agricultural adoptions, productivity increase and food security in Africa.

The points above express some of the gaps noticed in the literature; some of these gaps will be addressed by this study while others may be addressed by subsequent studies.

The main gap addressed by this study are the key ideas behind the success of GR in Asia, which are the adoption of agricultural technology as a package and the issue of food availability at the farm level and inverse farm size relationship. From the literature review this idea has not being fully exploited in Africa but it is the key idea behind the success of GR in Asia. This study brings together literatures on important aspect of agriculture like agricultural technology adoption, productivity increase and food availability in Africa. Finally, this thesis will contribute to understanding the fundamental issues of food availability in Nigeria and the dynamics of adoption of agricultural technology.

Chapter Three

Research Design, Methodology and Conceptual Framework of Econometric Models

3.0 Introduction

The broad aim of this study is to identify the range of socio-economic factors influencing adoption of modern agricultural technology in multiple food crops and its corresponding impact on productivity and food availability from farm production in South-eastern Nigeria. This research is geared towards exploiting the idea of adoption of agricultural technology as a package and the result used for policy planning and formulation, strategic and effective agricultural and rural development planning within the states that make up south-eastern Nigeria. Given the aim, objectives and specific hypotheses, analysis will be set out testing the theories by application of quantitative and qualitative techniques important to the objectives of the study. The following sections provide more details of the methodology of this study.

3.1 Quantitative/Qualitative Research

Having done the literature review, I came across methods that have been used in similar kinds of research like Mandola (2007) and Marra et al (2003) who looked at the propensity-score matching analysis of agricultural technology in Bangladesh and the risk and uncertainty of adoption of new agricultural technologies. Smale et al. (2001) modelled adoption as three simultaneous choices: the choice of whether to adopt the component of the recommended package, the decision of how much of some inputs like fertilizer to use and the decision of how to allocate different technologies across the land area. Some of these researches used the quantitative research approach or the qualitative research approach or a combination of both approaches.

The quantitative or structured research approach employs quantitative theoretical and methodological principles, techniques and statistics. Scientific observations are recorded in a numerical or some standardized coding format. On the other hand the qualitative or unstructured research approach employs none-quantitative standards and techniques; it is based on theoretical and methodological principles of symbolic interaction, hermeneutics and ethno-methodology (Grinnell and Stothers, 1988; Atkinson, 1998; David and Sutton, 2004). The difference between the two is better illustrated in Appendix 1, Table: 6. Given the advantages and disadvantages of both approaches, a combination of both approaches allows us to accommodate whatever shortcomings either of the approaches may have. For the purpose of this research and given the nature of issues being addressed by this study, this allows us the advantage of combining both approaches.

3.2 Research Protocols

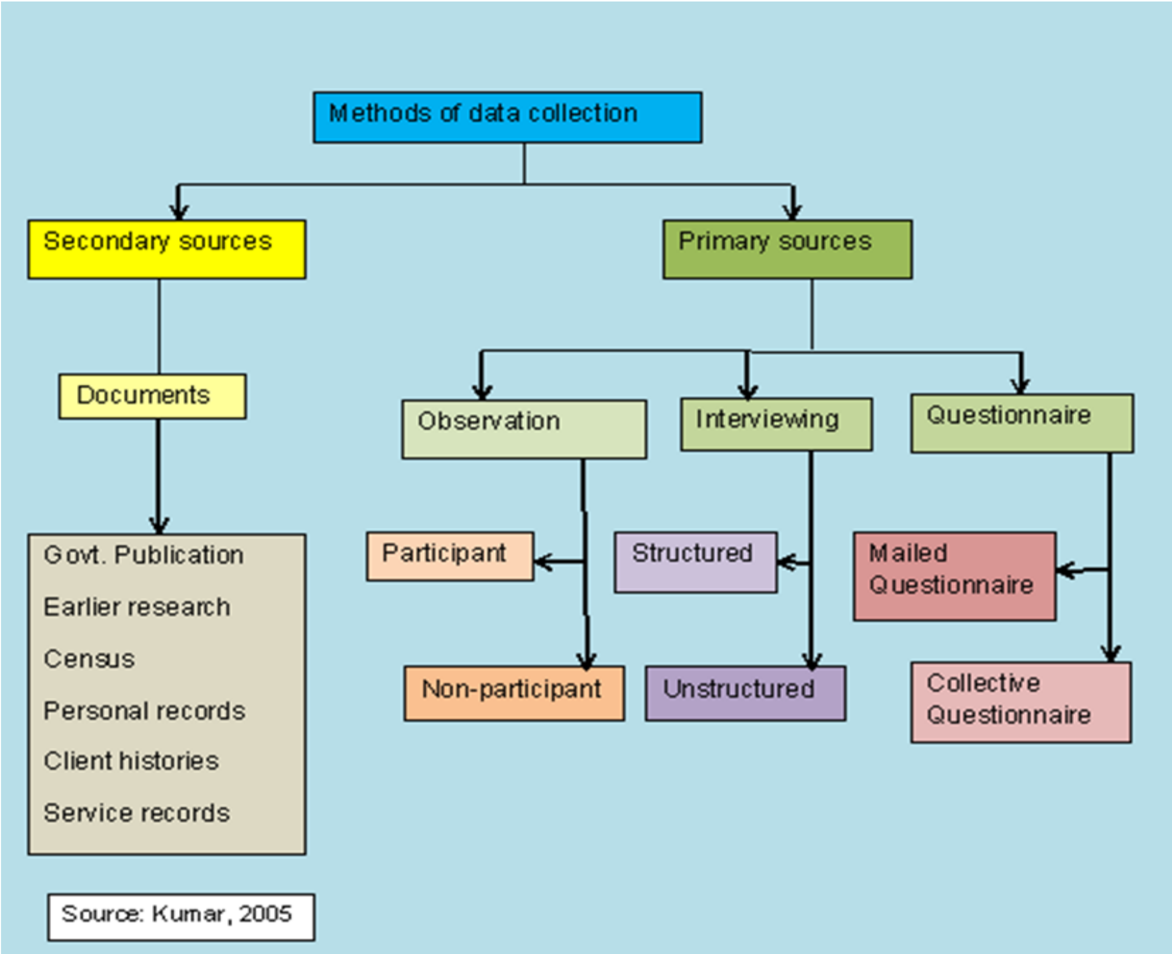
Conducting research that involves human participation requires ethical approval, therefore the University of Plymouth's ethical approval procedure for research was followed and ethical approval given for the research. Similarly, permission and co-operation of the agricultural departments of the states that make up south-eastern Nigeria was sought and the co-operation of Agricultural Development Programs (ADP) in all the south-eastern states was also sought and obtained. Also meetings and interviews were arranged with program managers ADP in the states, and the heads of key NGOs that have interests in agriculture in Nigeria.

3.3 Methods of Data Collection

There are two major methods of data collection for a problem or phenomenon, situation or issues, and at times the information required is already available and need only be extracted but there are times when the information needed is not available and needs to be collected from scratch. Information gathered using the first approach is said to be collected from secondary sources, whereas the sources used in the second approach are called primary sources (Kumar, 2005). Figure 3.1 below illustrates more on the different approaches. The choice of which method to use depends on the purpose of the study and each method has its own advantages and disadvantages; for example, it will be more expensive to conduct a primary data collection than a secondary data collection due to the cost and logistics associated with primary data collection. On the other hand, the time frame for the research will be shorter and enhanced if secondary data is to be used since it is already available and need not be collected from scratch, and the bias/difficulties associated with primary data collection are taken care of by the source of the secondary data (Babbie, 2007).

For the purpose of this research, a combination of both sources of data collection was used. Data from government publications, earlier research and records from NGOs was used in discussion; also primary data was generated through the use of questionnaires and interviewing of ADPs Program Managers and NGOs involved in agriculture in Nigeria.

Figure 3.1: Method of data collection



3.3.1 Primary Data Source

The main source of primary data for this research is a structured questionnaire; this was designed and administered in ten communities/villages in Local Government Areas (LGA) randomly chosen from the three senatorial districts of the two selected states in the zone (Ebonyi and Anambra states). Ebonyi state was chosen because it is a more rural and a new (younger) state relative to Anambra state that is more urban and older. They are chosen to represent the two extremes in terms of states in South-eastern Nigeria. Also a questionnaire was distributed to ADP staff in the two states. Another source of primary data was interviews with Program Managers (PM) ADP in the two states; country representative International Fertilizer Development Centre (IFDC) in Nigeria and a representative from the United Nation Development Program (UNDP) in Nigeria.

3.3.2 Secondary Data Source

Hakim, (1982) provided a traditional definition of secondary data as a further analysis of an existing data set which presents interpretations, conclusions of knowledge additional to, or different from, those presented in the first report on the inquiry as a whole and its main results. The main sources of secondary data for this study were from historic agricultural data and government reports on agriculture in Nigeria; documents from ADP in the zone, documents from NGOs interested in agriculture in Nigeria and PhD theses from Universities that have to do with adoption of agricultural technology.

3.3.3 Questionnaire/Interview Design

A structured questionnaire was designed and administered to gather relevant information. The questionnaire was designed to be consistent with World Bank sponsored integrated surveys on agriculture, that is, Living Standard Measurement Study survey (LSMS survey) implemented by Nigeria National Bureau of Statistics (NBS), but also to cover other areas relevant to this study that were not covered by the LSMS survey. The questionnaire and interview schedule was pilot tested and any observed corrections were made before it was administered.

A detailed well-structured questionnaire in line with the aim and objectives of the research was designed for farmers. This covered all areas that are of interest to this research and was such that it was easy for the farmers to understand and complete. This was administered to farmers from ten of the randomly selected communities/villages in the three LGAs randomly selected from the chosen states with the help of research assistance (Copy of the questionnaire is in Appendix 3, Section A). Questionnaires were also designed for ADP staffs about their work and in line with the objectives of the study (Appendix 3, Section B).

A structured interview was conducted with Program Manager ADP in the states and some NGOs in Nigeria. Some of the interview questions were unstructured open ended questions, allowing the interviewee room to express his opinion on the subject. Appendix 1, Table: 7 show some of the advantages and disadvantages of the questionnaire and interviewing methods of data collection. The nature of the study, type of study and population may determine which method to use; a combination of both methods was used in this study.

3.3.4 Questionnaire

The structured questionnaire that was administered to farmers in the zone was divided into five broad sections for easy extraction of information and to ensure that the research question, objective and hypothesis were all covered in the questionnaire. The first section covered the personal details of the respondent and their household information; the second section dealt with their farming system, production practice and irrigation facility information. The next section dealt with issues relating to their agricultural technology adoption and their constraints and the fourth section evaluated their food availability information and financial/social factors affecting their farming. The last section dealt with their marketing information and constraints. The questionnaire for ADP staffs was designed in line with the objectives of this study and covers issues like the socio characteristics of the staffs, their work history and perceptions about agriculture and agricultural technology adoption in the study area.

3.3.5 Interviewing

Open ended questions were used in the interviewing process and covered three main sections: first was identifying the problems of agriculture in the zone; second was a section on the policies they were taking to address these problems, and the third was on the future of agriculture in the zone. Also some of the questions were unstructured, allowing the interviewee more opportunity to express his opinion.

3.4 Sample Design/Sample Size

Kumar, (2005) defined sampling as a process of selecting a few (a sample) from a bigger group (the sampling population) to become the basis for estimating or predicting the prevalence of an unknown piece of information, situation or outcome regarding the bigger group. This occurs due to difficulties and the cost of obtaining information from the entire population; it has both advantages and disadvantages. Since what you have is an estimate or prediction of the entire population, there is the possibility of an error occurring in your estimate. Therefore, the main consideration in choosing a sample is the tolerance of the possibility of an error and doing everything possible to reduce this (Babbie, 2007).

For the purpose of this research, the study population were farmers in the ten randomly selected communities/villages in the LGA of the chosen states. The sampling unit was randomly selected from the study population using a multi-stage random sampling method. Three LGAs each were selected from Ebonyi and Anambra states and farmers randomly chosen in the following 3 stages.

Stage 1:- Three LGAs each were randomly selected from the two states

Stage 2:- Ten communities/villages where then randomly selected from the chosen LGA

Stage 3:- Farmers were then randomly selected from the data base of farmers held by the state ministry of agriculture of the chosen communities/villages and questionnaires were administered to them.

The sample size (n) of farming households in the study area was determined by applying the following formula (Rahman, 1998).

$n= Nz^2P\ (1-P)/Nd^2+z^2P\ (1-P)$

Where n = Sample Size

N= Total number of farm households

Z= Confidence level (at 95% level, z=1.96)

P= Estimated population proportion (0.5, this maximizes the sample size)

d = error limit of 5% (0.05)

3.5 Field Survey Outcome

Primary data was collected for this study which is consistent with integrated surveys on agriculture, that is, Living Standard Measurement Study survey (LSMS survey) sponsored by World Bank but implemented by the Nigeria National Bureau of Statistics (NBS) in conjunction with Nigerian Federal Ministry of Agriculture and Rural Development. The primary data was collected because of additional information relevant to the objectives of this study that was not covered by the LSMS survey. Data was collected in areas like food availability pattern of respondents, constraints affecting agricultural technology adoption, farm production and food availability in the study area that were not fully covered by the LSMS survey.

The field survey was carried out between the months of October and November 2011. Some of the interviews were carried out within the same period and October 2012. Details of outcomes of the field survey are in Table 3.1 below, it shows that in Ebonyi state 300 questionnaires were distributed to farmers, 290 were returned, of which only 259 were useable. Similarly in Anambra state, 300 questionnaires were distributed; 190 were returned, of which 141 were useable. The reason for the difference was because in Ebonyi state, most of the respondents asked to be guided through filling their questionnaires by the field research assistance, while in Anambra state most of the respondents asked that the questionnaires be dropped off for them.

Also 60 questionnaires were given to ADP staffs in Ebonyi and Anambra states-30 each. The same number were returned but only 28 from Ebonyi state were useable; while all from Anambra state were useable. Interviews were also carried out with Programme Manager ADP in Anambra and Ebonyi states, the country representative International Fertilizer Development Centre (IFDC) in Nigeria and a representative from United Nations Development Programme (UNDP) in Nigeria.

Table: 3.1 Field Survey Outcomes

Questionnaire	Interviewing	Secondary data source
Ebonyi State (300) (290) (259) **ADP** (30) (30) (28) **Anambra State** (300) (190) (141) **ADP** (30) (30) (30)	• **Programme Manager ADP in Ebonyi and Anambra state** • **Country Representative IFDC in Nigeria** • **Representative from UNDP in Nigeria**	• **Government publication and documents** • **Earlier researches** • **Publications/Records of NGOs**

Source: Field Survey, 2011

3.5.1 Plan of Analysis

Quantitative data generated from the questionnaire was inputted into a database and statistically analysed using SPSS (Sheppard, 2004). Descriptive statistics such as mean, modes, medians, tables and ranges (etc.) generated were used to determine relationships between factors and to identify current agricultural technology utilized in south-eastern Nigeria. Farm enterprise profitability and benefit cost ratio were determined for rice, yam and cassava farming enterprises.

Econometric tools like regression were used to evaluate the determinants food production and food availability in the study area. Bivariate probit models were designed and used to analyse the determinants of modern agricultural technology adoption on food crops in the study area. Food availability at farm level was determined by converting farm output available for consumption into calories and weighing this against FAO standard daily calories requirements and the food availability model designed for this study (Detail in Section 3.7.4).

3.6 Conceptual Framework for Methodological Analysis

This section defined the key variables that were used in analysis, the theoretical model of the conceptual framework underpinning household food availability decision making behaviours and other analytical tools that were used in this study.

3.6.1 Theoretical Model of Conceptual Framework Underpinning Household Decision Making Behaviours

The extent of farm household food availability and modern agricultural technology adoption decision making in this study is modelled within the framework of consumer demand and production theories following the modelling of production and consumption behaviours of a rural household by Singh et al. (1986) and Feleke et al. (2004). In line with Singh et al. (1986), the household utility function is specified as:

$$U = U(F_p, F_{m,} l; H_c) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (1)$$

Where U is a utility function that is assumed to be well behaved (twice differentiable, increasing in its arguments and strictly quasi-concave); F_p is a vector of farm-produce goods and consumed by the household; F_m is a vector of market-purchased goods consumed by the household and l is leisure. Therefore, the utility that the household derives from the various combinations and levels depends on the preferences of its members, which are shaped by the characteristics of the household H_c .

Following up on Singh et al. (1986) and Feleke et al. (2004), the household as both producers (firm) and consumer is assumed to maximize its utility from the consumption of these goods subjects to farm production, income and time constraints specified as:

$K(Q_i, L, R^0, G^0) = 0$ ………………………………………………….. (2)

$P_i(Q_i - F_p) - P_m F_m - w(L - L_f) + N = 0$ …………………………… (3)

$T = L_f + l$ ……………………………………………………………. (4)

Where K is an implicit production function that is assumed to be well behaved (twice differentiable, increasing in outputs, decreasing in inputs and strictly convex); Q_i is a vector of quantities of goods produced on farm; L is total labour inputs to the farm; R^0 is the household's fixed quantity of land; G^0 is the fixed stock of capital; P_i is the price of good i ; P_m is the price of a market-purchased goods; $(Q_i - F_p)$ is the marketed surplus of good i ; w is the wage rate; L_f is the household labour supply for on-farm use; N is nonfarm income that adjusts to ensure that Eq. (3) equals zero; and T is total time available to the household to allocate between work and leisure.

The income and time constraints can be combined by incorporating Eq. (4) into Eq. (3) as:

$$P_i\left(Q_i - F_p\right) - P_m F_m - w(L - T + l) + N = 0 \quad \text{.................................... (5)}$$

Rearranging equation (5) gives:

$$P_i F_p + P_m F_m + wl = P_i Q_i + wT - wL + N \quad \text{....................................... (6)}$$

The left-hand side of Eq. (6) is the household expenditure on food and leisure and the right-hand side is the full income equation. The expenditure side includes purchases of own farm-produce goods $(P_i F_p)$, the household's purchases of the market goods$(P_m F_m)$, and the household's purchases of its own leisure time(wl). The income side consists of the value of total agricultural production$(P_i Q_i)$, the value of the household's entitlement of time(wT), the value of labour on the farm, including hired labour(wL), and nonfarm income N.

According to the first-order conditions of the maximization of the constrained utility function, the relationship between production and consumption can be established in such a way that production decisions are made first before being used in allocating the full income between consumption of goods and leisure (Strauss, 1983). This assumption is based on all the relevant markets function and it is important to have this assumption because we are considering that consumption (food availability) depends on the production variables but not vice versa. Therefore, if the markets for inputs, labour and products do not function, farm production decisions cannot be made separately from the consumption decisions. If a commodity has an incomplete market, or if a household is at a corner (that is, if it consumes all of its output), there will exist a virtual (shadow) price which will be endogenous to the household (Singh et al. 1986 and Feleke et al. 2004).

Given the assumption of separability between the production and consumption decisions, we can mathematically derive the production side and consumption-side equations separately. For the production-side, the first-order conditions can be solved for input demand (L^*) and output supply (Q^*) in terms of all prices, fixed land, the wage rate and capital as:

$L^* = L^*(P_i, w, R^0, G^0)$ ………………………………………………………. (7)

This is the sum total of both the adopter of modern agricultural technologies (TA) and non-adopters of modern agricultural technology (Traditional Method "TM). It is expressed respectively as:

$L^*_{TA} = L^*_{TA}(P_{iTA}, w_{TA}, R^0_{TA}, G^0_{TA})$ …………………………………………(7a)

$L^*_{TM} = L^*_{TM}(P_{iTM}, w_{TM}, R^0_{TM}, G^0_{TM})$ ………………………………………(7b)

The output supply side (equation 8) is also the sum of the outputs of both adopters of technologies and non-adopters of technology.

$Q^* = Q^*(P_i, w, R^0, G^0)$ ……………………………………………………… (8)

The respective output supply of both adopters and non-adopters is expressed as follows:

$Q^*_{TA} = Q^*_{TA}(P_{iTA}, w_{TA,} R^0_{TA}, G^0_{TA})$…………………………………….....(8a)

$Q^*_{TM} = Q^*_{TM}(P_{iTM}, w_{TM,} R^0_{TM}, G^0_{TM})$ ………………………………….....(8b)

These solutions involve the decision rules for the quantities of labour inputs and outputs produced (production side). Given the optimal level of labour, the value of full income when profits have been maximized can be obtained by substituting L^* and Q^* into the right-hand side of the income constraints Eq. (6) as:

$X^* = P_i Q^* + wT - wL^* + N$ …………………………………………….. (9) and

$X^* = wT + \pi^*(P_i, w, R^0 G^0) + N$ ………………………………………… (10)

Where X^* is "full" income under the assumption of maximized profit π^*

The first-order conditions can be solved for consumption demand in terms of the wage rate, price and income as:

$F_k = F_k(P_i, P_m, w, X^*)$ ………………………………………………… (11)

Where $k = i, m$

The solutions involves the decision for the quantities of goods and leisure consumed (consumption demand side). Therefore, equations (7), (8) and (11) give a complete picture of the economic behaviour of the farm household. These are combined through the profit effect because income is determined by the household's production activities, implying that changes in variables influencing production also changes income; which in turn affects consumption behaviour of the farm household. Incorporating the household characteristics that shape its preferences(H_c), the demand for food indicated in Eq. (11) can be rewritten as:

$F_k = F_k[P_{i,}P_m, w, X^*(w, R^0, G^0, N), H_c]$ …………………………………… (12)

Where $k = i, m$

Since this study focuses on partial food availability at the farm level from farm produce, and do not consider other additional supplementary (purchase food) sources of food. This allows us to evaluate food availability at subsistence farming level and this is of great importance in developing countries where most of the food producers are subsistence farmers (Fabusoro et.al 2010). This also helps in better understanding of food security issues and the relationship between food availability and food security in developing countries; this is the rationale for the assumption and the fact that most of the respondents are small scale farmers (subsistence farmers, 81%) (Baiphethi and Jacobs 2009).

Equation (12), than be rearranged to reflect this as:

$F_k = F_k[P_i, w, X^*(w, R^0, G^0), H_c]$... (13)

Where $k = i, m$

3.6.2 Empirical Model

Determining the level of Partial Food Availability (PFA) at the farm-level from farm produce, we can now calculate the amount of calories (C_i) available in the respective staple food items. The extent of household PFA is determined by the size of the household, the ratio of adult male, female and children; and the difference between calorie availability and needs. Defining $C_i^* = C_i - \beta_i$

Where C_i is calorie availability and β_i is the consumption needs of the ith farm household. $C_i^* \geq 0$ Indicates that the farm household has adequate PFA, while $C_i^* < 0$ indicates that the farm household has inadequate PFA.

Therefore the total partial food availability model of ith farming household expressed as PFA per household per day per hectare is as follows:

$$PFA_{Ti} = \left\{ \frac{\sum_0^i f \left[\frac{(TR0_i - TR0S_i)\ C + (TY0_i - TY0S_i)C + (TC0_i - TC0S_i)C}{365} \right]}{h_i} \right\} / Hi$$

Where:

$PFA_{Ti} = Total\ Partial\ Food\ Availability\ of\ ith\ farmer$

$TR0_i = Total\ Rice\ Output\ of\ ith\ farmer$

$TR0S_i = Total\ Rice\ Output\ Sold\ by\ ith\ farmer$

$TY0_i = Total\ Yam\ Output\ of\ ith\ farmer$

$TY0S_i = Total\ Yam\ Output\ Sold\ by\ ith\ farmer$

$TC0_i = Total\ Cassava\ Output\ of\ ith\ farmer$

$TC0S_i = Total\ Cassava\ Output\ Sold\ by\ ith\ farmer$

$C = Calorie\ for\ the\ crops$

$h_i = Farm\ size\ of\ the\ ith\ farmer$

$Hi = family\ size\ of\ the\ ith\ household$

3.6.3 Definition of Some Key Variables

In the course of this research analysis, the following key variables among others were used to look at the relationship between variables, and the productivity and technology adoption level of respondents. The variables were as follows:

Farm size: - This refers to the total land area (hectare) under the respondent's (farmer) cultivation in the farming year. For the purpose of this study, respondents were categorized into three main farm size categories; small scale farm (0.1 - 2 ha), medium scale farm (2.01 - 3 ha) and large scale farm (≥ 3.01 ha) households.

Age of respondent: - This refers to the age (years) of head of household (HH) and for the purpose of analysis, respondents were categorized into the following age categories (25 - 39, 40 – 60 and ≥ 61 years).

Household size: - This refers to the number of members living in the same house with the head of household. For the purpose of this study it was categorized into the following (1 – 4 and ≥ 5) households. It is important to note that household size refers to in the bivariate probit and regression analysis (Chapters 7 and 8) do not reflect the adult equivalent of the household. Unfortunately, the data does not have information on the age of every individual; therefore it is somewhat difficult to accurately derive adult equivalent measures of the household.

Years of farming experience: - This refers to the number of years that the respondents have been engaged in farming activities. For the purpose of analysis, respondents have been categorized into the following, low experience (0 – 10), moderate experience (11 – 20), high experience (≥ 21) years of farming experience.

Educational level of respondent: - This refers to years of formal education of respondents. Respondents were categorized into the following educational levels, low/no education (0 – 6), moderate education (7-12) and high education (≥ 13) years of education for respondents.

Farm output: - This refers to the total output (kg/ha) produced by the respondent (farmer) in his cultivated area in the farming year.

3.6.4 Regression Analysis

Ordinary Least Square (OLS) multiple regression techniques were used to measure the degree of correlation between the dependent variables {Food Production (FP) and Partial Food availability (PFA)} and its corresponding exogenous variable. The rationale behind estimating FP and PFA independently is to evaluate the direction and magnitude of the effect of the same set of socio-economic exogenous variables on each of them.

The model specification for them is expressed as follows:

FP = $\beta_0 + \beta_1 X_1 + \varepsilon$ ……………….. Explicit Stochastic form

$$FP = \beta_O + \sum_{1}^{k} \beta_{ik} X_{ik} + \varepsilon_i$$

PFA = $\beta_0 + \beta_1 X_1 + \varepsilon$ ……………….. Explicit Stochastic form

$$PFA = \beta_O + \sum_{1}^{k} \beta_{ik} X_{ik} + \varepsilon_i$$

Where

FP = Food Produced

PFA = Partial Food Availability

X = Factors affecting food availability/food production

$\beta_0 =$ Constant

$\beta_1 =$ Regression coefficient

ε = Stochastic error term

The model specification for a multiple regression is given as follows:

$FP_i = f(X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8 + X_n)$ ………………Implicit form

$$FP_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \varepsilon$$

$PFA_i = f(X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8 + X_n)$ ………………Implicit form

$$PFA_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \varepsilon$$

Explicit form

$FP_i =$ Food Availability for ith farm or farmer

$PFA_i =$ Partial Food Availability for ith farm or farmer

$X_1 =$ Family size

$X_2 =$ Age of household head

$X_3 =$ Years of farming experience

$X_4 =$ Level of education of farmer

$X_5 =$ Farm size

$X_6 =$ Gender

$X_7 =$ Main occupation of household head

$X_8 =$ Training of household head

$X_9 =$ Proportion of rented-in land

$X_{10} =$ Number of extension contact

$X_{11} =$ Distance to extension centre

$X_{12} =$ Yam share of food

$X_{13} =$ Cassava share of food

$X_{14} =$ Fertilizer used

$\beta_0 - \beta_{14} =$ Regression coefficients

$\varepsilon =$ Stochastic error term

3.6.5 Bivariate Probit Model: The Theoretical Framework

Many studies have analysed the determinants of adopting modern/improved agricultural technologies (including HYVs of rice, wheat and/or maize, cassava) by farmers in Nigeria and other developing countries. These studies are largely univariate probit or Tobit regressions of technology adoption on variables representing the social economic circumstances of farmers (e.g., Hossain 1989; Ahmed and Hossain 1990; Shiyani et. al 2002; Rahman 2003, Floyd et. al. 2003; Ransom et. al. 2003; Barrett 2004, Chirwa 2005). The implicit theory underpinning such modelling is the assumption of utility maximization by rational farmers which is described below.

We denote the adoption of HYV as dv and the adoption of fertilizer as df; where $p = 1$ for adoption and $p = 0$ for non-adoption. The underlying utility function which ranks the preference of the i^{th} farmer is assumed to be a function of farmer as well as farm-specific characteristics, Z (e.g. family size, farming experience, farm size, extension contact etc.) and an error term with zero mean.

$U_{i1}(Z) = \beta_1 Z_i + \varepsilon_{i1}$ For adoption and

$U_{i0}(Z) = \beta_0 Z_i + \varepsilon_{i0}$ For non-adoption

Since the utility derived is random, the ith farmer will adopt an agricultural system if and only if the utility derived from the adoption is higher than non-adoption; i.e., $U_{i1} > U_{i0}$ Thus, the probability of adoption of the ith farmer is given by (Nkamleu and Adesina 2000; Ajibefun, et al. 2002 and Rahman 2008):

$$p(I) = p(U_{i1} > U_{i0})$$

$$p(I) = p(\beta_1 Z_i + \varepsilon_{i1} > \beta_0 Z_i + \varepsilon_{i0})$$

$$p(I) = p(\varepsilon_{i0} - \varepsilon_{i1}) < \beta_1 Z_i - \beta_0 Z_i)$$

$p(I) = p(\varepsilon_i < \beta Z_i)$

$p(I) = \emptyset(\beta Z_i)\emptyset$

Where $\emptyset$ is the cumulative distribution function for ε the functional form of $\emptyset$ depends on the assumption made for the error term ε, which is assumed to be normally distributed in a probit model. Thus for the ith farmer, the probability of the adoption of a diversified HYV and fertilizer respectively is given by:

$\emptyset_{dv}(\beta Z_i) = \int_{\alpha}^{\beta Z_i} \frac{1}{\sqrt{2\pi}}\, exp\, \left\{\frac{-t^2}{2}\right\} dt$ …………………… (1)

$\emptyset_{df}(\beta Z_i) = \int_{\alpha}^{\beta Z_i} \frac{1}{\sqrt{2\pi}}\, exp\, \left\{\frac{-t^2}{2}\right\} dt$ …………………….. (2)

The two equations can each be estimated consistently with the single-equation probit method but such a commonly used approach is inefficient because it ignores the correlation between the error terms $\varepsilon_{dv}\ and\ \varepsilon_{df}$ of the underlying stochastic utility function of HYV and fertilizer respectively. We apply the bivariate probit model in order to circumvent this limitation. Therefore, the bivariate probit model which is based on the joint distribution of the two normally distributed variables and is specified as follows: (Greene 2003 and Rahman 2008):

$$f(dv, df) = \frac{1}{2\pi\sigma_{dv}\sigma_{df}\sqrt{1-\rho^2}}\, e^{-\left((\varepsilon_{dv}^2+\varepsilon_{df}^2-2\rho\sigma_{dv}\sigma_{df})/(2(1-\rho^2))\right)} \qquad (3)$$

$\varepsilon_{dv} - \frac{dv-\mu_{dv}}{\sigma_{dv}}\ and\ \varepsilon_{df} - \frac{df-\mu_{df}}{\sigma_{df}}$

Where p is the correlation between dv and df, the covariance is

$\sigma_{dv,df} = \rho\sigma_{dv}\sigma_{df}$; $while\ \mu_{dv}, \mu_{df}, \sigma_{dv}\ and\ \sigma_{dv}$ are the means and standard deviations of the marginal distributions of dv and df respectively. The distribution is independent if and only if $p = 0$. The full maximum likelihood estimation procedure is utilized using the software program NLOGIT-4 (Economic software, Inc. (ESI) 2007).

Therefore, the bivariate probit model is developed to empirically investigate the socioeconomic factors underlying the decision to adopt HYV seed and/or fertilizer. The dependent variable is whether the farmer adopts HYV seed and/or fertilizer; for HYV represented by dv, the variable takes the value 1 if the farmer adopts HYV and 0 if otherwise. Similarly, for fertilizer represented by df; the variable takes the value 1 if the farmer adopts fertilizer and 0 if otherwise. The use of the empirical model will be discussed and further explained in Chapter Seven.

3.6.6 Partial Food Availability Calculation

For the purpose of this study, the term Partial Food Availability (PFA) means the quantity of a farmer's total output available for own consumption converted into calories divided by the number of days in a year (365 days) and divided by total farm size. This gives us the Partial Food Availability per day per hectare (PFA/D/ha calorie). Therefore the food availability for each household is their PFA/D/ha divided by their Household size (H). This varies from one household to the other depending on the number of adult male/female and children. For the purpose of this study the term PFA refers to food availability at the farm level from own farm production (Section 3.6.2)

The three food crops grown by respondents in this study are rice, yam and cassava; their calories are rice (3660 calories/kg), yam (3702.70 calories/kg) and cassava (1601.94 calories/kg). They were calculated as follows: (www.nutritiondata.self.com; www.caloriecounter.about.com)

Rice: - Since the husk of rice is not eaten, the paddy rice is converted to raw edible rice using the ratio of 40 kg of paddy rice = 28kg of edible raw rice. The calorie for 1 kg of rice is worked out as follows

$$1\ cup\ of\ rice = 188g = 688\ calories$$

$$1\ kg\ of\ rice = \left(\frac{1000}{188}\right) 688 = 3660\ calories$$

Therefore, Edible rice (calorie) is $R_e = \left[\left(\frac{X}{40}\right) 28\right] 3660$ where X is the rice kg

Yam: - The yam is converted into calories as follows:

$$1\ cup\ of\ yam = 150g = 177\ calories$$

$$1\ kg\ of\ yam = \left(\frac{1000}{150}\right) 177 = 1180\ calories$$

Cassava: - The cassava is converted into calories as follows:

$$1\ cup\ of\ cassava = 206g = 330\ calories$$

$$1\ kg\ of\ cassava = \left(\frac{1000}{206}\right) 330 = 1601.94 calories$$

3.6.7 Farm Profitability

This section discusses the net profit of each of the crop enterprises (Rice, Yam and Cassava) and their Benefit Cost Ratio (BCR). The key variables that are used to determine the profitability of farm enterprise in this study are defined and explained in this section. Also BCR of each of the farm enterprises are defined and explained. The key variables are:-

Variable Cost (VC): - This is the costs that change with level of production of the farmer; that is if the farmer increases his farming activities or scaled up his farming then variable cost is likely to scale up too. In this study, the variable cost is the sum total of total material input cost, total labour cost and transportation cost (Chapter 6 Table 6.16, Section A). The services of farm equipment and tools are not captured in the variable cost because none of the farmers have access to farm machinery or tools; the entire farmers still uses crude farm implements like hoes and cutlasses. Also there is no specific farm house; rather the farmers store their farm products in their residential house or local barns.

Unit price of output: - The unit price used to determine the Total Revenue (TR) of each of the farm enterprises is the actual selling price for farmers that sold their farm output and the mean selling price for those that do not sell their farm produce. This implies that for farmers that do not sell their farm produce, the mean selling price of those that sold their farm produce were used to determine the TR of their farm produce.

Total Revenue (TR): - This is the total output of each farm enterprise multiplied by their market unit selling price for farmers that sold their farm produce and mean market unit selling price for farmers that do not sell their farm produce; it varies from one farm enterprise to the other.

Gross Margin (GM): - This is the difference between the Total Revenue (TR) of each farm enterprise and the Total Variable Cost (TVC).

Fixed Cost (FC): - These are the costs that are associated with farm production but are fixed, which means that they remain the same throughout the production period. For this study the fixed costs are the mean cost for farmers renting-in land for farm production and mean interest paid on any loan acquired for farm production by farmers that have loan. It is important to note that the mean cost of renting-in land and loan interest payment are just for farmers that rented-in land or had any loan, to avoid distort comparisons with farmers that do not use this facilities.

Net Profit (NP): - This is the difference between Gross Margin (GM) and the Total Fixed Cost (TFC) for each farming enterprise.

Benefit Cost Ratio (BCR): - This is the Total Revenue (TR) for each farming enterprise divided by their Total Cost (TC). It is a ratio and implies the return for every Naira invested in the farm enterprise. The BCR value is good if it is positive and has the value of 1 or more. Therefore the higher the BCR value, the better the return on every additional naira invested on that farm enterprise.

3.7 Limitation of Study

The main constraint to this study is the lack of reliable panel data on the adoption of agricultural technology in the zone, which can be used to compare the results of this study. Cross-sectional study does not give the full picture but a snap of the situation at a particular point in time, but this study will help to provide more information on this very important aspect of agriculture, especially in the area of planning and policy formulation (Doss, 2006). Given the large area this study covered, it was a tedious, time consuming and expensive event, but these problems were cushioned by meticulous planning, part-funding from the Seale-Hayne Educational Trust Fund and help from Plymouth of University School of Geography.

Chapter Four

Study Area and Outlook of Agricultural Production Trends in the Study Area

4.0 Introduction

This chapter will extensively discuss the study area; it will outline an overview of Nigeria and describe the primary study area (south-eastern Nigeria). It will outline a brief history of the study area, geographic location, population, its people and agricultural production practices. The chapter will also look at the agricultural production trend in Nigeria, and production output trend of some major crops in the study area.

4.1 Study Area

Nigeria is a federal republic comprising thirty six states and its federal capital territory Abuja. The country is located in West Africa and shares land borders with the republic of Benin (773 km) in the west, Chad (87 km) and Cameroon (1690 km) in the east and Niger (1497 km) in the north. It has a coastline area of at least 853 km, most of which lies on the Gulf of Guinea on the Atlantic Ocean (Wikipedia, 2012).

Nigeria has a total land area of 923,768 km sq. (356,669 square miles) it lies between latitudes 4º and 14ºN, and longitudes 2º and 15º E. It has a varied landscape of tropical rainforest climate in the south, with annual rainfall of 60 to 80 inches a year. Its most extensive topographical region is found by the valleys of the Niger and Benue rivers. Southwest of the Niger lays a rugged highland and to the southeast of Benue are hills and mountains which form the Mambilla Plateau. Between the far south and the far north is the savannah zone where rainfall is between 20 and 60 inches per year. The savannah zone is divided into three categories, Guinean forest-savannah mosaic plain with tall grass and trees, Sudan savannah similar but with shorter grasses and shorter trees and the Sahel savannah, comprising patches of grass and sand found mostly in the northeast (FOS, 2010).

For the purpose of this research, this study will be focusing more on the primary study area which is south-eastern Nigeria; it is one of the 6 geo-political/agricultural zones in the country and has similar economic, political, ethnic and agricultural history. The zone was chosen because of its unique location and the fact that it is one of the regions in pre/post independent Nigeria. It is located in southern Nigeria and occupies a land area of 75,488km2 comprising nine states, namely Abia, Akwa-Ibom, Anambra, Bayelsa, Cross River, Ebonyi, Enugu, Imo, and Rivers. These states fall into two geo-political zones in Nigeria, namely the South-south and Southeast. While Akwa-Ibom, Bayelsa, Rivers and Cross River are in the South-south, Abia, Anambra, Ebonyi, Enugu and Imo are in the Southeast and is the primary study area. The region has a total population of 31,371,941 and an average population density of 416 persons per square kilometre (FOS, 2010).

Southeast Nigeria is a diverse area and lies within the rain forest belt of Nigeria, which is characterised by high temperatures and humidity, with a substantial amount of rainfall during the rainy period of the year. The most common soils are Ultisols, which are acidic, with pH ranging from 4.0 in the highest rainfall areas to around 5.5 further north. Rural population densities in southeast Nigeria are amongst the highest in Africa, and in many areas pressure on land has led to shortening fallow periods and declining soil fertility (Enete, 2010).

Agriculture in the region is predominantly based on bush fallow rotation, with cassava, yam and rice as the main crops. Palm tree plantation is the major cash crop in the area and land holdings are small and often fragmented. Figure 4.1 below shows the map of Nigeria with the five states that make up south-eastern Nigeria's geo-political/agricultural zone. Two states were chosen from the five states in the zone as the primary study area, where questionnaires were distributed to farmers and ADP staffs for this research. Ebonyi state was chosen because it is the most agrarian of all the states and well known for its agricultural produce, and Anambra state was chosen because it is the oldest state in the zone.

Figure 4.1: Map of Nigeria

Source: Wikipedia, 2012

4.1.1 Ebonyi State Nigeria

Ebonyi state was created on 1st October 1996 from Enugu and Abia states; and has a total landmass of 5,935 square kilometres of which 80% is rich in arable (Nwibo, 2012). It has an estimated population of 2,173,501 people with a growth rate of 3.5% per annum (NPC, 2006). The population of the state is about 70% rural and the economy is primarily dependent on agriculture, which contributes about 90% of its Gross Domestic Product (GDP). About 75% of its people are engaged in one form of farming or another and are mostly subsistence farmers (Ebonyi Agricultural Policy 2010).

The state has a tropical climate with average rainfall ranges of 1,250 to 2,500 mm per year. The rainy season is from April to November and the dry season is from November to early April. However, a short dry spell is usually experienced during the month of August and this is termed the August break. Lowland areas popularly called fadama are scattered throughout and serve as good sites for rice and dry season vegetable farming; other major crops grown in the state are yam, cassava, cocoyam, groundnut, maize, vegetables and cowpea (Edeh et al, 2011). It has an average annual temperature of about 27ºC with relative humidity of 85% (Nwakpu, 2003). The vegetation of the state is a mixture of savannah and semi-tropical forest with underlying parent materials consisting of shale inter-bedded with sand and limestone. The soil is textually clay loam, fairly to poorly drained with gravely sub-soil in some locations, especially the upland adjacent to lowland areas (Ekpe et al, 2005).

Agricultural production in Ebonyi state is predominantly at subsistence level although some commercial farms are now springing up. About 90% of the farmers are small holders and land rotation with a fallow period of up to four years used to be the practice, but with the increased pressure on land as a result of urbanization, the fallow periods are now becoming shorter (Ebonyi Agricultural Policy 2010). The state is made up of thirteen local government areas, which are divided into three senatorial/agricultural zones, namely: Ebonyi North, Ebonyi Central and Ebonyi South zones. Detailed methodology on the data collection process is shown in Chapter 3; Figure 4.2 below is a map of Ebonyi state with the thirteen local government areas.

Figure 4.2: Map of Ebonyi State

Source: NBS, 2010

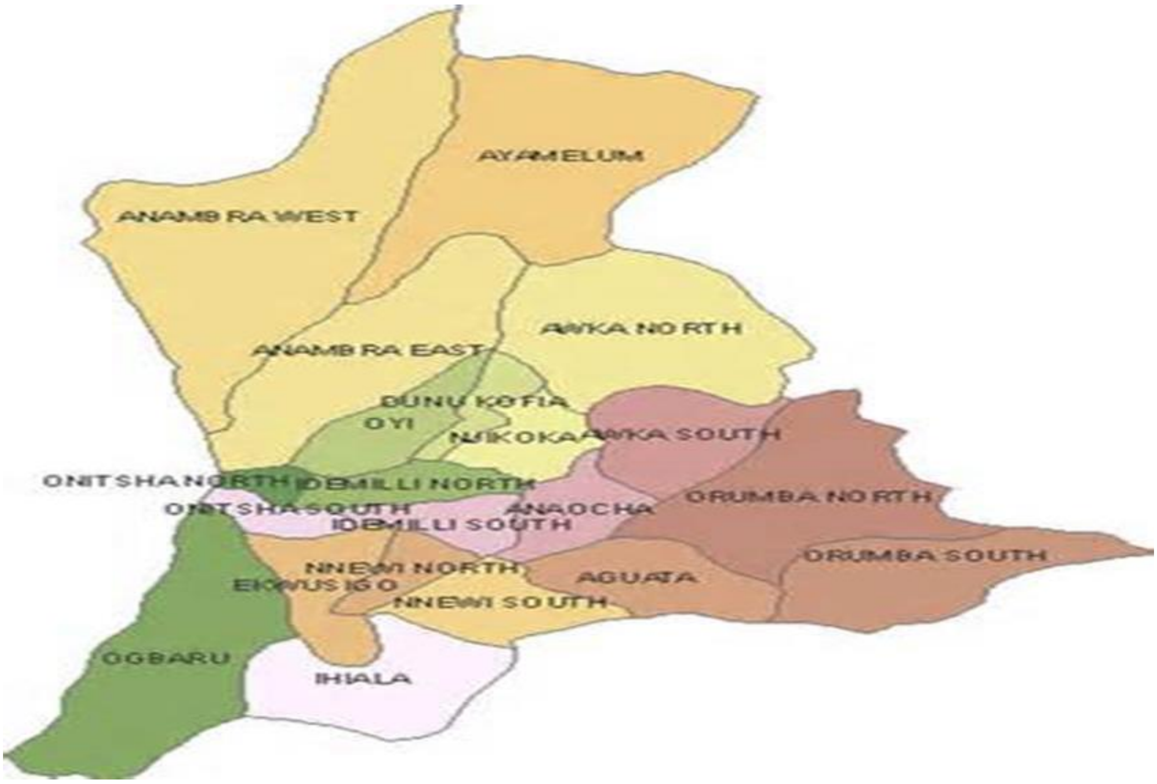
4.1.2 Anambra State Nigeria

Anambra state was carved out of the old Anambra state in 1991 and has a land area of 4,415.54 square kilometres and population of 4.18 million; 70% of the land is rich for agricultural production (Nkematu, 2000 and NPC, 2006). The state has 21 Local Government Areas (LGA), consisting of 177 autonomous communities. The climate can generally be described as tropical with two identifiable seasons, the rainy or wet and dry seasons. Farming is the predominant occupation of the rural people, the majority of whom are small holder subsistence farmers.

Agriculture is the mainstay of the rural economy; other key sectors are manufacturing and commerce. Agricultural activities include farming (crop production), livestock and forestry. The state economic policy thrust is articulated in its State Economic Empowerment Development Strategy (SEEDS) document, which puts the rehabilitation of abandoned agricultural schemes, adoption of improved technologies and the empowerment of rural farmers at the heart of its economic policies (Anambra state policy document, 2010).

For the purpose of this research, Awka North, Anambra West and Ayamelum Local Government Areas were randomly selected from the 21 LGAs in the state. Details of the data collection process are covered in the methodology (Chapter 3); Figure 4.3 below shows a detailed map of Anambra state.

Figure 4.3 Map of Anambra State



Source: Google Image, 2012

4.2 Production Output Trends and Land Area Cultivated for some Major Crops in Nigeria[1]

This section will show estimated land area cultivated and estimated output production for some major crops in Nigeria. The data is from the agricultural performance survey of 2010 wet season in Nigeria, published by National Agricultural Extension and Research Liaison Service (NAERLS) and National Programme on Agricultural and Food Security (NPAFS). Due to difficulties in getting reliable data, it is very difficult to project beyond 2009, since some of the earlier data is not compatible with the most recent data. The 2009 Crop, Area and Yield Survey (CAYS) figures of NPAFS were used as a basis for the estimation of both land area cultivated and production output for each crop in each state. The harmonized CAYS 2009 figure for land area cultivated was

[1] The figure for south-east geo-ecological zone comprises that for both south-east and south-south geo-political zones.

incremented by the appropriate percentage increase arrived at by the state ADP Project Monitoring and Evaluation (PME) unit to derive the land area figure cultivated in 2010 (Table: 4.1). Similarly, the 2009 harmonized crop production output figure for each crop was incremented by the appropriate percentage increase arrived at by the PME to give the crop production output figure for 2010 (Table: 4.2).

4.2.1 Land Area Cultivated For Major Crops in Agricultural Ecological Zones in Nigeria

Table: 4.1 below shows that the North Central zone (NCZ) has the largest land cultivated area for yam, maize, rice, melon, soybean and groundnut; this is followed by the North West zone (NWZ) for millet, sorghum and cotton; the South east zone (SEZ) with cassava and cocoyam and the North East zone (NEZ) with cowpea. The table also shows that NEZ has the highest percentage change for the land area cultivated in 2010 from the figure of 2009 for the following crops, cowpea, millet, sorghum and soybean; followed by SEZ with cassava, cocoyam and groundnut; NCZ with yam, rice and cotton. Similarly, the table indicates that sorghum (5,544,350 ha) has the largest land area cultivated, followed by maize (5,256,430 ha), millet (4,089,190 ha), cassava (3,982,550 ha), cowpea (3,620,690 ha) and soybean (449,780 ha). Cocoyam (473,700 ha) and melon (771,650 ha) are the ones with the least land area cultivated. Cowpea, cassava, soybean and yam have the highest percentage change in land area cultivated while cotton, melon and millet have the least percentage in land area cultivated.

Table: 4.1 Land area cultivated (000ha) in 2010 for major crops in different agricultural ecological zones in Nigeria, with percentage change from 2009

Crops	Year	Agricultural Ecological Zones In Nigeria					
		South West	South East	North Central	North West	North East	Total
Cassava	2010	904.50	1685.42	1089.23	290.42	12.98	**3982.55**
	% Change	2.90	20.00	2.70	NA	1.90	**9.00**
Yam	2010	529.60	1018.81	1240.02	98.09	NA	**2886.52**
	% Change	2.70	7.70	10.00	-1.10	NA	**7.50**
Cocoyam	2010	149.76	252.39	54.13	12.85	4.57	**473.70**
	% Change	6.00	8.90	0.80	1.10	NA	**6.70**
Maize	2010	1201.04	616.39	1483.75	952.01	1003.24	**5256.43**
	% Change	4.85	3.81	3.00	2.40	2.12	**3.20**
Rice	2010	**180.57**	**274.36**	**853.97**	**439.13**	**264.74**	**2012.74**
	% Change	**1.02**	**1.69**	**4.40**	**1.40**	**4.40**	**3.90**
Millet	2010	1.40	NA	867.20	2093.17	1127.42	**4089.19**
	% Change	NA	NA	1.36	-2.60	10.84	**1.60**
Melon	2010	103.00	109.48	493.43	NA	65.74	**771.65**
	% Change	3.42	3.42	-0.68	NA	8.79	**1.20**
Soybean	2010	6.46	4.70	213.74	212.88	12.00	**449.78**
	% Change	0.62	1.70	0.40	17.50	18.90	**8.30**
Cowpea	2010	59.92	18.75	318.07	1176.89	2047.06	**3620.69**
	% Change	9.74	2.80	5.55	8.80	14.96	**11.80**
Groundnut	2010	18.69	22.00	884.45	662.12	857.98	**2445.24**
	% Change	5.10	14.30	1.92	5.30	5.11	**4.10**
Sorghum	2010	32.42	NA	1507.60	2296.29	1708.04	**5544.35**
	% Change	0.76	NA	6.70	2.10	9.01	**5.40**
Cotton	2010	11.00	NA	32.10	177.29	46.30	**266.69**
	% Change	NA	NA	1.48	NA	NA	**0.10**

Source: NAERLS and NPAFS 2010

4.2.2 Production Output for Major Crops in Agricultural Ecological Zones in Nigeria

Similarly, Table: 4.2 below shows the production output for major crops in different ecological zones in Nigeria. It shows that NCZ has the highest production output for yam, maize, rice, melon, soybean and groundnut; followed by NWZ with millet, sorghum and cotton; SEZ with cassava and cocoyam and NEZ with cowpea. It also shows that NEZ has the least production output for most of the crops while the South West Zone (SWZ) appears to have an average production output for most of the crops. The table also indicates that NEZ recorded the highest percentage change in production output over that of 2009 for the following crops, millet, melon, soybean, groundnut and sorghum; followed by SWZ for cocoyam, maize, rice and cowpea; SEZ for cassava and yam. NWZ and SEZ recorded a negative percentage change in production output for cowpea, groundnut, sorghum, cotton, cowpea and groundnut respectively. Millet (6.0%) and cassava (5.1%) have the highest percentage change in production output over that of 2009 while sorghum (1.4%) and cotton (-8.3%) have the least and negative percentage change in production output respectively.

Table: 4.2 Production output (000 MT) in 2010 for major crops in different agricultural ecological zones in Nigeria, with percentage change from 2009

Crops	Year	Agricultural Ecological Zones In Nigeria					
		South West	South East	North Central	North West	North East	TOTAL
Cassava	2010	14257.40	21405.17	14011.76	2741.16	75.26	**52490.75**
	% Change	5.20	6.70	3.30	2.00	0.10	**5.10**
Yam	2010	7384.52	12053.47	17826.48	1017.66	NA	**38282.13**
	% Change	3.90	4.90	4.30	2.70	NA	**4.40**
Cocoyam	2010	1259.98	1791.19	321.16	81.23	26.80	**3480.36**
	% Change	4.40	4.20	0.80	3.30	NA	**3.90**
Maize	2010	2289.49	1040.66	2467.25	1968.18	1577.82	**9343.40**
	% Change	8.52	4.80	3.70	3.00	1.01	**4.30**
Rice	2010	307.32	771.47	1748.67	867.8	385.68	**4080.94**
	% Change	12.60	1.50	1.70	7.30	5.20	**3.90**
Millet	2010	1.11	NA	1003.39	2668.80	1488.57	**5161.87**
	% Change	NA	NA	4.25	2.30	14.60	**6.00**
Melon	2010	56.97	58.45	296.44	NA	43.04	**454.90**
	% Change	5.58	2.26	1.21	NA	8.20	**2.50**
Soybean	2010	8.13	2.49	280.37	242.79	8.75	**542.53**
	% Change	4.90	2.50	0.50	6.50	11.20	**3.40**
Cowpea	2010	34.58	9.93	213.04	438.16	959.35	**1655.06**
	% Change	12.50	-3.00	10.10	-14.90	12.20	**3.20**
Groundnut	2010	21.18	20.86	1306.13	689.74	973.86	**3011.77**
	% Change	3.10	-0.50	1.65	-4.60	11.10	**2.90**
Sorghum	2010	26.49	NA	1878.18	2933.52	1922.18	**6760.37**
	% Change	0.63	NA	5.90	-6.30	10.80	**1.40**
Cotton	2010	10.64	NA	13.63	204.26	59.97	**288.50**
	% Change	NA	NA	2.86	-10.50	NA	**-8.30**

Source: NAERLS and NPAFS 2010

4.2.3 Yields per Hectare for Major Crops in Different Agricultural Ecological Zones in Nigeria

Tables 4.3 and 4.4 below show the yield per hectare for major crops and indicate that in 2010, NCZ had the highest yield per hectare for yam, soybean, cowpea and groundnut; followed by NEZ for millet, melon and cotton; NWZ and SWZ for maize, sorghum, cassava and cocoyam respectively. The table also shows that cassava and yam has the highest yield per hectare while cowpea and melon has the lowest yield per hectare. Table 4.4 shows that when yield per hectare in 2010 is compared to that of 2009 as percentage change in yield, there appears to be a negative yield per hectare for most crops apart from maize, millet, rice and melon. This may be due to the high incident of pest and diseases, flood and scarcity of inputs (NAERLS and NPAFS 2010).

Table: 4.3 Yield per hectare for major crops in different agricultural ecological zones in Nigeria

Crops	Year	Agricultural Ecological Zones In Nigeria					
	2010	South West	South East	North Central	North West	North East	Total
Cassava		15.76	12.70	12.86	9.44	5.80	**13.18**
Yam		13.94	11.83	14.38	10.37	0	**13.26**
Cocoyam		8.41	7.10	5.93	6.32	5.86	**7.35**
Maize		1.91	1.69	1.66	2.07	1.57	**1.78**
Rice		1.70	2.81	2.05	1.98	1.46	**2.03**
Millet		0.79	0	1.16	1.28	1.32	**1.26**
Melon		0.55	0.53	0.60	0	0.65	**0.59**
Soybean		1.26	0.53	1.31	1.14	0.73	**1.21**
Cowpea		0.58	0.53	0.67	0.37	0.47	**0.46**
Groundnut		1.13	0.95	1.48	1.04	1.14	**1.23**
Sorghum		0.82	0	1.25	1.28	1.13	**1.22**
Cotton		0.97	0	0.42	1.15	1.30	**1.08**

Source: NAERLS and NPAFS 2010

Table: 4.4 Yield per hectare for major crops in 2010 rain-fed season in Nigeria

Crop	2009			2010			Percentage Difference In
	Area (000 Ha)	Production Output (000 MT)	Yield Ton/ha	Area (000 Ha)	Production Output (000MT)	Yield Ton/ha	Yield Over That Of 2009
Cassava	3652.52	49939.96	13.672	3982.55	52490.75	13.18	-3.6
Cocoyam	444	3349.37	7.544	473.7	3480.36	7.35	-2.60
Cowpea	3236.99	1604.18	0.496	3620.69	1655.06	0.46	-7.9
Groundnut	2349.93	2926.07	1.245	2445.24	3011.77	1.23	-1.90
Maize	5092.22	8957.40	1.759	5256.43	9343.40	1.78	1.10
Millet	4023.09	4870.96	1.21	4089.19	5161.87	1.26	4.13
Rice	1937.79	3926.38	2.026	2012.74	4080.94	2.03	0.10
Yam	2687.53	36679.00	13.648	2886.52	38282.13	13.26	-2.80
Sorghum	5258.12	6665.01	1.268	5544.35	6760.35	1.22	-3.90
Soybean	415.26	524.84	1.264	449.78	542.53	1.21	-4.60
Cotton	366.37	423.80	1.157	366.69	388.50	1.08	-8.50
Melon	762.84	443.80	0.582	771.65	454.90	0.59	1.40

Source: NAERLS and NPAFS 2010

4.3 Outlook for Production Output and Land Area Cultivated for Major Crops in South East Geo-Political Zone in Nigeria

The land area cultivated for major crops in the south east geo-political zone is shown in Table: 4.5 below. This indicates that Enugu state has the largest land area cultivated for yam and cocoyam; followed by Imo state with cassava and maize; and Ebonyi state with rice. Abia and Anambra states appear to have the least land area cultivated for most of the crops; this may be because of them having more commercial centres than other states in the zone (Nwibo, 2012).

Table: 4.5 Land area cultivated (000 ha) for major crops in 2010 rain-fed season in the south east geo-political zone of Nigeria with percentage change from 2009

Crops	Year	States In South East Geo-Political Zone In Nigeria					Total
		Anambra	Enugu	Ebonyi	Abia	Imo	
Cassava	2010	106.4	276.06	72	45	310.05	**809.51**
	% Change	1	5	5.63	3.2	0.3	**13.03**
Yam	2010	65.82	274.26	109.97	35	54.2	**539.25**
	% Change	0.98	5	4.85	-9.8	0	**2.86**
Cocoyam	2010	20.71	43.87	11.49	17.11	29.26	**122.44**
	% Change	1.02	5	-6.36	0.06	4.5	**2.42**
Rice	2010	14.95	23.81	97	9	24.00	**168.76**
	% Change	1	6	-5.6	-0.5	5	**-2.89**
Maize	2010	38.45	76.62	23.2	63	130.25	**331.52**
	% Change	1	5	4.69	4.8	0	**2.46**

Source: NAERLS and NPAFS 2010

The table also shows that Enugu state has the highest percentage change in land area cultivated in 2010 over that of 2009 for yam, cocoyam, rice and maize, followed by Ebonyi state with cassava. Also, it shows a negative percentage change in land area cultivated for cocoyam, rice and yam in Ebonyi and Abia states respectively. Cassava (809,510 ha) has the largest land area cultivated, followed by yam (539,250 ha) and maize (331,520 ha) in the zone. Furthermore, the table shows that cassava (13.03%) has the highest percentage change in land area cultivated in 2010, followed by yam (2.86%) while rice (-2.89%) has a negative percentage change in land area cultivated.

Similarly, Table: 4.6 below show the production output for major crops in the south east geo-political zone. It indicates that Enugu and Imo states have the highest production output for yam, cocoyam, cassava and maize respectively, while Ebonyi state has the highest production output for rice.

Table: 4.6 Production outputs (000mt) for major crops in 2010 rain-fed season in the south east geo-political zone of Nigeria, with percentage change from 2009

Crops	Year	States In South East Geo-Political Zone In Nigeria					
		Anambra	Enugu	Ebonyi	Abia	Imo	Total
Cassava	2010	1724.29	3608.94	1092.15	742.28	3642.07	10809.73
	% Change	1.24	5	5.57	11.9	2.2	3.92
Yam	2010	951.25	3249.16	1519.95	601.02	765.95	7087.33
	% Change	1	5	4.95	1.7	0	3.59
Cocoyam	2010	161.2	279.14	91.28	155.03	240.91	927.56
	% Change	1.1	5	-6.32	0.05	0.8	1.27
Rice	2010	36.75	70.09	322.35	23.53	24.3	477.02
	% Change	1.5	6	-5.8	-1.2	2.1	-3.08
Maize	2010	80.23	131.21	48.9	84.15	185.53	530.02
	% Change	1.2	-5	4.69	15.7	8.9	4.5

Source: NAERLS and NPAFS 2010

When production output is compared as a percentage change of that of 2009, the table shows that Enugu and Abia states have the highest percentage change in production output for yam (5%), cocoyam (5%), rice (6%), and cassava (11.9%) and maize (15.70%) respectively, while Ebonyi and Abia states have a negative percentage change in production output for cocoyam (-6.32%), rice (-5.80% & -1.20%). The table also shows a positive percentage change in total production output for cassava (3.92%), yam (3.59%), cocoyam (1.27%) and maize (4.5%), but a negative percentage change for rice (-3.08%).

Yield per hectare for major crops in the south east geo-political zone is shown in Tables 4.7 and 4.8 below. They show that Abia and Ebonyi states have the highest yield per hectare for cassava, yam, cocoyam, and rice and maize respectively. Also, when percentage difference in yield per hectare in 2010 is compared with that of 2009 (Table 4.8), there is a negative percentage difference in yield per hectare for cassava, cocoyam and rice and a positive percentage difference in yield per hectare for yam and maize. This indicates that any increase in production output may be because of an increase in land area cultivated and not an increase in productivity (NAERLS and NPAFS 2010).

Table: 4.7 Yield per hectare (ton/ha) by states for major crops in rain-fed season in south east geo-political zone of Nigeria in 2010

Crops	Year	States In South East Geo-Political Zone In Nigeria					
	2010	Anambra	Enugu	Ebonyi	Abia	Imo	Total
Cassava		16.21	13.07	15.17	16.50	11.75	13.35
Yam		14.45	11.85	13.82	17.17	14.13	13.14
Cocoyam		7.78	6.36	7.94	9.06	8.23	7.58
Rice		2.46	2.94	3.32	2.61	1.01	2.83
Maize		2.09	1.71	2.11	1.34	1.42	1.60

Source: NAERLS and NPAFS 2010

Table: 4.8 Yield per hectare (ton/ha) for major crops in 2009 and 2010 in rain-fed season in the south east geo-political zone of Nigeria

Crop	2009			2010			Percentage difference in yield over that of 2009
	Area (000Ha)	Production Output (000MT)	Yield (Ton/ha)	Area (000Ha)	Production Output (000MT)	Yield (Ton/ha)	
Cassava	716.14	10401.8	14.52	809.51	10809.73	13.35	-8.06
Cocoyam	119.55	915.94	7.66	122.44	927.56	7.58	-1.04
Yam	524.24	6841.42	13.05	539.25	7087.33	13.14	0.69
Rice	172.09	492.2	2.86	168.76	477.02	2.83	-1.05
Maize	323.57	507.18	1.57	331.52	530.02	1.60	1.91

Source: NAERLS and NPAFS 2010

Chapter Five

Socio-Economic Characteristics and Production Practices of the Farmers

5.0 Introduction

This chapter will look at the socio-economic and demographic characteristics of head of household (HH) of sampled farms and their production practices. The data collection procedures were explained in the methodology chapter, and the field survey report (Chapter 3, Table: 3.3), showed that in Ebonyi state only 86.3% of sent out questionnaires were useable, while in Anambra state only 47% of sent out questionnaires were useable, with reasons explained in Chapter 3.

Overall, 400 questionnaire respondents (Ebonyi state 259 and Anambra state 141), were useable in this study. Most of the respondents practiced mixed farming (combination of more than one crop) and crops farmed by respondents in this study are rice, yam and cassava. The crops were chosen because as shown in Chapter 4 section 4.3, they are among the most important staple food crop and because of their role in food security/availability of the study area. The study showed that 35.75% (143) of respondents were at least rice farmers, 86.0% (344) cassava farmers and 74.50% (294) of them farmed yam; a more detailed discussion of the crop production practice is explained later in the chapter.

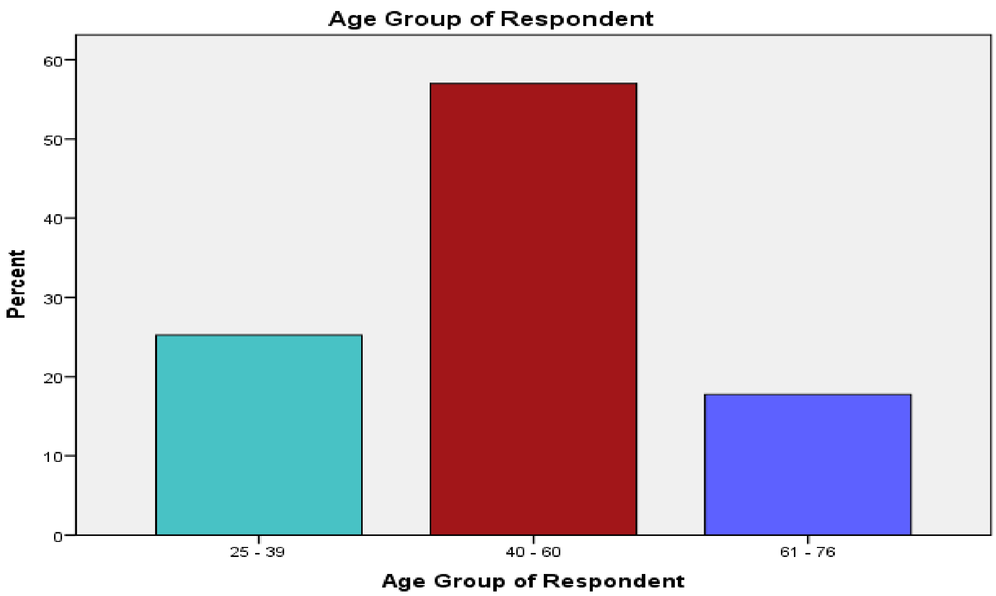
5.1 Socio-Economic and Demographic Characteristics of the Sample Farmers

This section will discuss some of the basic characteristics of the head of household of sampled farms such as age, education, years of farming experience, gender, household size, marital status, amount of land owned and farm size.

5.1.1 Age, Education and Years of Farming Experience

The age of a farmer plays an important part in his/her crop production decisions, farm management practices and agricultural technology adoption decisions (Rahman, 2011). The age of farmers in this study ranges from 25 years to 76 years; the mean age of the sample farmers was 49 years, with a standard deviation of 12.14 (more details about the age of respondents are in Appendix 1, Table:1). Figure 5.1 below shows that 25.3% of the respondents are below 40 years, 57% are 40 – 60 years and 17.7% are 61 – 76 years. This is in line with other studies in Nigeria such as Afolami et al., (2012) and Igwe, (2013) that recorded a mean age of 48 and 53 years, respectively, among farmers in south-eastern Nigeria.

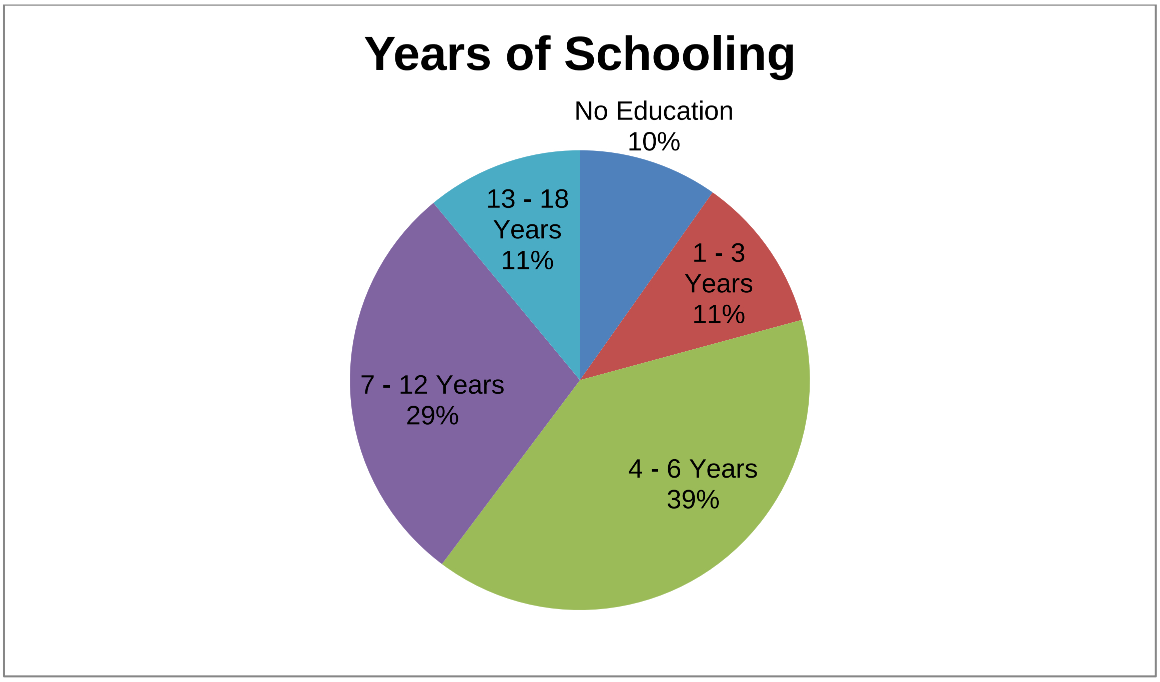
Figure 5.1: Age group of respondents



Source: Field Survey, 2011

Education is considered as one of the crucial factors influencing the attitude of the farmer towards the adoption of agricultural technology; it helps a person to have day to day information about agricultural technology (Miah, 2001). In this study, the level of education of the respondents was measured by their years of schooling. The average number of years of schooling of respondents was 7.84, with standard deviation of 1.73 (Appendix 1, Table: 1). Figure 5.2 below shows that 60% of farmers have ≤ 6 years of schooling, 29% 7 – 12 years and 11% have more than twelve years of schooling. This is consistent with similar studies such as Igwe, (2013) and Rahman, (2011) that identified similar level of education in their respective studies.

Figure 5.2: Years of schooling of respondents



Source: Field Survey, 2011

In addition, the years of farming experience in this study measures the actual years spent by respondents in farming. This is a very important factor in that it indicates the real number of years spent by respondents in farming, regardless of their age; so a respondent may be older but has spent fewer years in farming than a younger respondent. Studies such as Ajibefun et al., (2002) and Rahman, (2011), show that farmers who have more experience in farming generally attain higher levels of technical efficiency. The average years of farming experience of respondents is 19.78, with a standard deviation of 13.62; furthermore, 29% of respondents have less than 10 years farming experience, 35% have 10 – 24 years and 36% have ≥ 25 years of farming experience (Appendix 1, Table: 1).

5.1.2 Gender, Household Size and Marital Status

The data on sex distribution of household heads shows that 80.8% (323) of respondents are male and 19.2% (77) are female. This is consistent with studies such as Ajibefun et al (2002) and Rahman, (2011) which show more male farmers than female famers in their respective studies. In these farming villages (as in the majority of other African rural communities) males dominate ownership of assets, leadership of households and formal employment (Igwe, 2013). The low representation of women as heads of households could be related to strong cultural and traditional values within the communities, which tend to exclude women from major responsibilities, such as land ownership, governance and being head of household. It has been reported that this exclusion affects all categories of women, married, divorced or widowed, and translates to little or no access to assets of production and decision making (Stephen and Lenihan, 2010).

The mean household size was 4 with a standard deviation of 1.91; a detailed analysis shows that 41% of respondents had 1 – 3 household members, while 59% had 4 or more household members. Household size has been shrinking in Nigeria since the early 1990s from the levels common in the 1960s, 1970s and 1980s. This is due to better medical facilities, the improved economic situation and advice from the government, such as campaigns in the late eighties advising people to have 4 or less children (NEEP, 2010). The study also shows that 63.5% (254) of respondents are married, 18.5% (74) widowed, 4% (16) divorced and 14% (56) single.

5.1.3 Land Owned and Farm Size

Land is the single most important asset for any farmer because farm families depend mainly on it for their subsistence and livelihood. Land owned refers to the total land owned by the respondent, including land not in agricultural use, leased out or mortgaged out. Farm size refers to respondents land that is under cultivation, including leased-in and mortgaged-in lands. The average land owned is 1.13 ha with standard deviation of 1.16; 12.8% of respondents own no land, 43.5% own 0.1 – 0.99 ha, 36.5% own 1 – 3 ha and 7.3% own more than 3.0 ha (Table 5.1).

Table: 5.1 Lands owned and farm size of respondents

Land owned			Farm size		
Hectares	**Frequency**	**%**	**Hectares**	**Frequency**	**%**
0	51	12.8	0.1-0.99	200	50.0
0.1 - 0.99	174	43.5	1.0-1.99	117	29.3
1.0- 1.99	100	25.0	2.0-3.0	50	12.5
2.0-3.0	46	11.5	3.1-5.0	30	7.6
3.1-6.0	29	7.3	5.1-8.5	3	.8
Total	**400**	**100**	**Total**	**400**	**100**
Mean	**1.13**		**Mean**	**1.27**	
Standard Deviation	**1.16**		**Standard Deviation**	**1.11**	
Variance	**1.35**		**Variance**	**1.23**	

Source: Field Survey, 2011 (N.B: The mean, Std. Deviation and variance were calculated from the real value of the data and not the range value)

The average farm size of respondents was 1.27 ha with standard deviation of 1.11 (Table 5.1); 50% of respondents cultivated less than 1 ha, 29.3% cultivated 1 – 1.99 ha, 12.5% cultivates 2 – 3 ha and 8.4% cultivated more than 3 ha. This is in line with other studies such as Ajibefun et al (2001); Igwe, (2013) and Rahman, (2011) that looked at similar issues in Nigeria and other developing countries.

5.1.4 Farming Categories of Respondents

The review of literature such as, Ajibefun et al. (2001), Igwe, (2013) and Fabusoro et al. (2010) shows that about 90% of Nigeria's food is produced by small-scale farmers who cultivate small plots of land (0.1 – 2 hectares) with crude implements and depend on rainfall rather than irrigation systems. For the purpose of this study, and in line with other studies on agricultural production in Nigeria like the NEPPA report, (2010) and Fabusoro et al. (2010), respondents have been grouped into the following categories; small scale farm which refers to respondents with 0.1 – 2.0 hectares; medium scale farm, referring to farmers with 2.01 – 3.0 hectares; and large scale farm referring to farmers with 3.01 hectares and above.

Analysis of the data collected (Table 5.2) shows mean farm size values of 0.82 ha (small scale), 2.54 ha (medium scale), 4.04 ha (large scale) and standard deviations of 0.47, 0.24, 1.01, respectively. It also shows that 81% of the respondents are small scale farmers. This is in line with other similar studies such as Fabusoro et al (2010) and Igwe, (2013) which interestingly also show an increase in small scale farmers in south-eastern Nigeria from 75% in 2005 to 79% in 2009.

Table 5.2: Farm size category of respondents

Farm Category	Frequency	%	Range (Hectare)	Mean Farm Size	Std. Deviation	Variance
Small	324	81.0	0.1 - 2	0.82	0.456	0.209
Medium	43	10.8	2.01 - 3	2.54	0.239	0.057
Large	33	8.3	≥ 3.01	4.04	1.006	1.012
Total	**400**	**100**	**-**	**-**	**-**	**-**

Source: Field Survey, 2011 (N.B: The mean, Std. Deviation and variance were calculated from the real value of the data and not the range value)

This is because of continued pressure on land due to population increase (NBS, 2010), lack of access to credit facilities and a range of other factors as shown in the literature review. Furthermore, this study shows that 8.3% of respondents are a large scale farmer which is in line with Igwe, (2013) which reported a decrease in large farm size farmers in south-eastern Nigeria between 2005 and 2009.

5.1.5 Farming Category, Age Group and Household Size Group

Analysis of the age group distribution of heads of household in relation to their farming category shows the mean age of 47 years for small scale farmers, 54 years for medium scale farmers and 60 years for large scale farmers; it also shows a standard deviation of 12.03, 9.26 and 8.07 respectively (Table 5.3).

Table: 5.3 Farming category, age group and household size group of respondents

Farm Category	Age Group (Years)	Freq.	%	Mean	Household Size Group (Person/hh)	Freq.	%	Mean
Small **324**	25 –39	99	30.6	47 (12.03)	1 – 4	218	67.3	4 (1.81)
	40 – 60	179	55.2		5 - 9	106	32.7	
	61 - 76	46	14.2					
Medium **43**	25 –39	2	4.7	54 (9.26)	1 – 4	21	48.8	5 (1.86)
	40 – 60	30	69.8		5 - 9	22	51.2	
	61 - 76	11	25.6					
Large **33**	-	-	-	60 (8.07)	1 - 4	11	33.3	5 (1.90)
	40 –60	19	57.6		5 - 9	22	66.7	
	61 - 76	14	42.4					

Source: Field Survey, 2011 (N.B: The mean, Std. Deviation and variance were calculated from the real value of the data and not the range value; parenthesis indicates standard deviation)

Analysis indicates an increase in the mean age of farmers, moving from small farm size farmers to large farm size farmers. The literature suggests that this may be because of pressure on land and the fact that older farmers have more resources to acquire more land or more networks (extended family/friends) to lease-in land for their farming. A more detailed analysis shows that 30.6% of small farm size farmers are between 25 – 39 of age; with 4.7% of medium farm size farmers falling into this age group (25 – 39 years). None of the large farm size farmers are 25 – 39 years. This suggests the accumulation of lands by farmers as they grow older. This is consistent with reports on the state of agriculture in Nigeria and studies such as Fabusoro et al. (2010) as stated before.

The household size group of respondents (Table 5.3) shows a mean value of four members per household for small farm size farmers and five members per household for medium and large farm size farmers, respectively. This is consistent with other studies like Rahman, (2011) that recorded 5.43 persons per household among maize farmers in Bangladesh, and Fabusoro et al, (2010), Agwu, (2004), and Igwe, (2013) that showed that large farm size farmers have large household sizes in Nigeria. Their standard deviation was 1.81, 1.86 and 1.90 respectively. The data therefore shows that the percentage of 1 – 4 persons per household decreases with increasing farming scale. Likewise, it shows that the percentage of 5 – 9 persons per household increases with increasing farming scale.

In general, household sizes have been reducing in Nigeria from what they used to be in the 1960s and 1970s; we now have smaller household size, which may be due to an educational campaign by the government in the late 1980s and early 1990s and other factors like the economy and improvement in health care (NBS, 2010).

5.1.6 Farming Category, Educational Level Group and Years of Experience Group

Education is one of the main factors influencing the attitude of farmers towards the adoption of modern technology or new ideas; it is known to lead to willingness of rural people to adopt new ideas (World Bank, 2008). Educational level categories used in this study are in line with other studies in developing countries and Nigeria such as Rahman, (2011), Fabusoro et al (2010) and Igwe, (2013) for easy of comparison. Accordingly, they are low education (0 – 6) years, medium education (7 – 12) years and high education (13 – 18) years.

Table: 5.4 Farming category, educational level group and farming experience group of respondents

Farm Category	Educational Group	Freq.	%	Mean	Farming Experience Group	Freq.	%	Mean
Small	0 – 6	180	55.6	8.18	0 – 10	145	44.8	17.66
324	7 – 12	104	32.1	(4.84)	11 – 20	64	19.8	(12.91)
	13 – 18	40	12.3		21 – 50	115	35.5	
Medium	0 – 6	31	72.1	7.12	0 – 10	9	20.9	25.70
43	7 – 12	8	18.6	(4.49)	11 – 20	12	27.9	(13.38)
	13 – 18	4	9.3		21 – 50	22	51.2	
Large **33**	0 – 6	30	90.9	5.48	0 – 10	1	3.0	32.85
	7 – 12	3	9.1	(2.93)	11 – 20	5	15.2	(11.28)
	-	-	-		21 – 50	27	81.8	

Source: Field survey, 2011 (N.B: The mean, Std. Deviation and variance were calculated from the real value of the data and not the range value; parenthesis indicates standard deviation)

Analysis of the educational levels of respondents in relation to their farming category (Table 5.4) shows a mean value of 8.18, 7.12, 5.48 (standard deviation value of 4.84, 4.49, and 2.93) for small, medium and large farm size farmers, respectively. A more detailed analysis shows that the percentage of low education farmers increases as scale increases from small scale to large scale. This is consistent with the literature and in line with World Bank, (2008) which states that people with higher education are more likely to participate in wider non-farm employment.

Farming experience, perhaps not surprisingly, is known to influence levels of farm productivity; studies such as Ajibefun et al. (2002) show that technical inefficiencies in production are correlated closely to levels of farming experience of the farmers.

The farming experience category of respondents in relation to their farming scale (Table 5.4) shows a mean value of 17.66, 25.70, 32.85 and standard deviation value of 12.91, 13.38, and 11.28 for small, medium and large farm size farmers, respectively. Further analysis shows that the percentage of low experience farmers decreases as scale increases from small scale to large scale farms. This is consistent with other reports (NEEP, 2010), on the state of agriculture in Nigeria and studies like Nwibo, (2012); Fabusoro et al (2010) and Igwe, (2013) which show that large scale farmers have more farming experience. This is also not surprising in view of the age/scale relationship referred to earlier in this study.

5.2 Production Practices of Respondents

The aim of this sub-section is to measure the inputs used by the respondents in crop production in the study area; inputs such as human labour, labour used for ploughing, seed, fertilizers, pesticides, manure and irrigation are assessed.

5.2.1 Human Labour

Human labour is one of the most important inputs for crop production; it is broadly classified into two groups, family and hired labour; in this study it refers to all the labour involved in crop production such as planting, weeding, farm management and harvesting, with the exclusion of labour used for ploughing which is discussed in the next section. Family labour includes the farm operator himself and other labour from members of his/her family; hired labour includes casually and/or permanently hired labour. The cost of family labour was determined by applying the principle of opportunity cost, whilst the cost of hired labour was calculated from direct cash payment and expenses in kind for hiring labour (Table 5.5).

Table 5.5: Human labour used for rice, cassava and yam farming

Study Area	Farm Category	Percentage of Human Labour Used (Man-day/ha)								
		Rice			Cassava			Yam		
		Family	Hired	Total	Family	Hired	Total	Family	Hired	Total
Ebonyi State	Small	74.33	26.67	100 (60)	80.88	19.12	100 (68)	77.11	22.89	100 (83)
	Medium	67.65	32.35	100 (34)	70.37	29.63	100 (54)	69.81	30.19	100 (53)
	Large	68.97	31.03	100 (29)	75.00	25.00	100 (48)	68.75	31.25	100 (48)
	All Areas	**71.11**	**28.89**	**100 (45)**	**79.37**	**20.63**	**100 (63)**	**75.34**	**24.66**	**100 (73)**
Anambra State	Small	72.41	27.59	100 (116)	68.87	31.13	100 (106)	67.52	32.48	100 (117)
	Medium	63.49	36.51	100 (63)	68.29	31.71	100 (41)	61.11	38.89	100 (54)
	Large	70.97	29.03	100 (31)	70.45	29.55	100 (44)	68.75	31.25	100 (48)
	All Areas	**72.28**	**27.72**	**100 (101)**	**69.00**	**31.00**	**100 (100)**	**66.67**	**33.33**	**100 (108)**
All Areas	Small	72.94	27.06	100 (85)	76.25	23.75	100 (80)	72.63	27.37	100 (95)
	Medium	66.67	33.33	100 (36)	71.15	28.85	100 (52)	68.52	31.48	100 (54)
	Large	68.97	31.03	100 (29)	72.92	27.08	100 (48)	64.58	35.42	100 (48)
	All Areas	**71.43**	**28.57**	**100 (63)**	**75.68**	**24.32**	**100 (74)**	**72.62**	**27.38**	**100 (84)**

Source: Field Survey 2011 Note: (Figures in parenthesis are predicted human labour used)

As shown in Table 5.5, the human labour used/required for the farming of the crops varies significantly from crop to crop; therefore the human labour used for the crop production will be discussed separately. Human labour was measured in terms of man-days, usually 8 hours working time a day. In the case of women and children, man-day equivalent hours were estimated and computed by converting all women and children hours into man-day equivalent hours, assuming 1 adult man : 1.5 adult women : 2 children (Rahman, 2011).

Rice

Table 5.5 reveals that the mean human labour used by rice farmers in all areas was 63 man-day/ha, with a standard deviation of 44, of which 71% and 29% were family supplied and hired respectively. Perhaps not surprisingly, labour use decreases from 85 man-day/ha in small scale farms to 29 man-day/ha in large scale farms. The results for each state shows that in Ebonyi state, the mean human labour used by rice farmers was lowest, 45 man-day/ha, with standard deviation of 22, of which 71% and 29% were family and hired labour supplied respectively. Once again, there are decreases in labour use as scale increases; it is suggested by Igwe, (2013) that small scale farms are better managed than large scale farms in his study and that there is a shortage of labour in Ebonyi state due to migration to urban areas for better paid jobs.

In Anambra state, the mean human labour used for rice production was much higher at 101 man-day/ha, with standard deviation of 54, of which 72% and 28% were family and hired labour supplied respectively. Just as in Ebonyi state, labour use decreases as scale increases and the differences in the labour use in the two states reflects the fact that Anambra state is more urban/developed and workers migrate from Ebonyi state to work in farms in Anambra state for better pay.

Generally, the family provides most of the human labour used in farming in the study area and small scale farms use more human labour than large scale farms. This is partly because most small scale farmers go to their farm almost on a daily basis even when it is not necessary for them to go. In the words of one of the small scale farmers, “I always go to my farm every day, even if it is just to make sure everything is okay and I enjoy doing this”. The high labour use by small scale farms is reflected in their yield per hectare as shown in Chapter Six Table 6.1; this implies that they are better managed than large scale farms.

Cassava

The mean human labour used by cassava farmers in all areas was 74 man-day/ha, with standard deviation of 30 of which about 76% and 24% were family and hired labour, respectively. Again, human labour use decreases from 80 man-day/ha to 48 man-day/ha moving from small scale to large scale farms (Table 5.5).

The table also shows that human labour use for cassava farming in both states follows the same pattern as that of rice farms above. Human labour use for cassava farming in Anambra state is higher than that of Ebonyi state and the reasons are the same as the ones mentioned above. Also, most of the human labour used is from the family, and cassava yield as shown in Chapter Six shows that small scale farms have higher yield per hectare.

Yam

The mean human labour used by yam farmers in all areas was 84 man-day/ha, with standard deviation of 40 of which 73% and 27% were family and hired labour, respectively (Table 5.5). Just as for rice and cassava farms, human labour use decreases as farming scale increases in the study area. Human labour use for yam farming in both states follows the same trend as that of rice and cassava as discussed before.

Overall, human labour used by farmers in the study area decreases as respondents farming scale increases for all the crops (Table 5.5). The higher human labour usage by small scale farms and in Anambra state is reflected in their yield per hectare as shown in Table 6.1 in Chapter Six. Furthermore, the difference in labour usage in the two states has already been discussed before and studies such as Igwe, (2013) show that there is shortage of labour in rural areas due to migration to urban areas. The high labour use by small scale farms implies that they are better managed than large scale farms in most developing countries (Rahman, 2011).

5.2.2 Ploughing and Land Preparation Labour

Ploughing is the act of tilling the soil in readiness for planting; in this study, the term will refer to labour used for land preparation and tilling the soil. It is broadly classified into two groups, family ploughing labour and hired ploughing labour and is measured in man-day per hectare. The implements used for land preparation and ploughing are still crude (local machetes and hoes) and in the word of one of the farmers, “ I still use my local hoe and machetes for ploughing and land preparation, since tractors are not available, and even if they are available I cannot afford them”.

As before, the cost of family ploughing labour is determined by applying the principle of opportunity cost and the cost of hired ploughing labour is calculated from their direct cash payment and expenses in kind.

Rice

The mean ploughing labour used by rice farmer across the states, (Table 5.6) is 18 man-day/ha (Standard Deviation (SD) 10) of which 44% and 56% were family and hired ploughing labour, respectively. Ploughing labour decreases from 23 man-day/ha in small scale farms to 11 man-day/ha in large scale farms. This may be because of the difficulty in getting enough people to do the ploughing in large scale farms and in the words of one of the large scale farmers, "It is always a challenge getting enough people to do my ploughing. We do not have access to tractors and due to the large area cannot depend on family and friends".

While in Ebonyi state, the mean ploughing labour is 14 man-day/ha (SD 6) of which 36% and 64% were family and hired ploughing labour, respectively. Just as in all areas, ploughing labour decreases as farming scale increases; this implies that small scale farms use more ploughing labour than large scale farms. Likewise, in Anambra state, the mean ploughing labour was 25 man-day/ha (SD13) of which 56% and 44% were family and hired ploughing labour, respectively. Similarly, ploughing labour decreases as farming scale increases.

The table shows a relatively higher use of hired ploughing labour in the study area, and when you compare the two states, the percentage of hired ploughing labour is slightly higher in all farming categories in Ebonyi state than in Anambra state. This may be because Ebonyi state is a more rural state where farmers depend more on extended families and friends to do their ploughing.

Table: 5.6 Ploughing labour used for rice, cassava and yam production

Location	Farm Category	Percentage Ploughing Labour Used (Man-day/ha)								
		Rice			Cassava			Yam		
		Family	Hired	Total	Family	Hired	Total	Family	Hired	Total
Ebonyi State	Small	41.18	58.82	100 (17)	47.06	52.94	100 (17)	52.38	47.62	100 (21)
	Medium	18.18	81.82	100 (11)	40.00	60.00	100 (15)	37.50	62.50	100 (16)
	Large	27.27	72.73	100 (11)	37.50	62.50	100 (16)	41.18	58.82	100 (17)
	All	**35.71**	**64.29**	**100 (14)**	**47.06**	**52.94**	**100 (17)**	**50.00**	**50.00**	**100 (20)**
Anambra State	Small	58.62	41.38	100 (29)	56.67	43.33	100 (30)	50.00	50.00	100 (24)
	Medium	38.46	61.54	100 (13)	60.00	40.00	100 (15)	7.69	92.31	100 (13)
	Large	45.45	54.55	100 (11)	50.00	50.00	100 (14)	50.00	50.00	100 (14)
	All	**56.00**	**44.00**	**100 (25)**	**57.14**	**42.86**	**100 (28)**	**50.00**	**50.00**	**100 (22)**
All Areas	Small	52.17	47.83	100 (23)	52.38	47.62	100 (21)	52.17	47.83	100 (23)
	Medium	25.00	75.00	100 (12)	40.00	60.00	100 (15)	37.50	62.50	100 (16)
	Large	27.27	72.73	100 (11)	40.00	60.00	100 (15)	43.75	56.25	100 (16)
	All	**44.44**	**55.56**	**100 (18)**	**50.00**	**50.00**	**100 (20)**	**50.00**	**50.00**	**100 (20)**

Source: Field Survey, 2011 Note (Figure in parenthesis are predicted ploughing labour used)

In the words of one of the farmers from Ebonyi state, “I rely very much on my friends and extended family to help me out in ploughing and I in turn help them in theirs”.

Cassava

The mean ploughing labour used by cassava farmers in all area (Table 5.6) was 20 man-day/ha (SD 8) of which 50% were family and hired ploughing labour, respectively. Again just like in rice farms, ploughing labour decreases from 21 man-day/ha in small scale farms to 15 man-day/ha in both medium and large scale farms. The reasons are the same as those discussed for rice farms above.

In Ebonyi state, the average ploughing labour was 17 man-day/ha (SD 6) of which 47% and 53% were family and hired ploughing labour, respectively. Likewise, in Anambra state, the average ploughing labour was 28 man-day/ha (SD 9) of which 57% and 43% were family and hired ploughing labour, respectively. Ploughing labour in both states decreases as farming scale increases.

Overall, in all areas, medium and large scale farms have higher hired ploughing labour than small scale farms. This may be because they have better access to resources and can afford to hire ploughing labour while small scale farms depend more on family and friends. When you compare the two states, Ebonyi state has a relatively higher percentage of hired ploughing labour than Anambra state. This may be because Ebonyi state is a more rural state with better family and friends’ network as suggested by one of the farmers above and the shortage of ploughing labour in the urban areas. Also the table shows that Anambra state has a higher ploughing labour usage than Ebonyi state. This is reflected in the yield per hectare in the two states as stated before.

Yam

The mean ploughing labour used by yam farmers in all areas (Table 5.6) is 20 man-day/ha SD 7) of which 50% were family and hired ploughing labour, respectively. Again, just as in rice and cassava farms, ploughing labour decreases from 23 man-day/ha in small scale farms to 16 man-day/ha in large scale farms and the reasons are as mentioned before.

In Ebonyi state, the average ploughing labour was 20 man-day/ha (SD 6) while in Anambra state, the average ploughing labour was 22 man-day/ha (SD 7) of which 50% were family and hired ploughing labour, respectively in both states. Ploughing labour use in both states decreases as farming scale increases and the reasons are as discussed before. Anambra state has a slightly higher ploughing labour usage than Ebonyi state and small scale farms consistently have the highest ploughing labour usage in the study area.

Generally, comparing ploughing labour used, apart from rice farmers in Anambra state; cassava and yam farmers consistently have slightly higher ploughing labour usage in the study area. This may be because cassava and yam are more labour intensive because they need bigger soil heaps (yam and cassava planting beds are bigger than those of rice) and use of ploughs rather than rice, which only needs a flat bed.

Ploughing labour source is almost evenly distributed between family and hired labour, apart from medium scale yam farmers in Anambra state where the farmers said they are too old and had to use mostly hired labour. Also, this may be due to shortage of labour; most farmers do their ploughing themselves or rely on extended families and friends as stated before. Small size farms consistently have the highest ploughing labour usage in the study area; this implies that small size farms are better managed than other farm categories. This is reflected in the yield per hectare among the farm categories (Chapter 6, Table 6.1) that shows that small size farms are the most productive farm category.

5.2.3 Variety Used and Seed Rate

This section will considers the different varieties (local or improve variety) and seed rate used by farmers for rice, cassava and yam production; the type of variety used is very important because of its effect on productivity. Studies such as Rahman, (2011) and Obasi et al. (2013) indicate the importance of variety used by farmers in their respective studies. Due to the significant differences in the crops, the varieties used and seed rates will be discussed individually for the crops.

Rice

Rice is a very important strategic and daily staple food crop in Nigeria. The potential land area for rice production in Nigeria is between 4.6 million to 4.9 million hectares (ha), of which only about 1.7 million ha or 35% of available land area is presently cropped (WARDA, 2013). Small-scale farmers, with holdings of less than 1 ha, produce most of the rice in Nigeria; however, WARDA, (2013) states that rice production at farm level is constrained by several factors, such as insufficient appropriate technology, poor supply of inputs, low yield, quality of local varieties, lack of irrigation facilities and poor extension systems among others. Farmers in the study area use various types of rice variety such as mass bullet (20%), R-Box (12%), Fadama (10%) and local varieties (equalizer/kporokporo (58%). Due to the non-availability of seed from ADP when needed, most farmers source their seed from their own previous harvest, other farmers and/or their local market. This has led to the dilution of the quality of seed available and hence more needs to be done to address this problem by the government.

Table 5.7 shows that across the two states, the mean seed rate for rice was 60kg/ha; a more detailed breakdown showed that small scale farms use the highest seed rate of 74 kg/ha followed by medium scale farms (44 kg/ha) and large scale farms (38 kg/ha). This is below the Recommended Seed Rate (RSR) of 80kg/ha and also depends on the viability of the seed (WARDA, 2013). The actual seed rate to be used is dependent upon a range of factors including the variety, viability, area to be planted, percentage germination and percentage filled grain (ibid).

The mean seed rate used by farmers in both Ebonyi and Anambra states is below RSR stated above; and seed rate usage in the study area decreases as the farming scale increases. This may be due to the difficulty in sourcing HYV from ADP and resultant cost implication. The table reveals that most of the farmers in Anambra state bought their seeds. This is because of poor harvest last season and in the words of one Anambra rice farmer, “Had to buy most of my seeds for planting this year because of poor harvest last year; hopefully, this will not happen again”.

Cassava

Cassava is grown in over 90 countries and is the third most important source of calories in the tropics, after rice and maize (Tsegia et al, 2002). It is a staple for half a billion people in Africa, Asia and Latin America; it is grown mainly by poor farmers, many of them woman and often in marginal lands.

Table 5.7: Percentage mean seed rates for rice, yam and cassava stem cutting

Study Area	Farm Category	Percentage Seed rate of crops (kg/ha)								
		Rice			Cassava stem cutting			Yam		
		Own	Bought	Total	Own	Bought	Total	Own	Bought	Total
Ebonyi State	Small	86.11	13.89	100 (72)	94.74	5.26	100 (114)	76.53	23.47	100 (1244)
	Medium	95.45	4.55	100 (44)	94.34	5.66	100 (106)	88.36	11.64	100 (1134)
	Large	100	-	100 (39)	96.08	3.92	100 (102)	84.69	15.31	100 (1032)
	All	**90.91**	**9.09**	**100 (55)**	**94.64**	**5.36**	**100 (112)**	**79.48**	**20.52**	**100 (1199)**
Anambra State	Small	16.67	83.33	100 (78)	54.84	45.16	100 (124)	28.28	71.72	100 (1061)
	Medium	-	100	100 (53)	100	-	100 (93)	50.40	49.60	100 (873)
	Large	78.38	21.62	100 (37)	100	-	100 (97)	85.10	14.90	100 (960)
	All	**21.43**	**78.57**	**100 (70)**	**58.68**	**41.32**	**100 (121)**	**33.49**	**66.51**	**100 (1045)**
All Areas	Small	52.70	47.30	100 (74)	80.51	19.49	100 (118)	61.04	38.96	100 (1178)
	Medium	88.64	11.36	100 (44)	94.34	5.66	100 (106)	86.28	13.72	100 (1115)
	Large	94.87	5.13	100 (39)	97.03	2.97	100 (101)	84.80	15.20	100 (1013)
	All	**65.00**	**35.00**	**100 (60)**	**83.48**	**16.52**	**100 (115)**	**66.75**	**33.25**	**100 (1152)**

Source: Field Survey, 2011 Note (Figure in parenthesis are predicted seed rate used)

For these people and their families, cassava is vital for food availability and income generation and it is a major source of commercial feed, fibre for paper and textile manufacturers and starch for food and pharmaceutical industries (Tsegia et al, 2002 and CGIAR, 2011).

Global production of cassava has nearly doubled over the past 30 years to about 230 million tons in 2010, with over half of this grown in Africa, a third in Asia and 14% in Latin America. Major producers are Brazil, Indonesia, Thailand, the Democratic Republic of Congo and Nigeria, which is the largest producer, growing 38 million tons in 2010 (CGIAR, 2011). In Nigeria, the crop is common and grown in 24 of the 36 states; nearly 90% of cassava produced is for domestic consumption and is usually produced by smallholder farmers (ibid). The fact that the country still spends at least US$680 million annually on the importation of flour, starch, glucose and animal feed, which are made from processed cassava, has led to the development of cassava flour inclusion policies and programs like the Cassava Plus Project in Nigeria (Research interview in this study (IFDC), 2011 and DADTCO, 2013).

The production of cassava is dependent on the supply of quality stem cuttings but the multiplication rate of this vegetative planting material is very low when compared with other grain crops that are propagated by seed. Stem cuttings are bulky and highly perishable as they dry up within a few days (IITA, 2013). In this study, 60% of respondents that grow cassava use HYV stem cuttings (TMS 30572, NR 8082, NR 8083 and TMS 92/0326) and 40% use local variety (Kam kam, Tobe ofe and Iwu ocha). Farmers source their planting materials either from their reserves, fellow farmers, and local markets and/or from the ADP office.

Table 5.7 shows that in all areas, the stem rate is 115kg/ha (3kg = 1 bundle), of which 83% and 17% were family and bought stems, respectively. This is below the recommended stem planting rate of 180kg/ha (60 bundles/hectare) that is advised by IITA, (2013). Also stem rate decreases from 118kg/ha to 101kg/ha respectively for small and large scale farms. The reasons are the same as mentioned for rice farmers above.

The table also shows that cassava stem rate usage in both Ebonyi and Anambra states is below the RSR stated above. Small scale farms consistently have the highest stem rate usage in the study area and farmers in Anambra state have a slightly higher stem rate usage than those in Ebonyi state. This is reflected in the yield per hectare of cassava as shown in Table 6.1 in Chapter Six. Also there are problems of effective supply channels, cassava stems are too bulky and have a tendency to quickly dry up if not used as soon as possible; most of the stems used in the study area are the farmers own reserves.

Yam

Yam tuber, like other root crops is essentially a starchy or carbohydrate food with the principal function of supplying calories to the body; it is a staple food for at least 60 million people in West Africa (IITA, 2013b). Yams are usually prepared for consumption in a variety of ways which includes boiling, frying, baking, processing to yam flour, pounded yam and yam pottage. Apart from its nutritional value, yam plays an important role in social and religious festivals; in many areas in West Africa, it is a vital integral part of the cultural heritage of the people and occupies an important place in many traditional marriages and traditional religious festivals (Oguntade et.al, 2010).

Yam production in Nigeria has more than tripled over the past 45 years, from 6.7 million tonnes in 1961 to 39.3 million tonnes in 2006 (FAO, 2007). This increase in output is attributed more to increases in land area planted than an increase in productivity; though the cultivated area has increased production, average yield per hectare has declined drastically from 14.9% in 1986 – 1990 to 2.5% in 1996 – 1999 (CBN, 2002, Agbaje et.al,2005; FAO, 2007; Nwosu and Okoli; 2010). Nigeria is the largest producer of yam in the world, contributing two-thirds of global yam production (NBS, 2012). In this study, 80% of the respondents that grow yam use local varieties (Iguma, Akiri Obialuogo etc.) and the remaining use HYV. Yam seed production is costly and farmers keep about 30% of their harvest as seed yam for next season (IITA, 2013b); in line with this, most of the respondents source their yam seed from their reserves, others from their local markets and a few from ADP.

Table 5.7 shows that in all areas, the seed rate is 1152kg/ha (1kg = 8 cuttings) of which 67% and 33% were own and bought seeds respectively; it also shows that seed rate decreases from 1178kg/ha to 1013kg/ha for small and large scale farms respectively. This is below the RSR of about 12,000 (1500 kg/ha) cuttings per hectare (KAU, 2011).

The table also shows that the yam seed rate used in both Ebonyi and Anambra states is below the RSR stated above. Small scale farms consistently have the highest yam seed rate usage in the study area and farmers in Ebonyi state have a higher seed rate usage than those in Anambra state. The reasons are the same as those discussed for both rice and cassava farmers above.

Overall, apart from yam farmers in Ebonyi state, farmers from Anambra state consistently have higher seed rate usage for all the crops. Also small size farms consistently have the highest seed rate usage for all the crops in the study area and most of the seeds used are own seeds. Seed rate usage in the study areas decrease as the farming scale increases for all the crops in the study area. The reasons for this are as discussed before, and the seed rate usage by farmers in the study area for all crops are below the RSR. This highlights the difficulties in accessing HYV planting materials for all crops in the study area.

5.2.4 Fertilizer Application

Farmers in this study apply fertilizers such as Nitrogen Phosphorous Potassium 15:15:15 (NPK 15:15:15), NPK and Urea based fertilizers and liquid fertilizer. Almost all the respondents complained about the cost, their unavailability when needed, the long distance they have to travel to the city and the quality of the fertilizer available in their local market. The types of liquid fertilizer mostly used by respondents in this study are DR Earth liquid solution concentrated and AG Grand natural fertilizer. The price of fertilizer in the study area depends on the source; it is most expensive in the local market and cheapest if the farmers are lucky to buy from the ADP office.

Fertilizer Application for Rice

Only 59.44% of rice farming respondents use any kind of chemical fertilizer for their farming (44.71% and 55.29% from Anambra and Ebonyi states, respectively). A more detailed breakdown of the type of fertilizer shows that 85.9% of farmers use NPK 15:15:15, 7.1% Urea and 7.1% use liquid fertilizer. Fertilizer should be applied based on the quality and residual nutrients found in the soil after soil testing, and the type of fertilizer applied will depend on what is available to the farmers. Rice variety (Lowland or Upland rice) will also determine the type of fertilizer that should be used, since some of the rice strains respond better to different kinds of fertilizer. Since soil testing is not easily available in developing countries like Nigeria, the general recommended advice is the application of fertilizers in two stages. First, nitrogen based fertilizer should be applied at about one week before transplanting and worked well into the soil at the rate of 60 – 80 kg/ha; after this, phosphorus or urea based fertilizer should be applied 6-8 weeks after transplanting at the rate of 30kg/ha (Agriculture-Food Canada , 2007; IITA, 2008; WARDA, 2013).

Table 5.8 Respondents' fertilizer application in relation to study area and farm category

Study Area	Farm Category	Respondents mean fertilizer application (Kg/ha)					
		Rice Farmer	Percentage of Farmer	Yam Farmer	Percentage of Farmer	Cassava Farmer	Percentage of Farmer
Ebonyi State	Small	153.71	36.17 (17)	168.18	53.66 (22)	105.32	63.64 (21)
	Medium	99.11	29.79 (14)	103.72	24.39 (10)	65.92	21.21 (7)
	Large	84.51	34.04 (16)	119.44	21.95 (9)	99.33	15.15 (5)
	All	**113.89**	**55.29 (47)**	**141.76**	**37.96 (41)**	**96.05**	**33.00 (33)**
Anambra State	Small	134.00	81.58 (31)	162.74	92.54 (62)	141.66	92.54 (62)
	Medium	133.33	5.26 (2)	300.00	1.49 (1)	160.00	1.49 (1)
	Large	72.22	13.16 (5)	101.67	5.97 (4)	101.94	5.97 (4)
	All	**125.84**	**44.71 (38)**	**161.14**	**62.04 (67)**	**139.57**	**67.00 (67)**
All Areas	Small	140.98	56.47 (48)	164.16	77.78 (84)	132.47	83.00 (83)
	Medium	103.38	18.82 (16)	121.57	10.19 (11)	77.68	8.00 (8)
	Large	81.58	24.71 (21)	113.97	12.04 (13)	100.49	9.00 (9)
	All	**119.23**	**59.44 (85)**	**153.78**	**36.73 (108)**	**125.21**	**29.07 (100)**

Source: Field Survey 2011 (Figures in parenthesis are predicted farmers frequency)

Table 5.8 shows that in all areas, rice farmers use 119.23kg/ha of fertilizer and that 140.98 kg/ha, 103.38 kg/ha, 81.58 kg/ha were used by small, medium and large scale farmers respectively; compared with the recommended application rate of 110kg/ha. The mean fertilizer application by farmers in Anambra and

Ebonyi states is above the Recommended Fertilizer Rate (RFR) stated above, and small scale farmers apply the most fertilizer in the study area.

Comparing fertilizer usage in Anambra and Ebonyi states, Table 5.8 shows that even though Ebonyi state has a higher percentage of farmers using fertilizer, Anambra state has a higher mean usage (125.84 kg/ha). It is to be noted that apart from small scale farmers, most other farm categories apply far lower rates than the RFR. This is mainly due to the issues mentioned above; in the words of one of the respondents, “I don’t have the money to buy enough fertilizer for my farm and it is not readily available; more needs to be done to teach us the best way to apply it”.

Overall, the percentage of rice farmers using adequate fertilizer rates is very low, especially among medium and large farm size farmers, and more needs to be done to address this situation. In the words of one of the large farm size respondents, “My problem is not the cost of the fertilizer but its availability when needed; the government (ADP) sells fertilizer to farmers not according to their farm size but ration it per farmer not minding their farming scale”.

Fertilizer Application for Cassava

Only 29.07% of the cassava farming respondents use some kind of chemical fertilizer for their farming (67% and 33% were from Anambra and Ebonyi states, respectively). More detailed analysis of the type of fertilizer shows that 61% use NPK/Urea based compound fertilizer and 39% use liquid fertilizer. Fertilizer is usually applied at 8 weeks after planting, in a ring of about 6cm - 10cm from the plant, or it is broadcast, with care, around the plant making sure the fertilizer does not touch the stem or leaves. The Recommended Fertilizer Rates (RFR) for cassava is dependent on the soil type, nutrient level in the soil and the type of fertilizer available. The RFR are NPK 15:15:15 (600kg/ha); NPK 20:10:10 (450kg/ha) and NPK 12:12:17 (750kg/ha) depending on the fertilizer available to the farmer (IITA, 2013).

The fertilizer application rates of respondents are shown in Table 5.8. The table shows that in all areas, cassava farmers only use 125.21 kg/ha (132.47 kg/ha, 77.68 kg/ha, 100.49 kg/ha used by small, medium and large scale farmers, respectively) which is below the RFR stated above. The mean fertilizer application in Anambra and Ebonyi states is also below the RFR. It is also noted that small scale farms apply the most fertilizer in the study area except in Anambra state. Comparing fertilizer applications in Anambra and Ebonyi states, Anambra state has a higher percentage (67%) of farmers that apply fertilizer and a higher mean usage. The overall findings of this study are consistent with similar studies such as Igwe, (2013) and Obasi et al. (2013) that also show low fertilizer applications.

Fertilizer Application for Yam

Only 36.73% of yam farming respondents use any kind of chemical fertilizer for their farming, (62.04% and 37.96% were from Anambra and Ebonyi states, respectively). A detailed analysis of the type of fertilizer shows that 72.2% use NPK 15:15:15, 0.9% Urea and 26.9% liquid fertilizer, respectively. Fertilizer application should be split, to minimize fertilizer leaching; the first application being made about one month after emergence of the plant and the second about 7 – 9 weeks later. The RFR is about 200-400kg/ha of compound fertilizer, depending on the type available (Law-Ogbomo and Remison, 2008 and Hawaii University, 2013).

Table 5.8 shows that in all areas, the farmers only use 153.78 kg/ha fertilizer (164.16 kg/ha, 121.57 kg/ha, 113.97 kg/ha respectively used by small, medium and large scale farms); this is below the RFR. The mean fertilizer application rates for Anambra and Ebonyi states are below the RFR mentioned above. Small scale farms have the highest mean fertilizer application in the study area apart from Anambra state; they also have the highest percentage of fertilizer users in the study area.

Overall, apart from small scale rice farmers, fertilizer application in the study area is below the RFR for all crops. Small scale farms consistently have the highest mean fertilizer application in the study area, except for yam and cassava farms in Anambra state; they also have the highest percentage of fertilizer users in the study area. Just as mentioned before, the system of fertilizer allocation by the government (ADP) needs to be addressed to reflect the farming scale of the farmers. Finally, some of the constraints affecting fertilizer application have already been discussed in this section but more detailed discussion will be done in Chapter Nine.

5.2.5: Pesticide Application

Farmers in the study areas spray their farms with pesticides to protect their crops from the attack of pest and diseases. For example, rice farmers protect their crops against pest and diseases like borers, army worm and blast diseases. Yam farmers protect against beetle and yam nematode; and cassava farmers protect against mosaic disease and mealy bugs (IITA, 2008; Hawaii University, 2013 and FAO, 2014).

For ease of discussion, the pesticides used have been divided into Selective pesticides (Oriyzo-plus, Dithane M-45, Round-up, Saro set and Dexate) and

Non-selective pesticides (Attacke, Bordeaux, No-pest and Benlate). The pesticides are sold to farmers in concentrated pre-prepared (Litres) form, who then are advised to dilute further, before applying to their land. This makes it difficult to determine the quality and strength of pesticide use; so a degree of care is needed in the analysis of such data. The price of pesticide depends on where the farmer buys it from; it is most expensive in their local market and more favourable if they are able to buy from the ADP office. The major constraints in the use of pesticide identified in this study are the quality of those sold in the local market, its availability when needed and knowledge of how best to apply it; more detailed discussion of these constraints is in Chapter Nine.

Table: 5.9 Respondents pesticide applications in relation to study area and farm category

Study Area	Farm Category	Respondents mean pesticide application (Litres/ha)					
		Rice Farmer	Percentage of Farmer	Yam Farmer	Percentage of Farmer	Cassava Farmer	Percentage of Farmer
Ebonyi State	**Small**	3.47	41.03 (16)	4.13	77.78 (21)	5.50	75.00 (15)
	Medium	1.77	25.64 (10)	2.51	7.41 (2)	5.00	5.00 (1)
	Large	1.79	33.33 (13)	2.75	14.81 (4)	3.68	20.00 (4)
	All	**2.47**	**54.17 (39)**	**3.80**	**28.42 (27)**	**5.11**	**22.22 (20)**
Anambra State	**Small**	2.32	84.85 (28)	5.07	98.53 (67)	5.34	98.57 (69)
	Medium	5.33	3.03 (1)	4.00	1.47 (1)	1.60	1.43 (1)
	Large	0.82	12.12 (4)	-	-	-	-
	All	**2.23**	**45.83 (33)**	**5.06**	**71.58 (68)**	**5.29**	**77.78 (70)**
All Areas	**Small**	2.74	61.11 (44)	4.85	92.63 (88)	5.37	83.33 (84)
	Medium	2.09	15.28 (11)	3.01	3.16 (3)	3.30	2.22 (2)
	Large	1.56	23.61 (17)	2.75	4.21 (4)	3.68	4.44 (4)
	All	2.36	**72**	**4.70**	**95**	**5.25**	**90**

Source: Field Survey 2011 (Figures in parenthesis are predicted frequency)

Pesticide Application for Rice

Only 50.35% of rice farming respondents uses any kind of pesticide for their rice farming (45.83% and 54.17% from Anambra and Ebonyi states). 70.8% of them use selective and 29.2% use non-selective pesticides. The Recommended Pesticide Rates (RPR) of most pesticides such as Dithane M-45 at 1ka/ha or Benlate at 1.5ka/ha, is to be dissolved in 500 litres of water (WARDA, 2013). The farmers now buy this dissolved pesticide and further dilute them before applying to their land, thereby making it difficult to determine the quality of the applied pesticide as mentioned before.

Table 5.9 shows that in all areas, rice farmers only use 2.36 litres/ha, and 2.74 litres/ha, 2.09 litres/ha and 1.56 litres/ha, respectively for small, medium and large scale farms. It also noted that the mean pesticide application for both Anambra and Ebonyi states is 2.23 litres/ha and 2.47 litres respectively. Pesticide application in the study area is far below the RPR mentioned above and small scale farms have the highest mean pesticide application in the study area except in Anambra state. The reasons for the low application of pesticide in the study area may be related to the constraints mentioned before.

Pesticide Application for Cassava

Only 26.16% of cassava farming respondents uses any kind of pesticide for their farming (77.78% and 22.22% from Anambra and Ebonyi states, respectively). In addition, only 25.8% of them use selective pesticides compared with 74.2% using non-selective pesticides. Table 5.9 shows that in all areas the respondents use 5.25 litres/ha and that 5.37 litres/ha, 3.30 litres/ha, 3.68 litres/ha, were respectively used by small, medium and large scale farms. Just like in all areas, the mean pesticide application in both Anambra and Ebonyi states is below the RPR stated above. Small scale farms consistently have the highest mean pesticide application and highest percentage of pesticide users in the study area.

Pesticide Application for Yam

Only 32.31% of yam farming respondents uses any kind of pesticides for their yam farming (71.58% and 28.42% from Anambra and Ebonyi states, respectively). Most of the respondents use non-selective pesticides (60.6%) and others use selective (39.4%). Table 5.9 shows that in all areas, the respondents use only 4.70 litres/ha and that the mean pesticide application in both states and all areas is below the RPR. The trends in pesticide application for yam farmers are similar to those of rice and cassava farmers.

Generally, none of the large scale yam and cassava farmers in Anambra state use any pesticide; this may be because of the constraints mentioned before and the difficulty in getting enough pesticide to cover their land. Overall, pesticide application in the study area is far below the RPR for all the crops. Apart from rice farmers in Anambra state, small scale farms have the highest mean pesticide application and users in the study area.

5.2.6 Manure Application

Manure is the most important way to increase organic matter in the soil, due to the cost and poor level of availability of chemical fertilizer when needed. Most farmers use organic manure to boost the nutrient level and soil structure of their land. The kind of manure used in the study area is mostly animal dung (cow, goat, sheep and chicken) which farmers source from their farm animals, locally or from their local market. Only 11% of rice farming respondents use any organic manure on their farm compared with 35.70% and 30.20% of cassava and yam farming respondents, respectively.

Table 5.10: Respondents farm category and mean manure application

Farm Category	Respondents mean manure application (Kg/ha)		
	Rice Farmers	Yam Farmers	Cassava Farmers
Small	439.74	464.12	373.25
Medium	369.57	216.30	165.33
Large	184.09	221.07	183.02
All Areas	389.50	427.61	346.74

Source: Field Survey 2011

Manure applications according to farming categories are presented in Table 5.10; this indicates that in all areas yam farmers use the most manure (427.61Kg/ha), followed by rice farmers (389.50Kg/ha) and cassava farmers (346.74Kg/ha) respectively. This is consistent with findings in Sutherland, (2014) and Hawaii University, (2013) which reveal that yam is one of the crops that does well with good organic manure. It also shows that small scale farmers use the most manure, with yam farmers having the highest (464.12Kg/ha). Manure use in the study area is far below the Recommended Dose (RD), which is 4.60 – 5.53 t/ha; this is because animal dung is not easily or readily available and domestic animal rearing is not predominant in the study area (ibid).

5.2.7 Irrigation

Irrigation is a very important input for crop production. It is essential for optimal plant growth and better yields (Litchfield, et al. 2002). Of all the crops covered in this study, rice is the one that most needs irrigation for optimal plant growth and better yield; typically, it requires about 1200mm to 1600mm of rainfall, evenly distributed throughout its growing period (IITA, 2008). Agriculture in Nigeria mostly depends on rainfall as irrigation facilities are limited, especially in south-eastern Nigeria. Most of the functional irrigation facilities available are in the northern part of Nigeria, where production is most vulnerable to drought (WARDA, 2013). None of the respondents in this study used any irrigation for their farming but almost all of them said they would like to use it if it were available. In the words of one of the farmers, “I would like to have access to irrigation, especially for my rice farming, but have to make do with rainfall which is not very reliable, especially during the early stage of plant growth”.

Overall, Chapter 5 described in detailed the socioeconomic characteristics of the farmers (section 5.1 – 5.16) and some of the interesting findings are that 75% of the farmers are ≥ 40 years old; 60% have ≤ 6 years of schooling and 71% have ≥ 10 years of farming experience. The mean farm size of the respondents is 1.27ha and 81% of them are small scale farmers.

Details of the respondents’ crop production practices were discussed in Sections (5.2 – 5.2.6); none of the farmers use the recommended seed rate for the crops and their fertilizer and pesticide application are below the recommended rates for the crops. The reasons are discussed in more details in the constraints chapter (Chapter 9) and the level of fertilizer, pesticide and HYV seed application in the study area is very low but consistent with literature and similar studies. Yam and cassava farms have the highest human and ploughing labour usage in the study area as expected and the chapter in general evaluated the socioeconomic and production practices of the farmers.

Chapter Six

Productivity of Crops by Farm Category, Farm Enterprise, Profitability and Benefit Cost Ratio

6.0 Introduction

This chapter will discuss farm productivity in terms of crop yield (rice, yam and cassava) in the study area as this relates to the farming category of the respondents; it also assesses crop yield in relation to factors affecting yield. This is done in view of identifying the variables that will be included in the econometrics analysis in Chapter Seven and Eight. Yield was chosen as the main yardstick to measure crop productivity level because of the effects agricultural technology adoption has on it (Rahman, 2011).

The discussion will be divided into two sections, Section A will deal with crop yield in the study area and farm category, in relation to some key socioeconomic characteristics of the farmers. Section B will then discuss crop yield in the study area and farm category, in relation to some key farm production factors. This chapter also discusses farm profitability of the different crop enterprises (rice, yam and cassava) grown by farmers in the study area.

SECTION A

6.1 Crop Yield

The yields of the three main crops (rice, yam and cassava) grown by farmers in the study area and how they relate to their farm category is presented in Table 6.1.

Table 6.1: Respondents mean crop yield, study area and farm category

Study Area	Farm Category	Rice Yield (Kg/ha)	% of Farmer	Yam Yield (Kg/ha)	% of Farmer	Cassava Yield (Kg/ha)	% of Farmer
Ebonyi State	**Small**	3151.70	44.33 (43)	5169.40	69.61 (142)	12405.13	74.49 (181)
	Medium	2722.91	29.90 (29)	5095.59	19.12 (39)	12244.92	15.64 (38)
	Large	2797.64	25.77 (25)	4879.30	11.27 (23)	11906.31	9.88 (24)
	All	**2932.25**	**67.83 (97)**	**5122.58**	**69.39 (204)**	**12330.81**	**70.64 (243)**
Anambra State	**Small**	3120.63	80.43 (37)	6419.81	87.78 (79)	12724.15	89.11 (90)
	Medium	2466.67	4.35 (2)	5083.33	3.33 (3)	12000.00	2.97 (3)
	Large	2680.77	15.22 (7)	5134.58	8.89 (8)	12061.81	7.92 (8)
	All	**3025.26**	**32.17 (46)**	**6261.02**	**30.61 (90)**	**12650.18**	**29.36 (101)**
All Areas	**Small**	3137.33	55.94 (80)	5616.38	75.17 (221)	12511.08	78.78 (271)
	Medium	2706.38	21.68 (31)	5094.71	14.29 (42)	12227.00	11.92 (41)
	Large	2772.07	22.38 (32)	4945.18	10.54 (31)	11945.18	9.30 (32)
	All	**2962.17**	**(143)**	**5471.08**	**(294)**	**12424.58**	**(344)**
ANOVA F-value d.f		**19.32*** (2,140)**		**6.11*** (2,291)**		**1.84 (2, 341)**	

Source: Field Survey 2011 One- way ANOVA using generalised linear mode Note: *** significant at 1% level (p <0.01) and Figures in parentheses are estimated frequency

It should be noted that only 35.75% (143) of the respondents farm rice, of which 67.83% (97) are in Ebonyi state and 32.17% (46) are in Anambra state. Table 6.1 shows that the mean yield per hectare for rice farmers in all areas is 2962.17 kg/ha, (2932.25 kg/ha and 3025.26 kg/ha respectively for Ebonyi and Anambra states); the yield level is similar to those estimated by National Programme on Agricultural and Food Security (NPAFS) on their 2009 Crop, Area and Yield Survey (CAYS) (Chapter 4, Table 4.3). Furthermore, it reveals that most of the respondents growing rice are small scale farmers and that small scale farmers have the highest yield per hectare in the study area followed by large and medium scale farmers. This implies that small scale farms are the most productive, efficient and better managed of all farm categories.

For yam farming respondents, the table reveals that 73.50% (294) of the respondents farm yam, of which 69.39% (204) are in Ebonyi state and 30.61% (90) are in Anambra state; this is because of the limited level of response in Anambra state as noted in Chapter 3. The mean yield for yam in all areas is 5471.08 kg/ha, with 5122.58 kg/ha and 6261.02 kg/ha, respectively, for Ebonyi and Anambra states. The differences in yield in the two states may be related to their level of farm input usage and production practices as noted in Chapter 5. Generally, yam yield in the study area is poor when compare to the level estimated by NPAFS (Chapter 4, Table 4.3). In the words of one of the farmers, “Yield this year is very poor and this is because of the many cases of yam beetles this year”. Just like in rice farms, small scale farms have the highest yield per hectare in the study area and other trends followed the same pattern.

For cassava farming respondents, 86% (344) of the respondents farm cassava, of which 70.64% (243) are in Ebonyi state and 29.36% (101) are in Anambra state. The mean yield for cassava in all areas is 12424.58kg/ha, with 12330.81kg/ha and 12650.18kg/ha, respectively, for Ebonyi and Anambra states. The yield level is similar to those estimated by NPAFS (ibid) and the reasons for the differences in the states are the same as the ones mentioned for yam farmers above. Cassava yield pattern follows similar trends to those for rice and yam farms discussed above.

The one-way ANOVA result shows that yields are significantly different across the rice and yam farms. It also shows an inverse relationship between farm size-productivity with small scale farms producing the maximum yield in all three crops and the large scale farms producing the least (Table: 6.1). This confirms the hypothesis of possible inverse farm size-productivity relationship as specified in Chapter 1.

Overall, Anambra state has a higher yield per hectare over Ebonyi state in all the crops; this may be because as shown in Chapter Five; farmers in Anambra state have higher mean farm input usage (fertilizer, pesticide, ploughing labour etc.) than those from Ebonyi state and this is reflected in their yield per hectare. This indicates that a higher level of input usage (agricultural technology adoption) given other factors may lead to higher yield level. Also, just as mentioned before, the table shows that small scale farmers consistently have the best yield per hectare for all the crops in the study area; this finding is consistent with literature and similar studies like Rahman, (2011); Fabusoro et al, (2010) and Igwe, (2013) that show that small scale farms are better managed and productive in developing countries.

6.1.1 Age of Respondents In Relation To Crop Yield

This evaluates the relationship between the age of respondents and their crop yield per hectare in relation to the study area and farm categories. It is evident from Table 6.2 that in all areas 25 – 39 year old rice farming respondents have the highest yield per hectare (3070.17 kg/ha), followed by ≥ 61 and 40 – 60 year olds. Also across the farm categories, small scale farms have the highest yield per hectare, of which ≥ 61 years farmers have the highest yield. This indicates an inconsistent relationship between the age of farmers and rice yield in the study area.

Similarly, the trend in Ebonyi state followed a close pattern to that observed in all areas, but across the farm categories in the state, 25 – 39 years farmers have the highest yield per hectare, while in Anambra state, ≥ 61 years farmers have the highest yield and they also have the highest yield across the farm categories in the state. This may be because the younger farmers are more likely to be more educated and the older farmers more experienced, and as shown in Chapter Nine, extension services in the study area are not very effective and face lots of constraints.

Table 6.2: Yield per hectare of crops according to study area, farm category and age of respondents

Study Area	Farm Category	Rice Yield (Kg/ha) according to respondent age (Years)				Yam Yield (Kg/ha) according to respondent age (Years)				Cassava Yield (Kg/ha) according to respondent age (Years)			
		25 – 39	40 - 60	≥ 61	All	25 – 39	40 - 60	≥ 61	All	25 - 39	40 - 60	≥ 61	All
Ebonyi State	**Small**	3263.25	3132.79	3060.54	**3151.70**	5187.46	5169.66	5097.13	**5169.40**	12430.89	12316.77	12734.00	**12405.13**
	Medium	2000.00	2747.87	2751.88	**2722.91**	4807.69	5057.84	5255.09	**5095.59**	12583.33	12296.43	12043.29	**12244.92**
	Large	-	2764.24	2840.15	**2797.64**	-	4518.06	5348.91	**4879.30**	-	12039.74	11748.61	**11906.31**
	All	**3136.92**	**2923.13**	**2866.17**	**2932.25**	**5174.13**	**5067.98**	**5217.64**	**5122.58**	**12434.70**	**12283.73**	**12266.99**	**12330.81**
Anambra State	**Small**	2936.67	3065.00	3402.50	**3120.63**	5813.10	6367.48	6715.94	**6419.81**	13027.78	12312.02	12312.02	**12724.15**
	Medium	-	2400.00	2533.33	**2466.67**	-	4125.00	7000.00	**5083.33**	-	11800.00	12400.00	**12000.00**
	Large	-	2573.07	2950.00	**2680.77**	-	5383.33	4720.00	**5134.58**	-	12303.33	11659.26	**12061.81**
	All	**2936.67**	**2960.85**	**3241.21**	**3025.26**	**5813.10**	**6199.52**	**6504.69**	**6261.02**	**13027.78**	**12296.32**	**13511.16**	**12650.18**
All Areas	**Small**	3146.61	3102.10	3270.98	**3137.33**	5258.10	5650.75	6103.42	**5616.38**	12492.63	12314.80	13334.27	**12511.08**
	Medium	2000.00	2732.74	2720.66	**2706.38**	4807.69	4993.51	5413.71	**5094.71**	12583.33	12260.97	12075.72	**12227.00**
	Large	-	2713.93	2857.05	**2772.07**	-	4758.41	5203.78	**4945.18**	-	12112.96	11729.47	**11945.18**
	All	**3070.17**	**2935.04**	**2991.18**	**2962.17**	**5244.02**	**5442.93**	**5787.32**	**5471.08**	**12494.67**	**12288.17**	**12748.60**	**12424.58**

Source: Field Survey 2011

Therefore, any advantage the younger farmers may tend to have is cancelled by the ineffectiveness of extension services in the study area and the experience of the older farmers. This key main difference in the two states, (25 – 39 & ≥ 61 years) further highlights the inconsistences in the relationship between yield and age of respondents.

Generally, the correlation between the age of respondents and their yield per hectare appears to be highly inconsistent in the study area. Also, across the farm categories, ≥ 61 years farmers have the highest yield except for small scale rice farmers in Ebonyi state. But the size of differences in yield among the age groups across the farm categories is not significantly much. Some of these differences may be mere noise in the data set, so may not warrant close discussion.

For yam farming respondents, the table reveals that in all areas, yam farmers who are ≥ 61 years old have the highest yield per hectare (5787.32 kg/ha), followed by 40 – 60 and 25 – 39 year old farmers; the same trend was observed in both Anambra and Ebonyi states. This indicates a positive relationship between the age of yam farming respondents and their yield in the study area. This implies that the older the farmer the higher his yield per hectare; this is expected and consistent with most literature and similar studies. It also shows that small scale farms consistently have the highest yield per hectare in the study area, followed by medium and large scale farms, except in Anambra state where it is followed by large and medium scale farms. This underlines the importance of yam as a very important cultural crop in south-eastern Nigeria (New Yam Festival) and the fact that its farming is dominated by older men; in some places females are forbidden from farming yam.

For cassava farming respondents, the table reveals that across all areas, cassava farmers who are ≥ 61 years old have the highest yield (12748.60 kg/ha) followed by 25 – 39 and 40 – 60 year old farmers. Also across the farm categories, small scale farmers and older farmers have the highest yield. The pattern of relationship indicates an inconsistent correlation between the age of respondents and their yield in all areas.

Similarly, the trends in both states followed the same pattern as those observed in all areas, and across the farm categories in both states except in Anambra state where 25 – 39 years cassava small scale farmers have the highest yield.

Actually, taking all the crops together, there is a good degree of consistency in terms of relationship between yield for each crop and age of respondent. Overall, small scale farms consistently have the highest yield for all crop types in the study area and the oldest farmers have the highest yield across the farm categories for almost all the crops. Just as mentioned before, the degree of differences in yield among the age groups across the farm categories is not significantly much. However, deeper analysis indicates a major difference in the states; it reveals that among small scale farmers in Ebonyi state, younger farmers are achieving the best yield except for cassava. Therefore, the relationship between the crops and the age of respondents appears to be highly inconsistent. It is necessary to include the age of respondents as one of the variables in the regression analysis in Chapter Eight and to observe if it is significant or not.

6.1.2 Years of Farming Experience of Respondents in Relation to Crop Yield

Tentatively, it might be expected that greater years of farming experience would have a beneficial influence on production parameters such as yield per hectare. Just as expected, Table 6.3 reveals that in all areas, rice farmers with the greatest farming experience (≥ 26 years) have the highest yield and across the farming categories. This indicates a positive relationship between years of farming experience and yield in all areas.

The same trend was noted for both Anambra and Ebonyi states, and small scale farmers consistently have the highest yield across the farm categories in the study area. This implies that the greater the farming experience of the farmer, the more likely they are to have higher yield. This is consistent with literature and studies such as Rahman, (2011) and Obasi et al. (2013) that showed similar findings in their respective studies.

For the yam farming respondents, the table reveals a similar trend to that observed for rice farmers. It shows that in the study area, the farmers with the greatest farming experience have the highest yield except in Ebonyi state where those with the least experience have the highest yield, although the difference in yield is not much. Similarly, across the farming categories, small scale farms and farmers with the greatest farming experience have the highest yield in the study area except in Ebonyi state. This may be because Ebonyi state has a greater proportion of farmers with low experience than Anambra state. Also farmers with the least experience tend to be younger and better educated; but due to the effectiveness of extension services (Chapter Nine) in the study area, the difference in yield between the least and more experienced farmers is not significantly much.

Table 6.3: Yield per hectare of crops according to study area, farm category and respondent years of farming experience

Study Area	Farm Category	Rice Yield (Kg/ha) according to respondent years of farming experience				Yam Yield (Kg/ha) according to respondent years of farming experience				Cassava Yield (Kg/ha) according to respondent years of farming experience			
		≤ 10	11 - 25	≥ 26	All	≤10	11 - 25	≥ 26	All	≤10	11 - 25	≥ 26	All
Ebonyi State	Small	3142.01	3129.01	3211.41	**3151.70**	5234.19	5103.74	5041.32	**5169.40**	12424.83	12246.49	12580.94	**12405.13**
	Medium	2642.48	2691.56	2796.51	**2722.91**	5074.84	4971.54	5182.68	**5095.59**	12314.75	12504.41	12040.88	**12244.92**
	Large	1945.95	2873.82	2816.37	**2797.64**	4800.00	4998.35	4829.03	**4879.30**	12083.33	11723.81	11975.09	**11906.31**
	All	**2906.56**	**2921.42**	**2988.11**	**2932.25**	**5215.41**	**5062.97**	**5032.42**	**5122.58**	**12415.05**	**12237.09**	**12246.21**	**12330.81**
Anambra State	Small	2983.33	3095.00	3191.11	**3120.63**	5288.89	6493.85	6523.23	**6419.81**	12693.59	12454.17	12924.96	**12724.15**
	Medium	-	2400.00	2533.33	**2466.67**	3750.00	4500.00	7000.00	**5083.33**	12000.00	11600.00	12400.00	**12000.00**
	Large	-	2596.92	2743.65	**2680.77**	-	5111.11	5148.67	**5134.58**	-	12116.67	12028.89	**12061.81**
	All	**2983.33**	**2958.17**	**3084.69**	**3025.26**	**5069.05**	**6289.11**	**6402.55**	**6261.02**	**12644.05**	**12402.31**	**12826.82**	**12650.18**
All Areas	Small	3097.58	3114.43	3197.88	**3137.33**	5237.92	5668.47	6050.73	**5616.38**	12451.91	12337.53	12805.30	**12511.08**
	Medium	2642.48	2670.74	2774.58	**2706.38**	4927.64	4935.26	5273.54	**5094.71**	12279.78	12434.84	12059.78	**12227.00**
	Large	1945.95	2790.75	2802.52	**2772.07**	4800.00	5032.18	4908.94	**4945.18**	12083.33	11841.67	11987.90	**11945.18**
	All	**2974.84**	**2932.73**	**2987.03**	**2962.17**	**5204.96**	**5485.77**	**5698.63**	**5471.08**	**12438.12**	**12299.05**	**12517.87**	**12424.58**

Source: Field Survey 2011

For the cassava farming respondents, the table reveals that across all areas in the study area, farmers with the most experience have the highest yield except in Ebonyi state where those with the least experience have the highest yield. Also across the farm categories in the study area, the relationship between yield and years of farming experience is highly inconsistent. This may be due to the ineffectiveness of extension services in the study area as mentioned before and discussed in Chapter Nine.

Overall, taking all the crops together, the table shows that in all, in the study area, farmers with the most farming experience produce the highest yield except for yam and cassava farmers in Ebonyi state. Some of the reasons for this have already been discussed above. Similarly, across the farm categories in the study area, small scale farms consistently produce the highest yield per hectare for all the crops. Also there is a relatively more consistent relationship between yield and years of farming experience among rice and yam farmers, and farmers with the most years of farming experience produce the highest yield. While for cassava farmers, the relationship between yield and years of farming experience is more highly inconsistent especially among farmers in Ebonyi state and all areas. Therefore, years of farming experience is included as one of the variables in both the bivariate probit and regression analysis to ascertain if it has any significant effect or not.

6.1.3 Educational Level of Respondents In Relation To Crop Yield

As the previous section has revealed, there is a clear relationship between years of farming experience of farmers and production yield in some cases. However, there have been examples where small scale farmers with less experience produces better yield than those with more experience. This will be explored more in this section. Over all respondents, about 9.8% are illiterate, 50.5% have had some form of primary education, 28.8% have had secondary education and 11% have had above secondary education respectively.

Table 6.4 reveals that in all areas, above secondary education rice farmers have the highest yield (3055.95 kg/ha), followed by secondary, primary and illiterate farmers. This is expected and indicates that in all areas educational level has a positive relationship on yield. Also across the farm categories, small scale farms produce the highest yield and above secondary education small scale rice farmers produce the highest yield. This relationship is not consistent across the farm categories and this may be because of the issues surrounding agricultural extension services in the study area, as discussed before in this chapter.

Similarly, the trends in Ebonyi state followed the same pattern as that observed in all areas, while in Anambra state, illiterate farmers produce the highest yield but the differences in yield among the educational group level is significantly not much. Also across the farm categories in Anambra state, small scale farms produce the highest yield but the relationship between yield and educational group level is more inconsistent than in any other area.

For the yam farming respondents, the table reveals that in all areas, just like for rice farmers, above secondary school yam farmers have the highest yield per hectare (5607.46 kg/ha). While across the farm categories, small scale farms produce the highest yield but primary educated farmers produce the highest yield and thus the relationship between yield and educational level is not consistent.

Table 6.4: Yield per hectare of crops according to study area, farm category and respondents educational level

Study Area	Farm Category	Rice Yield (Kg/ha) according to respondents educational level					Yam Yield (Kg/ha) according to respondents educational level					Cassava Yield (Kg/ha) according to respondents educational level				
		Illiterate	Primary	Secondary	Above Sec	All	Illiterate	Primary	Secondary	Above Sec	All	Illiterate	Primary	Secondary	Above Sec	All
Ebonyi State	Small	3185.29	3124.16	3134.85	3280.00	3151.70	4770.26	5279.90	5141.52	5199.52	5169.40	12687.90	12306.33	12448.78	12376.22	12405.13
	Medium	2817.57	2688.99	2751.95	2697.62	2722.91	5054.97	5038.31	5369.58	4871.79	5095.59	12320.59	12199.19	12194.29	12491.67	12244.92
	Large	2660.12	2830.17	2785.79	-	2797.64	5143.97	4730.08	5322.22	-	4879.30	11710.29	11920.07	12089.68	-	11906.31
	All	2882.27	2892.94	3006.09	3061.61	2932.25	4909.23	5122.17	5176.33	5158.56	5122.58	12426.67	12218.17	12412.99	12389.80	12330.81
Anambra State	Small	3100.00	3169.09	3037.67	3033.33	3120.63	6146.67	6413.09	6251.19	6954.17	6419.81	12158.97	12881.37	13443.06	11603.70	12724.15
	Medium	-	2466.67	-	-	2466.67	-	5083.33	-	-	5083.33	-	12000.00	-	-	12000.00
	Large	-	2680.77	-	-	2680.77	-	5134.58	-	-	5134.58	-	12061.81	-	-	12061.81
	All	3100.00	3013.51	3037.67	3033.33	3025.26	6146.67	6194.36	6251.19	6954.17	6261.02	12158.97	12744.05	13443.06	11603.70	12650.18
All Areas	Small Farm	3148.74	3148.27	3095.98	3209.52	3137.33	5395.90	5857.18	5262.89	5683.56	5616.38	12423.44	12579.23	12584.36	12197.95	12511.08
	Medium	2817.57	2664.29	2751.95	2697.62	2706.38	5054.97	5043.50	5369.58	4871.79	5094.71	12320.59	12174.29	12194.29	12491.67	12227.00
	Large	2660.12	2788.34	2785.79	-	2772.07	5143.97	4864.92	5322.22	-	4945.18	11710.29	11965.42	12089.68	-	11945.18
	All	2923.09	2937.44	3015.66	3055.95	2962.17	5308.40	5568.91	5276.65	5607.46	5471.08	12327.24	12429.15	12537.85	12225.27	12424.58

Source: Field Survey 2011

Similarly, the trend in both states follows the same pattern as that observed in all areas. But across the farm categories in the states, even though a small scale farm produces the highest yield, the relationship between yield and educational level is not consistent. This follows similar patterns as those observed in the farming experience section and further highlights the inconsistences and the issues with agricultural extension services in the study area.

For the cassava farming respondents, the table shows that in all areas, secondary school level cassava farmers have the highest yield (12537.85 kg/ha). This seems to be an anomaly since the trend is different from those observed among rice and yam farmers. Likewise, across the farming categories, this anomaly continues and the relationship between yield and educational level is observed to be highly inconsistent when compared to those of rice and yam farms.

Similarly, the trend in both states follows the same pattern as that observed in all areas only that the inconsistences observed in the states are more than those in all areas. The anomaly observed in cassava farms may be due to the constraints associated with farm input availability, extension services and other barriers that are discussed later in Chapter 9.

When you take the crops together, rice and yam farmers with the greatest level of education produce the highest yield in the study area but the trend is not consistent across the farm categories. While for cassava farms, the trend seems to be an anomaly where farmers with the greatest level of education produce the least yield, this may be due to interference by other factors as mentioned above. As observed before, small scale farms consistently produce the highest yield in the study area for the entire crop, highlighting their importance in the food availability of the study area. Generally, the relationship between yield and educational level in the study area is observed to be inconsistent and highly inconsistent for cassava farms. Therefore it is included as a variable in the econometric analysis in Chapters Seven and Eight to observe if it has any significant effect.

6.1.4 Family Size of Respondents in Relation to Crop Yield

Just as observed in Chapter 5 (Section 5.2.1 and 5.2.2) and Section 6.1 of this Chapter, family size plays an important role in providing labour towards farm production in the study area. Since the mean family size in the study area is 4, the family size of respondents was divided into two sub groups (≤ 4 & ≥ 5 size family) to observe its effect on yield.

Taken as a whole, 62.5% of the respondents have a family size of four or less (≤ 4); with 37.5% having a family size of five or more (≥ 5). Table 6.5 reveals that in all areas, rice farmers with five or more family size have the highest yield (2962.17 kg/ha). Likewise, across the farm categories, small scale farms and farmers with higher family size produce the highest yield. This indicates a positive relationship between yield and family size and implies that the higher the family size, the more likely the yield is to be higher. This is consistent with studies such as Obasi et al. (2013) that observed a similar trend as long as the family members are engaged in the farming activities. Equally, the trend observed in both states, follows the same pattern as that in all areas, except across the farm categories in Ebonyi state where farmers with smaller family size have the highest yield. But this difference in yield is not significant enough to warrant close discussion and may be due to noise in data set.

Table 6.5: Yield per hectare of crops according to study area, farm category and respondent family size

Study Area	Farm Category	Rice Yield (Kg/ha) according to respondent family size			Yam Yield (Kg/ha) according to respondent family size			Cassava Yield (Kg/ha) according to respondent family size		
		≤ 4	≥5	All	≤ 4	≥ 5	All	≤ 4	≥ 5	All
Ebonyi State	**Small**	3162.98	3144.32	**3151.70**	5141.77	5218.71	5169.40	12490.32	12224.47	**12405.13**
	Medium	2618.99	2819.90	**2722.91**	4910.75	5271.19	5095.59	12304.37	12185.47	**12244.92**
	Large	2679.02	2864.36	**2797.64**	4994.51	4817.85	4879.30	11590.56	12064.18	**11906.31**
	All	**2863.69**	**2980.36**	**2932.25**	**5094.59**	**5161.00**	**5122.58**	**12418.78**	**12188.93**	**12330.81**
Anambra State	**Small**	2961.74	3381.67	**3120.63**	6457.05	6348.09	6419.81	12820.98	12548.65	**12724.15**
	Medium	-	2466.67	**2466.67**	3750.00	5750.00	5083.33	12000.00	12000.00	**12000.00**
	Large	2517.30	2746.15	**2680.77**	5791.67	4915.56	5134.58	12500.00	11915.74	**12061.81**
	All	**2926.18**	**3143.21**	**3025.26**	**6383.64**	**6068.33**	**6261.02**	**12796.99**	**12426.28**	**12650.18**
All Areas	**Small**	3047.27	3227.39	**3137.33**	5620.05	5609.65	5616.38	12596.28	12339.74	**12511.08**
	Medium	2618.99	2778.35	**2706.38**	4852.71	5314.71	5094.71	12289.15	12167.80	**12227.00**
	Large	2649.61	2836.22	**2772.07**	5153.94	4845.77	4945.18	11772.45	12023.70	**11945.18**
	All	**2887.73**	**3024.21**	**2962.17**	**5504.40**	**5423.45**	**5471.08**	**12528.12**	**12260.31**	**12424.58**

Source: Field Survey 2011

For the yam farming respondents, the table shows that in all areas, yam farmers with four or less family size have the highest yield (5504.40 kg/ha). This indicates a negative relationship between yield and family size. This is not expected but a more detailed analysis shows that the differences in yield are not significantly much. Also across the farm categories, small scale farms and farmers with the least family size produce the highest yield except for medium scale farms.

Likewise, the trend observed in Anambra state follows a similar pattern as that observed in all areas, while in Ebonyi state, farmers with higher family size produce higher yield except for large scale farms, although the difference is significantly not much. This indicates an inconsistent positive relationship between yield and family size in Ebonyi state.

For the cassava farming respondents, the table shows similar trends to those observed for yam farms. It shows that farmers with less family size (≤ 4) produce the highest yield in all areas and across the farm categories. This indicates a negative relationship between yield and family size in the study area.

The trend observed for both states is similar to that in all areas and the same trend follows up even across the farm categories except for large scale farms in Ebonyi state. This is not expected and just as mentioned before, detailed analysis indicates that the differences in yield is not enough to warrant much discussion on it.

Overall, taking the crops together, small scale farms consistently produce the highest yield as observed before in the study. The relationship between yield and family size is more consistent for rice farms and more inconsistent for yam and cassava farms. Yam and cassava farmers with a smaller family size produce the highest yield in the study area, which is in line with Obasi et al. (2013) observation in his study that family size has a positive relationship with yield as long as the family members are engaged in the farming activities. Therefore this variable is included in the econometric analysis in Chapter Seven & Eight to observe if they have any significant effects.

6.1.5 Distance to Extension Office of Respondent in Relation to Crop Yield

Tentatively, it is expected that the closer a farmer is to the extension centre/office, the more likely he is to come into contact with an extension agent; and the most likely the farm yield is to increase as a result of this. Taken as a whole, 71.5% of the respondents stated their distance to the nearest extension office. The respondents were then divided into two sub groups, those that are ≤ 9 km from the extension office and others that are ≥ 10 km in line with the mean distance to the extension office. The result is presented in Table 6.6.

The table reveals that across all areas, rice farmers that are closer (≤ 9 km) to the extension office produce the better yield. The same trend was observed across the farm categories. This finding is in line with Ayansina, (2011) who observed in his study that farmers with more contact with extension agents have higher yield. The trend observed in Ebonyi state is consistent with that observed across all areas, but differs from those in Anambra state. This may be because Anambra state is more developed with a better road network, as observed in Chapter Four.

For the yam farming respondents, the table shows a similar trend to that observed for rice farms. Farmers that are closer to the extension office consistently have the better yield in the study area.

Table 6.6: Yield per hectare of crops according to study area, farm category and respondent distance to extension office

Study Area	Farm Category	Rice yield (Kg/ha) according to respondent distance to extension office (Km)			Yam yield (Kg/ha) according to respondent distance to extension office (Km)			Cassava yield (Kg/ha) according to respondent distance to extension office (Km)		
		≤ 9	≥ 10	All	≤ 9	≥ 10	All	≤ 9	≥ 10	All
Ebonyi State	Small	3168.76	3057.91	**3152.93**	5159.47	5115.98	**5156.32**	12428.06	12277.97	**12414.42**
	Medium	2706.40	2520.00	**2692.06**	5100.04	5080.00	**5098.93**	12255.76	12866.67	**12290.67**
	Large	2833.65	1933.33	**2797.64**	4880.18	4860.00	**4879.30**	11938.04	11176.47	**11906.31**
	All	**2940.91**	**2813.42**	**2928.58**	**5115.09**	**5090.75**	**5113.49**	**12349.56**	**12281.97**	**12344.09**
Anambra State	Small	3397.22	3100.00	**3100.00**	5814.44	5288.89	**5709.33**	12359.80	12691.67	**12423.02**
	Medium	2400.00	-	**2400.00**	4125.00	-	**4125.00**	11800.00	-	**11800.00**
	Large	2680.77	-	**2680.77**	5096.67	-	**5096.67**	12070.63	-	**12070.63**
	All	**2967.76**	**3100.00**	**2984.29**	**5414.29**	**5288.89**	**5398.61**	**12238.89**	**12691.67**	**12299.26**
All Areas	Small	3201.40	3068.43	**3180.13**	5215.61	5155.88	**5210.53**	12421.51	12360.71	**12415.33**
	Medium	2694.14	2520.00	**2681.24**	5045.87	5080.00	**5047.67**	12229.72	12866.67	**12264.15**
	Large	2799.13	1933.33	**2772.07**	4932.43	4860.00	**4930.02**	11968.98	11176.47	**11943.41**
	All	**2944.75**	**2865.52**	**2936.75**	**5145.74**	**5127.90**	**5144.45**	**12337.67**	**12353.22**	**12339.02**

Source: Field Survey 2011

This is expected (ibid), since they are more likely to have the most contact with extension agents than those farmers living further away.

For the cassava farming respondents, the table shows that across all areas, cassava farmers with ≥ 10 km distance to their extension office have the better yield. This is not expected but a more detailed analysis shows that the difference in yield is not significant enough to warrant much discussion. Also across the farm categories, the relationship between yield and distance to extension office is not consistent, but small scale farmers that are closer to the extension office have the better yield.

The trend observed in Anambra state is similar to that across the all areas, but in Ebonyi state, farmers that are closer to the extension office have the better yield. This may be due to some of the reasons already discussed in this section.

Generally, distance to an extension office has a negative relationship to yield for all the crops in the study area except for cassava farmers across all areas and Anambra state. The difference in the two states may be because of the level of development in the states already discussed. Also small farm size farmers consistently have the highest yield per hectare for all crops in the study area; this implies just as observed before that they are the most productive and efficient farm category.

6.1.6 Extension Contact of Respondents in Relation to Crop Yield

Similar to Section 6.1.5 above, extension contact indicates how often the farmer comes in contact with extension agents. Tentatively, it is expected that the more the contact farmers have with an extension agent, the more likely they are to adopt agricultural technology; therefore it is expected to have a positive effect on yield.

Table 6.7: Yield per hectare of crops according to study area, farm category and respondent contact with extension workers

Study Area	Farm Category	Rice yield (Kg/ha) according to respondent contact with extension worker			Yam yield (Kg/ha) according to respondent contact with extension worker			Cassava yield (Kg/ha) according to respondent contact with extension worker		
		Contact	No Contact	All	Contact	No Contact	All	Contact	No Contact	All
Ebonyi State	Small	3500.00	3134.71	**3151.70**	4895.17	5190.18	**5169.40**	12713.89	12383.21	**12405.13**
	Medium	2708.49	2723.98	**2722.91**	5050.00	5099.39	**5095.59**	12127.78	12254.96	**12244.92**
	Large	2821.58	2794.37	**2797.64**	3881.08	5029.03	**4879.30**	12255.56	11856.42	**11906.31**
	All	**2983.10**	**2928.30**	**2932.25**	**4734.06**	**5155.65**	**5122.58**	**12539.81**	**12314.09**	**12330.81**
Anambra State	Small	2800.00	3129.54	**3120.63**	4711.11	6487.26	**6419.81**	12916.67	12719.77	**12724.15**
	Medium	-	2466.67	**2466.67**	3750.00	5750.00	**5083.33**	12000.00	12000.00	**12000.00**
	Large	2657.07	2740.00	**2680.77**	4956.67	5431.11	**5134.58**	12125.56	11955.56	**12061.81**
	All	**2680.89**	**3076.92**	**3025.26**	**4740.74**	**6429.94**	**6261.02**	**12307.64**	**12679.64**	**12650.18**
All Area	Small	3266.67	3132.29	**3137.33**	4852.69	5664.11	**5616.38**	12742.86	12498.45	**12511.08**
	Medium	2708.49	2706.23	**2706.38**	4725.00	5133.63	**5094.71**	12095.83	12241.18	**12227.00**
	Large	2718.76	2789.84	**2772.07**	4553.32	5081.48	**4945.18**	12174.31	11868.81	**11945.18**
	All	**2843.62**	**2974.03**	**2962.17**	**4736.46**	**5539.36**	**5471.08**	**12468.38**	**12421.00**	**12424.58**

Source: Field Survey 2011

Taken as a whole, just 7% of the respondents said that they had contact with extension agents in the previous year, while the rest did not respond to the question. This underlines the key issue (lack of contact) with agricultural extension services and agricultural technology adoption in Nigeria. Given the low level of response, one has to be careful in drawing inference from this, but this is in line with studies such as Ayansina, (2011) that observed more contact between farmers and private extension organisations than with public extension organisation (ADP) in his study.

Table 6.7 reveals that across all areas, rice farmers with no extension contact have the better yield (2974.03 kg/ha) than those with contact (2843.62 kg/ha). This is not expected but closer analysis shows that the difference in yield is not very much; but this highlights the lack of effectiveness of agricultural extension services in Nigeria. Across the farm categories, small scale rice farmers with extension contact have the better yield but the relationship is not consistent across the farm categories.

Similar trends were observed in Anambra state, where farmers with no extension contact have the better yield even across the farm categories. While in Ebonyi state, those with extension contact have the better yield, although the difference in yield is significantly not much. This indicates that extension contact has a negative relationship with rice yield in the study area.

For the yam farming respondents, the table shows that in the study area, yam farmers with no extension contact have the highest yield across all the farm categories. This indicates a negative relationship between extension contact and yield in the study area. This is not expected but may be due to the cultural status of yam in the study area and issues with the effectiveness of extension services in the study area as discussed before.

For the cassava farming respondents, the table shows that across all areas, cassava farmers with contact have the better yield (12468.38 kg/ha). Likewise, across the farm categories, farmers with extension contact have the better yield except for medium scale farmers; but the differences in yield are not significant. This indicates a positive relationship between yield and extension contact.

The trend in Ebonyi state is similar to that observed across all areas, but in Anambra state, those with no extension contact have the better yield. The difference in the states may be due to the apparent differences in the two states already discussed in this chapter and in Chapter 4.

Generally, one has to be careful in drawing any conclusive inference from this because of the low level of response to the question but just as observed before small scale farms consistently have the better yield for all the crops. Also apparent differences were observed in the relationship between yield and extension contact for both rice and cassava, and yam. It is important to note that the low level of extension contact observed in this study is in line with similar studies such as (ibid) and research interviews with ADP program managers in the study area, which stated that the ratio of extension agents to farmers is very low in the study area. Therefore, extension contact is included as one of the variables in the bivariate probit and regression analysis.

6.1.7 Respondents Training In Relation To Crop Yield

It is expected that farmers with more extension training are more likely to adopt agricultural technology; therefore it is expected that extension training will have a positive relationship with yield.

Table 6.8: Yield per hectare of crops according to study area, farm category and respondent training

Study Area	Farm Category	Rice yield (Kg/ha) according to respondent training			Yam yield (Kg/ha) according to respondent training			Cassava yield (Kg/ha) according to respondent training		
		Training	No Training	All	Training	No Training	All	Training	No Training	All
Ebonyi State	**Small**	3400.00	3139.58	**3151.70**	4827.50	5195.30	**5169.40**	12321.89	12416.06	**12405.13**
	Medium	-	2722.91	**2722.91**	5200.00	5089.95	**5095.59**	11800.00	12269.63	**12244.92**
	Large	3012.45	2768.35	**2797.64**	5133.33	4841.19	**4879.30**	11788.89	11923.08	**11906.31**
	All	**3167.47**	**2919.47**	**2932.25**	**4938.33**	**5137.21**	**5122.58**	**12220.24**	**12344.06**	**12330.81**
Anambra State	**Small**	5600.00	3051.76	**3120.63**	5533.33	6479.71	**6419.81**	12580.95	12736.22	**12724.15**
	Medium	2400.00	2533.33	**2466.67**	4500.00	5375.00	**5083.33**	11600.00	12200.00	**12000.00**
	Large	-	2680.77	**2680.77**	-	5134.58	**5134.58**	-	12061.81	**12061.81**
	All	**4000.00**	**2980.96**	**3025.26**	**5361.11**	**6325.30**	**6261.02**	**12458.33**	**12666.68**	**12650.18**
All Area	**Small**	4133.33	3098.52	**3137.33**	5062.78	5656.69	**5616.38**	12386.65	12525.42	**12511.08**
	Medium	2400.00	2716.59	**2706.38**	4966.67	5104.56	**5094.71**	11733.33	12265.97	**12227.00**
	Large	3012.45	2747.21	**2772.07**	5133.33	4925.02	**4945.18**	11788.89	11961.35	**11945.18**
	All	**3405.34**	**2939.36**	**2962.17**	**5059.13**	**5502.77**	**5471.08**	**12276.26**	**12440.85**	**12424.58**

Source: Field Survey 2011

Just as for extension contact above, only 8.5% of respondents state that they had any agricultural extension training in the previous year, while the remaining did not respond to the question.

Due to the low level of response, one has to take this into consideration when drawing conclusive inference from this finding. Also, the finding of a low level of extension training among farmers in this study is consistent with similar studies such as Ayansina, (2011), that identify low levels of extension training among farmers from public extension organisations (ADP) in his study.

Table 6.8 reveals that across all areas rice farmers with training have the better yield (3405.34 kg/ha). Similarly, across the farm categories, farmers with extension training have the better yield except for medium scale farms. This is expected and indicates a positive relationship between yield and extension training.

Similar trends to that observed across all areas were noted for both states and even across the farm categories, except for medium scale rice farmers. A more detailed analysis shows that most of the differences in yield are not sufficient to warrant further discussion.

For the yam farming respondents, the table shows that in the study area, yam farmers with no training have the better yield, even across the farm categories except for medium and large scale farms in Ebonyi state and all areas. This indicates a negative relationship between yam yield and extension training; this is not expected but may be due to the cultural importance of yam and underlining issues with extension services as discussed before.

For the cassava farming respondents, the table reveals that in the study area, cassava farmers with no training have the better yield, even across the farm categories. This indicates a negative relationship between cassava yield and extension training in the study area. This is not expected, but just like before, a closer analysis shows that differences in yield are not very significant and may be due to noise in the data set.

Generally, just as for extension contact, one has to be careful in drawing any conclusive inference from these findings due to the low level of response to the question; but the findings are consistent with similar studies (ibid). Overall, a negative relationship was observed between yam and cassava yield and extension training in the study area, while a positive relationship was observed between rice yield and extension training. This may be due to the apparent differences in rice production practices and that of yam and cassava (tuber crops), but since the differences in yield among the crops are not particularly significant, one has to be careful in drawing a conclusive inference from these findings. Therefore, extension training was included as one of the variables in the econometrics analysis to observe whether it has any significant effect on adoption and food production in the study area.

6.2 SECTION B

6.2.1 Fertilizer Application of Respondents in Relation to Crop Yield

This section discusses how respondents' fertilizer application relates to crop yield, and this will be done in sequence of the three crops as before. The threshold of fertilizer usage was grouped into low level usage (≤ 100 kg/ha) and high level usage (≥ 101 kg/ha). This was done in line with the mean fertilizer application in the study area and the literature. More detailed discussion of farmers' fertilizer and liquid fertilizer usage has been covered in Chapter Five, Section 5.2.5. It is expected that fertilizer application will have a positive relationship with yield (Rahman, 2011) and the result is presented in Table 6.9.

Interestingly, 40.2% of rice farmers did not use any fertilizer; the reasons for this are covered in the constraints chapter (Chapter Nine). Likewise, 4.2% used liquid fertilizer and 55.2% used fertilizer. This is highlighting the issue of low levels of fertilizer application as discussed in Chapter 5. Of those that used fertilizer, 45.9% used low levels (≤ 100 kg/ha) and 47.1% used high levels (≥ 101 kg/ha) of fertilizer respectively. None of the farmers in Ebonyi state used any liquid fertilizer; this is because of its non-availability and knowledge of how to use it as discussed in Chapter 9. Those that use liquid fertilizer have the best yield (3153.33 kg/ha) in the study area. This finding is consistent with Guodong, et al. (2012) that evaluates the active ingredients in liquid fertilizer and reveals that since they are already in liquid form it is easier for plants to absorb them.

Table 6.9 reveals that in all areas, rice farmers that applied higher levels of fertilizer have the better yield in the study area, but the differences in yield is not significant enough to draw conclusive inference from this finding.

Table 6.9: Yield per hectare of crops according to study area, farm category and respondent fertilizer application (kg/ha)

Study Area	Farm Category	Rice yield (kg/ha) according to respondent fertilizer application (kg/ha)				Yam yield (kg/ha) according to respondent fertilizer application (kg/ha)				Cassava yield (kg/ha) according to respondent fertilizer application (kg/ha)			
		NO Fertilizer	≤ 100	≥ 101	All	NO Fertilizer	≤ 100	≥ 101	All	NO Fertilizer	≤ 100	≥ 101	All
Ebonyi	**Small**	3182.09	3255.13	3023.44	**3151.70**	5202.88	4979.26	4991.99	**5169.40**	12417.84	12429.69	11920.00	**12405.13**
	Medium	2615.78	2856.41	2812.73	**2722.91**	5157.30	4735.24	5339.86	**5095.59**	12298.03	12009.72	-	**12244.92**
	Large	2940.75	2730.91	2675.83	**2797.64**	5024.00	4260.65	5146.15	**4879.30**	11808.85	12012.50	13333.33	**11906.31**
	All	**2968.76**	**2890.50**	**2897.02**	**2932.25**	**5179.41**	**4726.82**	**5075.00**	**5122.58**	**12345.05**	**12259.00**	**12155.56**	**12330.81**
Anambra	**Small**	2977.22	2957.50	3236.47	**3120.63**	5669.02	6500.00	6740.63	**6419.81**	12592.26	13500.00	13946.67	**12724.15**
	Medium	-	-	2466.67	**2466.67**	4125.00	-	7000.00	**5083.33**	11800.00	-	12400.00	**12000.00**
	Large	2915.38	2586.92	-	**2680.77**	5985.83	3933.33	5333.33	**5134.58**	12212.50	11488.89	12333.33	**12061.81**
	All	**2961.76**	**2814.97**	**3155.44**	**3025.26**	**5589.86**	**4960.00**	**6706.86**	**6261.02**	**12500.98**	**12695.56**	**13739.13**	**12650.18**
All Areas	**Small**	3143.68	3085.05	3152.78	**3137.33**	5260.72	5255.76	6235.46	**5616.38**	12443.82	12598.68	13541.33	**12511.08**
	Medium	2615.78	2856.41	2726.21	**2706.38**	5090.70	4735.24	5754.89	**5094.71**	12267.84	12009.72	12400.00	**12227.00**
	Large	2936.14	2688.56	2675.83	**2772.07**	5237.74	4137.91	5183.59	**4945.18**	11879.05	11837.96	12666.67	**11945.18**
	All	**2967.79**	**2865.32**	**3019.77**	**2962.17**	**5230.16**	**4771.66**	**6102.47**	**5471.08**	**12366.78**	**12327.21**	**13411.49**	**12424.58**

Source: Field Survey, 2011

Also across the farm categories, farmers that apply the higher level of fertilizer have the better yield except for large scale farms. Likewise, in Ebonyi state, farmers that applied no fertilizer have the better yield, whilst in Anambra state those that applied the higher level of fertilizer have the better yield. The differences in yield between those that applied no fertilizer and those that applied the different levels of fertilizer are not very significant. This may be because the level of fertilizer application is too low to make any significant difference in yield, as discussed in Chapter 5.

For the yam farming respondents, 63.3% did not apply any fertilizer, 9.5% used liquid fertilizer and 27.2% used fertilizer. Of those that used it, 81.25% used the lower level and 18.75% the higher level of fertilizer. Just like for rice farms, none of the farmers in Ebonyi state used liquid fertilizer, but those that do use liquid fertilizer in the study area have the best yield (6503.27 kg/ha).

Table 6.9, shows that in all areas, farmers that applied the higher level of fertilizer have the better yield in the study area. The same trend was noted across the farm categories expect for large scale farms. This indicates a positive relationship between fertilizer application and yam yield in the study area. The differences in yield among the same farm category and across the farm categories are not significant.

For the cassava farming respondents, 71% did not use any fertilizer, 11% used liquid fertilizer and 18% used fertilizer. Interestingly, of those that used fertilizer, 85% used the lower level of fertilizer and 15% the higher level of fertilizer. Those that used liquid fertilizer had a decent level of yield (12132.22 kg/ha) when compared to the other levels of fertilizer application.

Table 6.9 reveals that in all areas, farmers that applied the higher level of fertilizer have the better yield in the study area, except in Ebonyi state. Even though the differences in yield is not very significant much across the same farm category. It may be because the soil in Ebonyi state is good for cassava farming as noted by Nwibo, (2012) in his study.

Overall, none of the farmers in Ebonyi state use any liquid fertilizer for their farming; this may be because of their unavailability and knowledge of how to use it as mentioned before. Liquid fertilizer users and farmers that apply a higher level of fertilizer produce the better yield in the study area. There is not much significant difference in yield between those that did not apply any fertilizer and those that applied fertilizer. This indicates that the level of fertilizer application in the study area is significantly low and that its use does not make much difference to yield. Fertilizer application has a positive relationship with yield for all the crops in the study area except for cassava farms in Ebonyi state; and small scale farms consistently have the best yield in the study area. This implies that the higher the level of fertilizer application, the more likely is the yield to be higher. Therefore, fertilizer application was included as one of the variables for the regression analysis, to observe if it has any significant effect on food production and availability.

6.2.2: High Yield Variety (HYV) Usage of Respondents in Relation to Crop Yield

The relationship between HYV seed and crop yield is discussed in this section; farmers were sub divided into users of HYV and non-users of HYV and the result presented in Table 6.10. More detailed discussion of the types of varieties and seed rate was covered in Chapter 5, section 5.2.3.

Table 6.10: Yield per hectare of crops according to study area, farm category and respondent HYV seeds usage

Study Area	Farm Category	Rice yield (kg/ha) according to respondents use of HYV			Yam yield (kg/ha) according to respondents use of HYV			Cassava yield (kg/ha) according to respondents use of HYV		
		NO HYV	HYV	All	NO HYV	HYV	All	NO HYV	HYV	All
Ebonyi	**Small**	3182.70	3119.22	**3151.70**	5195.85	5097.01	**5169.40**	12407.84	12400.06	**12405.13**
	Medium	2938.32	2591.27	**2722.91**	4990.77	5176.59	**5095.59**	12240.13	12248.39	**12244.92**
	Large	2779.25	2830.33	**2797.64**	5018.48	4561.18	**4879.30**	11992.31	11734.31	**11906.31**
	All	**2996.10**	**2867.07**	**2932.25**	**5149.69**	**5067.16**	**5122.58**	**12345.63**	**12306.91**	**12330.81**
Anambra	**Small**	3135.26	3086.06	**3120.63**	6234.90	6775.93	**6419.81**	13184.06	12243.33	**12724.15**
	Medium	2466.67	-	**2466.67**	5083.33	-	**5083.33**	12000.00	-	**12000.00**
	Large	2627.56	3000.00	**2680.77**	5019.44	5480.00	**5134.58**	12215.74	11600.00	**12061.81**
	All	**3006.33**	**3078.89**	**3025.26**	**6058.72**	**6686.55**	**6261.02**	**13013.84**	**12215.36**	**12650.18**
All Areas	**Small**	3157.00	3107.82	**3137.33**	5542.20	5794.41	**5616.38**	12625.56	12335.61	**12511.08**
	Medium	2865.76	2591.27	**2706.38**	5004.65	5176.59	**5094.71**	12202.22	12248.39	**12227.00**
	Large	2737.88	2847.30	**2772.07**	5018.74	4765.36	**4945.18**	12053.24	11707.45	**11945.18**
	All	**3000.29**	**2909.44**	**2962.17**	**5429.74**	**5556.35**	**5471.08**	**12524.90**	**12276.62**	**12424.58**

Source: Field Survey, 2011

The constraints affecting the use of HYV are discussed in Chapter 9; but the use of HYV is expected to have a positive effect on crop yield (ibid).

For rice farming respondents, 58% did not use HYV, whilst 42% used HYV; this indicates a low level of HYV usage in the study area. The reasons for this are discussed in the constraints chapter (Chapter 9) and this finding is consistent with Madukwe, et al. (2002) and Ayansina, (2011) that noted low levels of HYV usage in their respective studies. Table 6.10 reveals that rice farmers that did not use HYV have the better yield in the study area except in Anambra state; where the difference in not very significant. This is contrary to expectations, but confirms the importance of adoption of agricultural technology as a package.

For yam farming respondents, 67% did not use any HYV and 33% used HYV seeds in the study area. Table 6.10 shows that farmers that used HYV have the better yield in the study area except in Ebonyi state; but the difference in yield is not significant enough to warrant conclusive inference from the finding. This finding is expected and indicates a positive relationship between the HYV seed usage and yam yield in the study area.

Interestingly, for cassava farming respondents, 60% did not use any HYV and 40% used HYV steam in the study area. Table 6.10 reveals that farmers that did not use HYV have the better yield in the study area, even though the difference in yield is not much. This indicates a negative relationship between the use of HYV and cassava yield in the study area. This is not expected and underlines and highlights the issue of the non-adoption (Chapter 7, section 7.1) of agricultural technology as a package in the study area.

Overall, the level of HYV seeds usage in the study area is low and except for yam farms; there is a negative relationship between the use of HYV and yield.

Just as mentioned before, the reasons for these are discussed in Chapter Nine where all the constraints are covered. Small scale farms consistently have the better yield in the study area and the section highlights the importance of adoption of agricultural technology as a package.

6.2.3 Pesticide Application of Respondents in Relation to Crop Yield

The respondents' pesticide application as it relates to their crop yield will be discussed in this section. Farmers pesticide application was grouped into low level application (≤ 4 litres/ha) and high level (≥ 4.01 litres/ha) application, in line with the mean pesticide application and literature. More details about pesticide application have already been discussed in Chapter 5. Due to the low level of pesticide application in this study and developing countries, it is expected that pesticide application will have a positive relationship with yield in this study area (ibid).

Taken as a whole, only 18% of the respondents use pesticide for their rice farming of which all of them use the lower level. Table 6.10 shows that none of the rice farmers used the higher level of pesticide; this may be because of the constraints associated with pesticide application as discussed in Chapter 5 & 9. Also noted in Chapter 5, is that pesticide application in the study area is below the RPR for all the crops in the study area.

For the yam farming respondents, only 23.7% of respondents use any kind of pesticide for their yam farming of which 64.2% use the lower level and 35.8% use the higher level of pesticide application. The table reveals that in the study area, farmers that apply the higher level of pesticide have the better yield, except in Ebonyi state.

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Table 6.11: Yield per hectare of crops according to study area, farm category and respondent pesticide application (Litre/ha)

Study Area	Farm Category	Rice yield (kg/ha) according to respondents pesticide application (Litre/ha)			Yam yield (kg/ha) according to respondents pesticide application (Litre/ha)			Cassava yield (kg/ha) according to respondents pesticide application (Litre/ha)		
		≤ 4	≥ 4.01	All	≤ 4	≥ 4.01	All	≤ 4	≥ 4.01	All
Ebonyi	**Small**	3110.01	-	**3110.01**	5080.99	4598.21	**4920.07**	12459.94	12234.38	**12339.64**
	Medium	2843.07	-	**2843.07**	5317.65	-	**5317.65**	-	13333.33	**13333.33**
	Large	2795.66	-	**2795.66**	4871.47	-	**4871.47**	11802.61	12666.67	**12018.63**
	All	**2936.78**	**-**	**2936.78**	**5062.75**	**4598.21**	**4942.32**	**12262.75**	**12387.50**	**12325.12**
Anambra	**Small**	3085.71	-	**3085.71**	6499.13	6572.84	**6528.83**	12288.41	13892.00	**12869.42**
	Medium	2533.33	-	**2533.33**	7000.00	-	**7000.00**	12400.00	-	**12400.00**
	Large	2603.65	-	**2603.65**	-	-	**-**	-	-	**-**
	All	**3010.54**	**-**	**3010.54**	**6511.34**	**6572.84**	**6535.76**	**12290.89**	**13892.00**	**12862.71**
All Areas	**Small**	3094.55	-	**3094.55**	6131.46	6166.30	**6144.92**	12311.95	13490.15	**12774.82**
	Medium	2814.91	-	**2814.91**	5878.43	-	**5878.43**	12400.00	13333.33	**12866.67**
	Large	2750.48	-	**2750.48**	4871.47	-	**4871.47**	11802.61	12666.67	**12018.63**
	All	**2970.59**	**-**	**2970.59**	**6036.39**	**6166.30**	**6082.89**	**12285.77**	**13462.14**	**12743.25**

Source: Field Survey 2011

This may be because of the soil type in Ebonyi state as discussed before and also the lack of knowledge of the best way to apply it, as discussed in Chapter 5 & 9. Also the difference in yield among the same farm category is not very significant, but it is significantly more across the farm categories.

For the cassava farming respondents, only 22.5% of respondents use any kind of pesticide for their cassava farming of which 61.1% use the lower level and 38.9% use higher level of pesticides application. The table shows that, in the study area, farmers that apply the higher level of pesticide produce the better yield; this is expected and indicates a positive relationship between cassava yield and pesticide application in the study area. The same trend was noted across the farm categories except for small scale cassava farmers in Ebonyi state. Closer analysis shows that the difference in yield is not significant and that it may be due to noise in the data set.

Generally, none of the rice farmers used the higher level of pesticides application in the study area and the reasons are already discussed before. Overall, farmers that used the higher level of pesticide application produce the best yield in the study area, except for yam farmers in Ebonyi state and the reasons have already been mentioned. It is important to note that small scale farms produce the better yield in the study area except for medium scale yam and cassava farmers in Ebonyi and Anambra states; this is not expected and may be a result of noise in the data set. Pesticide usage was not included in the econometrics analysis due to the subjective nature of its usage; farmers only need to use pesticides if the need arises and they can get on without using them.

6.2.4 Manure Application of Respondents in Relation to Crop Yield

Farmers manure application as it relates to their crop yield will be discussed in this section, and this will be done following a similar crop sequence as before. Farmers manure application was grouped into low level (≤ 350 kg/ha) and high level (≥ 351 kg/ha) manure application, in line with the mean manure application in the study area and literature. More detail about manure application, type and constraints has already been discussed in Chapter 5. Since manure improves the soil structure and nutrient level (Hawaii University, 2013), it is expected to have a positive relationship with crop yield.

Taken as a whole, only 11% of respondents use organic manure for their rice farming of which 50% use ≤ 350 kg/ha and the remaining 50% use ≥ 351 kg/ha. The reasons for the low level of application have already been discussed in Chapter 5. Table 6.11 shows that in the study area, rice farmers that apply the higher level of manure produce the better yield; this is expected but the relationship is not consistent across the farm categories. This may be due to other factors like timing of the application. As noted in Chapter 5 manure is not readily available in the study area.

For the yam farming respondents, only 30.3% of respondents use organic manure for their yam farming, of which 47.1% applied the lower level and 52.9% applied the higher level of manure. The table reveals that in the study area, farmers that apply the higher level of manure have the better yield except in Ebonyi state. Closer analysis shows that differences in yield in Ebonyi state are not very significant and may be due to better soil type, as noted by Nwibo, (2012) in his study.

Table 6.12: Yield per hectare of crops according to study area, farm category and respondent organic manure application (kg/ha)

Study Area	Farm Category	Rice yield (kg/ha) according to respondents manure application (kg/ha)			Yam yield (kg/ha) according to respondents manure application (kg/ha)			Cassava yield (kg/ha) according to respondents manure application (kg/ha)		
		≤ 350	≥ 351	All	≤ 350	≥ 351	All	≤ 350	≥ 351	All
Ebonyi State	**Small**	2638.89	3153.37	**3013.05**	5187.00	5003.91	**5098.85**	12363.90	12641.37	**12466.12**
	Medium	2801.85	2600.00	**2734.56**	5122.42	-	**5122.42**	12042.15	-	**12042.15**
	Large	2897.57	-	**2897.57**	4970.80	-	**4970.80**	12111.11	11785.71	**12064.63**
	All	**2800.99**	**3042.69**	**2910.85**	**5139.79**	**5003.91**	**5088.59**	**12297.92**	**12611.86**	**12397.97**
Anambra State	**Small**	2882.50	3058.61	**2988.17**	5723.48	6819.47	**6573.44**	12350.00	13157.59	**12955.69**
	Medium	-	-	**-**	3750.00	-	**3750.00**	11800.00	-	**11800.00**
	Large	2915.38	-	**2915.38**	5446.67	-	**5446.67**	11850.00	-	**11850.00**
	All	**2889.08**	**3058.61**	**2981.55**	**5542.98**	**6819.47**	**6475.80**	**12218.75**	**13157.59**	**12868.72**
All Areas	**Small**	2816.06	3096.51	**2997.00**	5338.32	6081.90	**5800.35**	12361.12	12931.74	**12655.63**
	Medium	2801.85	2600.00	**2734.56**	4969.93	-	**4969.93**	11993.72	-	**11993.72**
	Large	2902.66	-	**2902.66**	5076.55	-	**5076.55**	12045.83	11785.71	**12016.93**
	All	**2841.03**	**3051.38**	**2946.20**	**5238.82**	**6081.90**	**5684.75**	**12281.68**	**12914.11**	**12569.15**

Source: Field Survey 2011

For the cassava farming respondents, only 35.8% of the respondents use any organic manure for their cassava farming, of which 54.5% applied lower level and 45.5% applied the higher level of manure. The table shows similar trends as those observed for rice and yam farms. It shows that farmers that apply the higher level of manure have the highest yield in the study area, but the trend is not consistent across the farm categories.

Overall, except for yam farming respondents in Ebonyi state, manure application has a positive relationship with crop yield in the study area. Also, the degree of differences in yield across all areas shows that yam is the crop that is most responsive to manure application. This finding is consistent with Hawaii University, (2013) which reveal in their respective studies that yam is one of the crops that does well with good organic manure.

6.2.5 Seed Planting Rate of Respondents in Relation to Crop Yield

Respondents' seed planting application rates as it relates to their crop yield is discussed in this section. Farmers' seed application rate was grouped into lower level and higher level of application, in line with the mean seed rate application for the crops and literature. Detailed discussion of seed application rates, seed types and constraints have already been discussed in Chapter 5. Since the seed application rate used by farmers in this study is below the RSR (Chapter 5), it is expected that seed rate will have a positive relationship with yield.

Taken as a whole, only 68.5% of rice farming respondents use the lower level (≤ 60 kg/ha) and 31.5% use the higher level (≥ 60.01 kg/ha) of rice seed rate respectively. Just as expected, Table 6.12 reveals that farmers that apply the higher level of seed rate have the better yield in the study area. The trend is consistent even across the farm categories. This implies that an increase in seed rate application will increase rice yield in the study area.

For the yam farming respondents, 53.1% of them use the lower level (≤ 1150 kg/ha) and 46.9% used the higher level (≥ 1151 kg/ha) of yam seed rates. The table shows that in the study area, farmers that apply the lower level of seed have the better yield except in Anambra state.

This is not expected, and may be because of the recorded high level of yam beetle incidence, especially in Ebonyi state (Chapter 5). This may have led to the negative relationship shown in the table, and this is consistent, even across the farm categories.

For the cassava farming respondents, 39.8% of them use the lower level (≤115 kg/ha) and 60.2% use the higher level (≥ 116 kg/ha) of cassava stem rate. The trends observed for cassava farms are similar to those observed for rice farms. The table reveals that in the study area, cassava farmers that used the higher level of stem rate have the better yield. This is expected and highlights the issue of low crop seed rate usage in the study area. The trend is consistent, even across the farm categories, except for large scale farms, but the difference in yield is not very significant and this may be due to noise in the data set.

Generally, except for yam farming respondents in Ebonyi state, seed planting rate has a positive relationship with crop yield in the study area; and the reasons have already been discussed. Also the degree of differences in yield across all areas for all the crops shows that the rice crop is the most responsive to higher seed rate usage in the study area.

Table 6.13: Yield per hectare of crops according to study area, farm category and respondent seed planting rate (Kg/ha)

Study Area	Farm Category	Rice yield (kg/ha) according to respondents seed rate (Kg/ha)			Yam yield (kg/ha) according to respondents seed rate (Kg/ha)			Cassava yield (kg/ha) according to respondents stem rate (Kg/ha)		
		≤ 60	≥ 60.01	All	≤ 1150	≥ 1151	All	≤ 115	≥ 116	All
Ebonyi State	Small	3020.19	3317.81	**3151.70**	5496.35	4974.70	**5169.40**	12215.01	12519.54	**12405.13**
	Medium	2674.21	3144.98	**2722.91**	5259.50	4923.05	**5095.59**	12154.45	12400.00	**12244.92**
	Large	2797.64	-	**2797.64**	4593.35	5415.45	**4879.30**	11923.08	11788.89	**11906.31**
	All	**2826.07**	**3294.25**	**2932.25**	**5288.60**	**4996.64**	**5122.58**	**12147.90**	**12489.81**	**12330.81**
Anambra State	Small	2915.95	3245.22	**3120.63**	6448.80	6344.70	**6419.81**	12283.33	12798.57	**12724.15**
	Medium	2466.67	-	**2466.67**	5083.33	-	**5083.33**	12000.00	-	**12000.00**
	Large	2680.77	-	**2680.77**	5134.58	-	**5134.58**	12061.81	-	**12061.81**
	All	**2805.31**	**3245.22**	**3025.26**	**6233.95**	**6344.70**	**6261.02**	**12174.07**	**12798.57**	**12650.18**
All Areas	Small	2981.79	3278.06	**3137.33**	5989.89	5246.23	**5616.38**	12225.97	12632.62	**12511.08**
	Medium	2659.38	3144.98	**2706.38**	5236.52	4923.05	**5094.71**	12137.29	12400.00	**12227.00**
	Large	2772.07		**2772.07**	4781.61	5415.45	**4945.18**	11961.35	11788.89	**11945.18**
	All	**2821.19**	**3269.19**	**2962.17**	**5700.67**	**5211.55**	**5471.08**	**12152.48**	**12604.66**	**12424.58**

Source: Field Survey 2011

6.2.6 Human Labour of Respondents in Relation to Crop Yield

The term human labour as it relates to this study has already been defined and explained in Chapter 5 (Section 5.2.1). This section will discuss how human labour relates to crop yield, and this will be done in sequence of the three crops, as before. Human labour used by farmers was sub divided into two groups (≤ 75 & ≥ 76 man-day/ha), in line with the mean human labour used by farmers in this study and the literature. Since human labour indicates how well a farm is managed, it is expected that it will have a positive relationship with yield (Rahman, 2011).

Just 71.3% of rice farming respondents used ≤ 75 man-day/ha, and 28.7% of them used ≥ 76 man-day human labour in their rice farming. Table 6.13 reveals that in the study area, rice farmers who used the most human labour (≥ 76 man-day/ha) have the better yield per hectare. Small scale farms consistently have the better yield in the study area across the farm categories and none of the medium and large scale farms used the higher level of human labour. This may be due to issues around the availability of labour already discussed in Chapter 5. It is important to note that a difference in yield across the farm categories and among the same farm category is very significant.

This indicates that the optimal level of human labour usage has not been reached by rice farmers in the study area. These findings are consistent with studies such as Rahman, (2011) and Obasi, et al. (2013) that state that farmers that use more labour achieve better yields and manage farms better in their respective studies. This indicates a positive relationship between farmers' human labour usage and rice yield and implies that an increase in human labour usage will increase rice yield in the study area.

Table 6.14: Yield per hectare of crops according to study area, farm category and respondent human labour used (Man-day/ha)

Study Area	Farm Category	Rice yield (kg/ha) according to respondents human labour (Man-day/ha)			Yam yield (kg/ha) according to respondents human labour (Man-day/ha)			Cassava yield (kg/ha) according to respondents human labour (Man-day/ha)		
		≤ 75	≥ 76	All	≤ 75	≥ 76	All	≤ 75	≥ 76	All
Ebonyi State	Small	3099.75	3285.90	**3151.70**	5167.77	5171.03	**5169.40**	12344.16	12584.06	**12405.13**
	Medium	2722.91	-	**2722.91**	5154.81	4000.00	**5095.59**	12233.05	12383.33	**12244.92**
	Large	2797.64	-	**2797.64**	4665.42	7125.00	**4879.30**	11971.80	10400.00	**11906.31**
	All	**2882.32**	**3285.90**	**2932.25**	**5082.28**	**5191.91**	**5122.58**	**12279.64**	**12528.33**	**12330.81**
Anambra State	Small	2889.17	3184.48	**3120.63**	5272.22	6625.35	**6419.81**	12260.78	12832.05	**12724.15**
	Medium	2466.67	-	**2466.67**	4125.00	7000.00	**5083.33**	12000.00	-	**12000.00**
	Large	2680.77	-	**2680.77**	4896.67	6800.00	**5134.58**	12061.81	-	**12061.81**
	All	**2753.65**	**3184.48**	**3025.26**	**5037.78**	**6633.31**	**6261.02**	**12175.99**	**12832.05**	**12650.18**
All Areas	Small	3056.55	3214.17	**3137.33**	5182.87	5877.11	**5616.38**	12334.84	12736.19	**12511.08**
	Medium	2706.38	-	**2706.38**	5102.00	5000.00	**5094.71**	12214.65	12383.33	**12227.00**
	Large	2772.07	-	**2772.07**	4723.23	7016.67	**4945.18**	11995.03	10400.00	**11945.18**
	All	**2860.88**	**3214.17**	**2962.17**	**5076.05**	**5882.58**	**5471.08**	**12266.51**	**12708.59**	**12424.58**

Source: Field Survey 2011

For the yam farming respondents, 51% of them used the lower level of human labour (≤ 75 man-day/ha) for their yam farming, while 49% used the higher level of human labour (≥ 76 man-day/ha). The table shows that human labour usage by yam farmer in the study area follows similar trends as that observed for rice farms. Farmers that use more human labour have the better yield in the study area, even across the farm categories except for medium scale farms in all areas and Ebonyi state. This may be due to noise in the data set, since the differences in yield is not that significant.

For the cassava farming respondents, 64.2% of them used the lower level of human labour (≤ 75 man-day/ha) for their cassava farming, while 35.8% used the higher level of human labour (≥ 76 man-day/ha). Similarly, the table reveals that human labour usage by cassava farmers follows the same pattern as those of rice and yam farms discussed above. It shows that farmers with the higher level of human labour usage have the better yield in the study area and across the farm categories except for large scale farms in all areas and Ebonyi state. The reasons are the same as those discussed for yam farmers above.

Overall, just as expected, human labour usage has a positive relationship with yield for all the crops in the study area. But the degree of differences in yield across the farm categories and among the same farm category are not much, indicating that the optimal level of human labour usage has not been reached for all the crops. These findings are consistent with literature and similar studies (ibid), that show that in developing countries, farmers that used more labour tend to have better managed farms and yields. Just as mentioned before, small scale farms consistently have the better yield in the study area for all the crops.

6.2.7 Ploughing Labour of Respondents in Relation to Crop Yield

Ploughing labour as relates to this study has already been defined and explained in Chapter 5 (Section 5.2.2), but this section will discuss how it relates to crop yield. Ploughing labour was divided into two groups (≤ 20 & ≥ 21 man-day/ha) using the same principle that was applied for human labour above. Since in developing countries, most ploughing is done manually, ploughing labour indicates how well ploughed a farm land is; it is expected to have a positive relationship with yield (Rahman, 2011).

Taken as a whole, 78.3% of rice farming respondents used the lower level of ploughing labour (≤ 20 man-day/ha) for their rice farm, while 21.7% used the higher level of ploughing labour (≥ 21 man-day/ha). Table 6.14 reveals that similar to human labour discussed in the above section, farmers that used the higher level of ploughing labour produced the better yield in the study area, even across the farm categories. This indicates a positive relationship between rice yield and ploughing labour used, which implies that an increase in ploughing labour will tend to increase yield in the study area.

For the yam farming respondents, 61.4% of them used the lower level of ploughing labour (≤ 20 man-day/ha) for their yam farming, while 38.6% used the higher level of ploughing labour (≥ 21 man-day/ha). The table shows that across all areas, yam farmers who used the higher level of ploughing labour have the better yield. Across the farm categories, the relationship is not consistent, indicating that farmers that are using the higher level of ploughing labour, are using a level above the optimal needed.

Table 6.15: Yield per hectare of crops according to study area, farm category and respondent ploughing labour used (Man-day/ha)

Study Area	Farm Category	Rice yield (kg/ha) according to respondents ploughing labour (Man-day/ha)			Yam yield (kg/ha) according to respondents ploughing labour (Man-day/ha)			Cassava yield (kg/ha) according to respondents ploughing labour (Man-day/ha)		
		≤ 20	≥ 21	All	≤ 20	≥ 21	All	≤ 20	≥ 21	All
Ebonyi State	**Small**	3128.74	3326.15	**3151.70**	5265.46	5058.79	**5169.40**	12340.70	12729.44	**12405.13**
	Medium	2722.91	-	**2722.91**	5101.27	5003.85	**5091.01**	12189.42	12716.67	**12244.92**
	Large	2797.64	-	**2797.64**	4874.39	4902.62	**4879.30**	11844.24	12216.67	**11906.31**
	All	**2910.84**	**3326.15**	**2932.25**	**5164.58**	**5047.38**	**5121.86**	**12267.17**	**12674.12**	**12330.81**
Anambra State	**Small**	2919.39	3205.77	**3120.63**	6199.54	6645.73	**6419.81**	12191.67	12857.27	**12724.15**
	Medium	2466.67	-	**2466.67**	5083.33	-	**5083.33**	12000.00	-	**12000.00**
	Large	2680.77	-	**2680.77**	5134.58	-	**5134.58**	12061.81	-	**12061.81**
	All	**2790.60**	**3205.77**	**3025.26**	**5966.83**	**6645.73**	**6261.02**	**12136.02**	**12857.27**	**12650.18**
All Areas	**Small**	3081.75	3225.19	**3137.33**	5587.55	5648.22	**5616.38**	12324.83	12819.67	**12511.08**
	Medium	2706.38	-	**2706.38**	5099.81	5003.85	**5090.45**	12174.06	12716.67	**12227.00**
	Large	2772.07	-	**2772.07**	4951.48	4902.62	**4945.18**	11906.40	12216.67	**11945.18**
	All	**2889.37**	**3225.19**	**2962.17**	**5391.89**	**5599.02**	**5471.77**	**12250.92**	**12794.00**	**12424.58**

Source: Field Survey 2011

Likewise, the trend in Anambra state is similar to that noted across all areas, except that none of the medium and large scale farms used the higher level of ploughing labour. This may be because of issues with labour availability as already discussed in this study or they are using the optimal level needed as reflected in Ebonyi state. While in Ebonyi state, farmers that use the lower level of ploughing labour have the better yield, indicating that those using the higher level, are using a level above the optimal needed.

For the cassava farming respondents, 68% of them used the lower level of ploughing labour (≤ 20 man-day/ha) for their cassava farming, while 32% used the higher level of ploughing labour (≥ 21 man-day/ha). The table reveals that in the study area, cassava farmers who used higher level ploughing labour have the better yield per hectare. This is consistent even across the farm categories, except that none of the medium and large scale farms in Anambra state used the higher level of ploughing labour. This may be due to issues around labour availability as discussed before; the trend observed for cassava farms is similar to that for rice farms.

Overall, ploughing labour has a positive relationship with yield for all crops in the study area except for yam farms in Ebonyi state. This indicates that yam farmers that are using the higher level of ploughing labour are using a level above the optimal needed. These findings are consistent with the literature and studies such as (ibid), that state that labour usage should be such that it gives the optimal return (yield). It is important to note that just as discussed before, small scale farms consistently have the better yield for all the crops in the study area.

6.3 Profitability and Benefit Cost Ratio (BCR)

This section discusses the profitability of the farm categories and that of the different crop enterprises (rice, yam, and cassava) to determine which of the enterprises is the most profitable. This is done by analysing Total Variable Cost (TVC); Total Fixed Cost (TFC), Total Revenue (TR), Gross Margin (GM), Net Profit and Benefit Cost Ratio (BCR) for each crop enterprise.

6.3.1 Crop Enterprise Profitability and Benefit Cost Ratio

The net profit and BCR of each of the crop enterprises will be evaluated and discussed in this section. Key components like total variable cost, total revenue, gross margin, total fixed cost, net profit and BCR will be evaluated.

The total variable costs are costs associated with farm production that vary with output within the production period. The variable cost associated with farm production in this study is shown in Table 6.16. It is made up of the material input cost (seed, ploughing; fertilizer, manure and pesticide costs); labour cost (hired labour and own labour) and transportation cost (handling and transportation).

The seed cost (own and bought seed) for bought seed has been calculated using the real seed cost and the mean cost per kilogram of the bought seed for farmers own seed. Turning to the analysis, yam has the highest seed cost; this is because of the high value attached to seed yams. Cassava and rice are lower because as discussed in Chapter 5, section 5.2.3, their seeds are relatively readily available and not as valuable as seed yams.

Table 6.16: Crop enterprise profitability and benefit cost ratio

Section A Variable Cost Factors	Crop Enterprise			
		Rice	Yam	Cassava
Material input cost	Unit	Mean	Mean	Mean
Seed	#/ha	3354.53	51836.90	1146.36
Ploughing	#/ha	26387.14	42868.09	38140.14
Fertilizer	#/ha	14375.36	20576.70	17741.65
Manure	#/ha	1558.01	10000.00	2194.29
Pesticide	#/ha	2598.10	5170.65	5773.23
Hired Labour	#/ha	13903.89	22088.21	11371.88
Own Labour	#/ha	33291.93	48010.83	34798.96
Labour	#/ha	47195.82	70099.04	46170.84
Hired Labour As % Of Total Labour	%	29.46	31.51	24.63
Transportation	#/ha	15403.46	5661.57	5865.87
Total Variable cost(TVC)	#/ha	110872.40	206212.90	117032.40
Section B				
Total Revenue (TR)	#/ha	355460.40	547108.30	248491.60
Gross Margin (GM)	#/ha	244588.00	340895.40	131459.20
Section C Fixed cost				
Loan	#/ha	1847.62	1331.06	1568.96
Rent	#/ha	9074.87	9074.87	9074.87
Total Fixed Cost (TFC)	#/ha	10922.49	10405.93	10643.83
Total Cost (TC)	#/ha	121794.89	216618.83	127676.23
Section D				
Net Profit	#/ha	233665.51	330489.47	120815.37
Benefit Cost Ratio		2.92	2.53	1.95

Source: Field Survey 2011 Note: GM = TR–TVC; TC = TVC+TFC; Net Profit = GM–TFC; Benefit cost ratio =TR / TC; # = Naira (Nigeria currency); ha= hectare

Yam has the highest ploughing cost followed by cassava and rice, as discussed in Chapter 5; this is because of the nature of ploughed farm bed needed by yam and cassava. Rice land preparation is less intensive than that of yam and cassava that need large farm beds because they are root tuber crops and their ploughing is more labour intensive. Yam and cassava have higher fertilizer and pesticide costs than rice, while rice also has the lowest manure cost.

Family labour is imputed as an opportunity cost of the hired labour; some studies like Junankar, (1989) criticized the use of the same market wage rate for family and hired labour as a gross simplification, while others like Sevilla-Siero, (1991) suggested an alternative view that farmers, by segmenting the labour market, may turn a negative farm profit to a positive one. Yam and rice have a higher hired labour ratio than cassava and this is because they are both more labour intensive. Rice has the highest transportation cost followed by cassava and yam; this is because most of the rice farmers sell their produce at the central market where they are more likely to get the best price, thereby incurring higher transportation costs.

The total revenue (total output by unit price) of the crops is shown in Section B. It is the total gross yield value of the crop enterprise. Yam and rice have higher value than cassava; this is because of the market price of their output. The gross margin is the difference between the total revenue and the total variable cost of the crop. The table shows that yam and rice gross margins are higher than those of cassava.

The total fixed cost (section C) is the cost associated with farm production that does not vary with output and remains the same throughout the production period. In this study, it is the mean total of loan cost and land rent cost for farmers that have access to those facilities since none of the farmers has a designated farm house or has access to farm machines like tractors. The total cost is also shown in this section and it is the sum of the total variable cost and total fixed cost. Crop net profit (section D) is the difference between the gross margin and the total fixed cost. The table shows that yam and rice have a higher net profit value than cassava. But in order to determine which crop enterprise is the most profitable or gives the best return to investment, the benefit cost ratio was evaluated.

Benefit cost ratio (BCR) is a ratio that determines the return for each additional naira invested in each of the farm enterprises. It helps in identifying the relationship between the cost and benefit of farming each of the crop enterprises. It is derived from dividing Total Revenue (TR) by Total Cost (TC) for each of the crop enterprises. When you consider the BCR of the crop enterprises, it reveals the values, 2.92, 2.53 and 1.95 for rice, yam and cassava respectively. This implies that every naira invested into rice, yam and cassava production will give the above returns. Therefore, rice has the highest BCR and gives the best return to investment, followed by yam and cassava enterprises respectively, even though yam enterprises give the best net profit.

6.3.2 Farm Categories Profitability and Benefit Cost Ratio

The result of the profitability of the different farm categories is presented in Table 6.17; it reveals that for rice farming respondents, large scale farms have the best net profit. This is not expected since Table 6.1 shows that small scale farms produced the better yield; but the profitability analysis reveals that they also have the highest variable cost of production. This indicates that whereas the small scale farms treat farming as a way of life, the medium and large scale farms approach it as a business (Igwe, 2013). It is important to note that despite this, the difference in net profit is not enough to warrant conclusive inference from this finding. The benefit cost ratio (BCR) indicates the return to investment for any additional one naira (money) invested in rice enterprise. The table shows a positive return to investment and reveals that large (5.02) scale rice farms have the best return followed by medium (3.75) and small (2.36) scale farms respectively.

For yam farming respondents, Table 6.17 shows that medium scale farms have the most net profit, followed by large and small scale farms. This is not expected but the reasons are the same as those for rice farms. Interestingly, the table shows that the large scale farms give the best return to investment, followed by medium and small scale farms respectively. In all areas, the return to each additional one naira invested in yam farming is 2.53 naira.

Table 6.17: Farm categories profitability and benefit cost ratio

Farm Category	Respondents Farm Categories Net Profit and Benefit Cost Ratio					
	Rice		Yam		Cassava	
	Net Profit	BCR	Net Profit	BCR	Net Profit	BCR
Small	217182.10	2.36	328050.80	2.40	113216.60	1.83
Medium	238153.60	3.75	**341234.80**	3.03	**166187.70**	**3.12**
Large	**266449.90**	**5.02**	336344.60	**3.13**	148659.00	2.65
All	**233665.50**	**2.92**	**330489.50**	**2.53**	**121053.30**	**1.95**

Source: Field Survey, 2011

For cassava farming respondents, profitability follows the same trend as noted for yam farmers above, with medium scale farms being the most profitable and having the best BCR.

Overall, all the farm categories for all the crops are profitable and have a positive BCR. The section also highlights the issue of high variable cost for small scale farms and indicates that small scale farms treats farming as a way of life whilst medium and large scale farms see it as a business. It is important to note that a good proportion of the labour and ploughing costs are own or family provided; if this is taken into account, then the small scale farms will be the most profitable for all the crops. It is very important to note that the table shows that inverse-farm size profitability relationships do not hold in the study area since the large and medium scale farms give the best return to investment.

Overall, Chapter Six covered three important areas, the respondents' crop yield and its relationship to their socioeconomic factor and their production practices. It also evaluated the profitability of the farm categories and crop enterprises. An inverse relationship was noted between the yield of all the crops and their farm categories in the study area.

The relationship between the farmers yield and their socioeconomic factors were described in section (6.1.1 – 6.1.7) and a positive relationship was found between yam and cassava yield and the age and years of farming experience of the farmers. A negative relationship was noted between the respondents' rice and yam yield and their distance to the extension office.

Details of the respondents yield relationship with their production practices were described in sections (6.2.1 – 6.2.7) and one of the key findings is the positive relationship between yield and fertilizer application for all the crops. The profitability of the crop enterprises was described in section (6.3 – 6.3.2) and it reveals that rice farms give the best return to investment in the study area.

Chapter Seven

Determinants of agricultural technology adoption by farmers: A Bivariate Probit Analysis

7.0 Introduction

Several studies such as (Shiyani et al. 2002, Floyed et al. 2003, Ransom et al. 2003 and Rahman 2008) have analysed the determinants of adoption of modern/improved technologies such as High yield variety (HYV), irrigation and fertilizer by farmers in their respective studies. These are largely univariate probit or Tobit regressions of technology adoption on variables representing the socio economic characteristics or circumstances of farmers. The implicit theoretical underpinning of such modelling is discussed in Chapter 3.

A bivariate probit model in this study is developed to empirically investigate the socio-economic factors underlying the decision to adopt HYV and/or fertilizer usage. The dependent variable is whether the farmer adopts HYV and/or fertilizer; for HYV represented by dv, the variable takes the value of 1 if the farmer adopts HYV and 0 if otherwise. Similarly, for fertilizer, represented by df, the variable takes the value of 1 if the farmer adopts fertilizer and 0 if otherwise. Therefore, in a bivariate probit model, there are four possibilities and they are:

1. The non-adoption of both technologies (dv=0, df=0)
2. The adoption of fertilizer only (dv=0, df=1)
3. The adoption of HYV only (dv=1, df=0)
4. The adoption of both technologies (dv=1, df=1)

Variables were chosen, representing the socioeconomic circumstances of farmers in the study area and based on existing literature of technology adoption, which offer similar justification (Rahman, 2008). Also, the analysis of how some key socioeconomic circumstances and production practices of farmers relate to their crop yield (Chapter 6), influenced the choice of variable included in the bivariate probit analysis.

Therefore, the socio economic variables selected to explain the adoption decisions are: family size, farming experience, farmer's educational level, farm size, distance to extension office, gender of household head, main occupation of household head, farmer's training, proportion of rented-in land; number of extension contacts and ranks of decision to adopt HYV such as high yield, high profit, high quality and ready market.

The age of the respondents was not considered as a variable because the effects of age as a variable is inherent in the years of farming experience of the farmers; which was consider to be a more reliable variable given the main objectives of the study. Also the quadratic effects of age or any other variables (e.g. education) are not considered. This is because we are estimating a complex model, i.e. bivariate probit; therefore only simple direct effects of individual variable regression were considered.

Educational level is commonly used as an explanatory variable in many adoption studies such as Adesina and Baidu-Faoson (1995) and Nkamleu and Adesina (2000). The educational level is chosen as a variable for a number of reasons: at technical level, access to information and the capacity to understand the technical aspects and profitability may influence the crop production decision. The decision to include farming experience is straightforward; experienced farmers may be more likely to be open to adopting agricultural technology and have more access to land, especially in a developing country like Nigeria.

Distance to extension centre and number of extension contacts can be singled out as one of the important sources of information dissemination directly relevant to agricultural production practices, especially in counties like Nigeria where farmers have limited access to information. This fact is reinforced in studies like Adesina and Zinnah (1993) that find a significant influence of extension education on the adoption of land-improving technology. Also the distance to extension centre reflects the distance to input purchase centre, since this is where most of the farmers go to buy farm inputs like fertilizer and HYV seed from ADP. In addition, the ranking of the reasons for adopting HYV were included as variables to account for their influence in the decision to adopt HYV. The ranking identifies the revealed preference of the farmers on factors that will influence their decision to adopt HYV seeds

Therefore, this chapter will evaluate the agricultural technology adoption pattern as it relates to farm categories, and determine if agricultural technology is being adopted as a package in the study area. Lastly, it will evaluate the determinants of agricultural technology adoption by all the respondents and by rice, yam and cassava farmers using a bivariate probit analysis.

7.1 Agricultural Technology Adoption as a Package and Farm Categories of Respondents

This section discusses the agricultural technology adoption pattern of the respondents and evaluates if agricultural technology is being adopted as a package in the study area.

Table 7.1: Agricultural technology adoption pattern and farm categories of respondents

Farm Category	Agricultural Technology Adoption Pattern in Percentage				
	Non Adopters	Only Fertilizer Adopters	Only HYV Adopters	Adopters of Both	Total
Small	36.12 (117)	12.96 (42)	20.06 (65)	30.86 (100)	81.00 (324)
Medium	27.91 (12)	41.86 (18)	18.60 (8)	11.63 (5)	10.75 (43)
Large	24.24 (8)	42.43 (14)	6.06 (2)	27.27 (9)	8.25 (33)
Total	34.25 (137)	18.50 (74)	18.75 (75)	28.50 (114)	400

Source: Field Survey 2011 (NB: the parentheses are predicted estimated frequency)

Taken as a whole, Table 7.1 shows that only 28.50% of the respondents adopted agricultural technology as a package (fertilizer and HYV) in the study area, of which most of the adopters are small scale farms (87.72%) and the others are large (7.89%) and medium (4.39%) scale farms respectively. This finding is consistent with Madukwe, et al. (2002) and Agwu, (2004) who noted a low adoption of agricultural technology among cowpea farmers in his study of factors influencing adoption of improved cowpea production technology in Nigeria. Also the low adoption of agricultural technology as a package may be associated with the constraints affecting agricultural technology adoption as discussed in Chapter 9.

Similarly, only 18.50% and 18.75% of respondents adopted one element of the technology, which is fertilizer technology and HYV technology respectively, in the study area. Whereas most of the farmers that adopted either of the elements of the technologies are small scale farmers, more of them adopted HYV than fertilizer. This may be because of the cost of HYV relative to that of fertilizer, as discussed in Chapter 5.

Table 7.1 also reveals that high numbers of the respondents (34.25%) did not adopt any of the agricultural technology in the study area. This finding is consistent with studies such as Ajayi, (1996), Madukwe, et al. (2002) and Agwu, (2004) that noted low level adoption of agricultural technology in Nigeria in their respective studies. Just as stated before, the low level of adoption in the study area may be associated with the constraints and barriers militating against agricultural technology adoption as discussed in Chapter 9 and literature.

Across the farm categories, most of the farmers who adopted both technologies (87.72%) and either of the technologies (56.76% and 86.67%) respectively are small scale farmers; whilst medium and large scale farms are more likely to adopt fertilizer technology than either HYV seeds or both technologies. This implies that small scale farms are more likely to adopt HYV than fertilizer, while medium and large scale farms are more likely to do the opposite. These findings are consistent with (ibid), that noted in their studies that most of the adopters of agricultural technologies are small scale farms.

Almost a third of small scale farms and a quarter of medium and large scale farms did not adopt any technology in the study area. This highlights the main issue of low agricultural productivity in Nigeria and this finding is consistent with studies such as Obasi, et al. (2013), Igwe, (2013) and Agwu, (2004) that noted low productivity, low profitability of farm enterprises and low and non-adoption of agricultural technologies in their respective studies.

Adoption of agricultural technology as a package is the main principal behind the success of the Green Revolution in Asia as discussed in Chapter 2; this principal is not being applied in the study area as shown in the table. This may be due to the constraints and non-availability of credit facilities as discussed in Chapter 9. The main findings from this study are that a third of respondents either do not adopt or partially adopted only one element of the technology and that only 28.50% adopted agricultural technology as a package. More needs to be done to address the constraints affecting the adoption of agricultural technology in the study area and encourage the non-adopters and partial adopters to fully adopt agricultural technology as a package.

7. 2 Summary Statistics of Variables

A summary of the statistics of the variables used in the bivariate probit analysis is presented in Table 7.2, classified by adoption category. It provides a summary of the characteristics of the farms and shows that 52% of the respondents said that their main occupation is farming while the rest (48%) have other main or part-time occupation. Likewise, across the adoption categories, most of the adopters of both technologies and fertilizer and fewer of the non-adopters and HYV adopters have farming as their main occupation. The average years of educational level of respondent (7.84) is above the national average for farmers. This may be because of 48% of respondents do not having farming as their main occupation and therefore, are more likely to have some kind of education (Igwe, 2013). The mean years of farming experience is 20 years and across the adoption categories, the adopters of technology have a much higher level of farming experience than non-adopters.

Most of the respondents are male and the mean family size is 4; while the average farm size in the study area is 1.27 hectares. The mean distance to an extension centre is 3.64 km in difficult rural terrain and adopters of both technologies are closer to the extension centre. Only 8% and 11% of respondents have any agricultural technology adoption training and have contact with extension agents in the study area respectively; while only 17% of the farm land in the study area is rented-in.

The ranking of reasons for adopting HYV were used as variables to reflect how they influence the decision to adopt agricultural technology, the high yield rank (0.85) has the highest influence, while the high profit rank reason (0.53) has the least influence on the decision to adopt agricultural technology.

Table 7.2: Summary statistics of the variables

Variables	Unit of Measurement	All sample		Non-Adopters (dv=0,df=0)	Only fertilizer Adopters (dv=0,df=1)	Only HYV Adopters (dv=1,df=0)	Adopters of Both (dv=1,df=1)	F-test
		Mean	Std. D	Mean	Mean	Mean	Mean	
Family size	Person per household	3.88	1.91	3.59	4.51	3.76	3.88	3.92***
Farming experience	Years	19.78	13.61	14.24	22.24	17.04	26.71	22.19***
Educational level of farmer	Completed years of schooling	7.84	4.73	9.26	6.88	9.03	5.96	13.98***
Farm size	Hectare	1.27	1.11	1.26	1.13	1.13	0.95	13.88***
Distance to extension centre	Kilometre (Km)	3.64	3.56	5.16	3.97	3.97	1.48	26.88***
Gender	Dummy (1 if male and 0 if female)	0.81	0.39	0.72	0.85	0.79	0.90	5.19***
Main occupation	Dummy (1 if farmer and 0 if otherwise)	0.52	0.50	0.38	0.67	0.36	0.69	14.41***
Farmers training	Number	0.08	0.27	0.13	0.05	0.11	0.04	2.93**
Proportion of rented-in land		0.17	0.34	0.20	0.21	0.14	0.12	1.69
Extension contact	Number	0.11	0.47	0.15	0.16	0.08	0.04	1.53
High yield rank	Dummy (1 if yes and 0 if otherwise)	0.85	0.27	0.88	0.81	0.84	0.84	1.31
High profit rank	Dummy (1 if yes and 0 if otherwise)	0.53	0.41	0.37	0.57	0.49	0.70	15.60***
High quality rank	Dummy (1 if yes and 0 if otherwise)	0.81	0.27	0.82	0.79	0.82	0.80	0.30
Ready market rank	Dummy (1 if yes and 0 if otherwise)	0.60	0.37	0.57	0.71	0.55	0.60	2.64**
Number of respondents		400		137	74	75	114	

Source: Field survey 2011. Note: *** significant at 1% (p<0.01), ** significant at 5% (p<0.05) and *significant at 10% (p<0.10) (One-way ANOVA using generalized linear model (GLM))

Table 7.2 also shows the distinct features of farms, based on their adoption status. The F-test results show that except for a proportion of rented-in land, extension contact, high yield rank and high quality rank, significant differences exist across the farm adoption category with respect to the socio-economic circumstances of these farm households.

Just as stated before, for example, the years of farming experience is significantly higher among the adopters of both technologies (dv =1, df = 1) and most of them are male and have farming as their main occupation. Also they have significantly smaller farm size and are located at a shorter distance from the extension centre.

On the other hand, the adoption of HYV only (dv = 1, df = 0) has the lowest number of years of farming experience among those that adopt any technology, and the same farm size and distance to the extension centre with the adopters of fertilizer only (dv =0, df = 1). Their main occupation is mostly not farming and the fertilizer only adopters have the largest family size. Of the rank variables, only high profit rank and ready market rank are significant across the adoption categories.

7.3 Overall Bivariate Probit Analysis of Determinants of Agricultural Technology Adoption by All the Farmers

The results of the determinants of adoption of agricultural technology as an estimation of the bivariate probit model for all farmers are presented in the tables below. The key hypothesis that the correlation of the disturbance term between two equations dv and df is zero $\{p(dv, df)\}$ is strongly rejected at the 10 percent level of significance; implying that the use of a bivariate model to determine agricultural technology adoption decisions among farmers is justified (Rahman, 2008).

Five variables each have a significant relation with the decision to adopt HYV and the decision to adopt fertilizer respectively. Table 7.3 shows that farming experience has a significant positive relationship with the decision to adopt HYV; which means that older farmers are more likely to adopt HYV since they have better access to land and capital (Igwe, 2013). Also farm size and distance to extension centre have a significant negative relationship with the decision to adopt HYV. This is in line with literature and other similar studies in Nigeria and other developing countries (Ajibefun et al 2002, Rahman, 2011, Fabusoro et al 2010 and Igwe, 2013) that showed that small-scale farmers dominate agricultural production and that small scale farms are better managed than large scale farms. It is expected that the further away a farmer is from the extension centre, the more unlikely he is to adopt agricultural technology.

The table also shows that the decision to adopt HYV due to its high profitability (rank) has a significant and positive relationship with the decision to adopt HYV. This is expected and means that high profitability is one of the key factors that influence the decision to adopt HYV. While in the case for the ready market (rank), even though it is significantly related to the decision to adopt HYV, the negative coefficient implies that it is not the main factor that influences farmer’s decision to adopt or not to adopt HYV.

Table 7.3: Overall bivariate probit analysis of the decision to adopt HYV and/or fertilizer by all the respondents

Variables	Adoption of HYV		Adoption of fertilizer	
	Coefficient	t-ratio	Coefficient	t-ratio
Constant	0.083	0.213	-0.108	-0.336
Family size	-0.041	-0.966	-0.031	-0.72
Farming experience	0.029***	3.198	0.017**	2.215
Education of farmer	-0.014	-0.648	-0.035*	-1.909
Farm size	-0.289***	-3.422	0.077	1.079
Extension distance	-0.054***	-2.461	-0.106***	-6.064
Gender	0.156	0.795	0.316*	1.68
Main occupation	-0.302	-1.383	0.271	1.393
Farmers training	-0.027	-0.114	-0.660**	-2.089
Proportion of rented-in land	-0.100	-0.418	0.150	0.714
Extension contact	-0.190	-0.98	-0.102	-0.487
High yield rank	0.353	0.875		
High profit rank	1.181***	4.014		
High quality rank	-0.243	-0.601		
Ready market rank	-0.859***	-2.942		
Model diagnostic				
Correlation between the error terms: p (HYV, Fert.)	0.181*		1.842	
Log likelihood	-447.3995			
Number of observation	400			

Source: Field Survey 2011 (Note: ***=significant at 1 percent level (p<0.01); **=significant at 5 percent level (p<0.05); *=significant at 10 percent level (p<0.10))

On the other hand, farming experience and gender have significant positive relationships to the decision to adopt fertilizer, as expected. This corroborates the findings of Chirwa, (2005) and Rahman (2008), who note that educational level and farming experience both have a significant relationship with adoption in their respective studies. Distance to extension centre and farmers' training are significantly and negatively related to the decision to adopt fertilizer. That of distance to extension centre is expected, due to the state of infrastructure in Nigeria and most developing countries (Igwe, 2013) but that of farmers' training is not expected and underlines the state of agricultural extension services in

Nigeria and what it will take to make it effective, as reviewed in the literature and research interviews.

Table 7.4: Overall actual and predicted frequency of adopting HYV and/or adopting fertilizer

		Adoption of fertilizer		Total
		Non-adopter	Adopter	
Adoption of HYV	Non-adopter	137 (201)	74 (41)	211 (242)
	Adopter	75 (20)	114 (138)	189 (158)
	Total	212 (221)	188 (179)	400 (400)
Accuracy of joint prediction (%)				
Non-adopter of any	(dv=0 and df=0)			79.6
Only fertilizer adopter	(dv=0 and df=1)			24.3
Only HYV adopter	(dv=1 and df=0)			8.0
Adopter of both HYV and fertilizer	(dv=1 and dv=1)			74.6

Source: Field Survey 2011 Note: (Figures in parentheses are the predicted frequencies). The marginal means in the model are the univariate probabilities that the two variables equal one. NLOGIT-4 analyses the condition mean:

$E[dv\backslash df = 1, Z_1Z_2] = Prob[dv = 1\backslash df = 1, Z_1Z_2\rho]|Prob[df = 1|Z_1]$ $(ESI, 2007)$

The actual and predicted frequency of the adoption of HYV and/or fertilizer is presented in Table 7.4. The predictability of non-adoption of both technologies and the adoption of both technologies is very strong. This becomes weak when the farmer adopts fertilizer only and even weaker when he adopts HYV only. This is expected, as shown in Chapter 9, research interviews and literature review; agricultural extension services and input availability are major constraints hindering agricultural technology adoption and production in Nigeria (Madukwe et al. (2002), Ayansina, (2011), Fabusoro et al 2010 and Igwe, 2013). The low level of accuracy of joint prediction of HYV seeds only (dv=1, df=0) and inorganic fertilizer only (dv=0, df=1) may be because of their low level of adoption. This implies that the accuracy of joint prediction reflects the level of adoption or non-adoption of the different technologies. The table shows a robust result for the two extremes but that of HYV only and fertilizer only underline the fact that agricultural technology is not being adopted as a package.

Table 7.5: Overall bivariate probit total marginal effect of the variables on the decision to adopt HYV conditional on the adoption of fertilizer

Variables	Total Marginal Effect	
	Effect	t-ratio
Family size	-0.015	-0.887
Farming experience	0.011***	2.967
Education of farmer	-0.004	-0.443
Farm size	-0.120***	-3.479
Extension distance	-0.017*	-1.784
Gender	0.047	0.601
Main occupation	-0.134	-1.53
Farmers training	0.021	0.213
Proportion of rented-in land	-0.047	-0.493
Extension contact	-0.071	-0.907
High yield rank	0.142	0.876
High profit rank	0.474***	4.031
High quality rank	-0.097	-0.602
Ready market rank	-0.344***	-2.944

Source: Field Survey 2011: Note: The total marginal effect is decomposed into a direct effect produced by the presence of the variable in the first equation (i.e. dv) and an indirect effect produced by the presence of the same variable in the second equation (i.e. df) respectively. The total marginal effects are the partial derivatives of the explanatory variables on the probability of adopting HYV conditional on the adoption of fertilizer: i.e.; $E\left[dv|df = 1, Z_{1,}Z_2\right] = Prob\left[dv = 1|df = 1, Z_{1,}Z_2\rho\right]|\ Prob[df = 1|Z_1]$ .The joint probability of adopting HYV conditional on the adoption of fertilizer is 0.54. The effects of the dummy variables are computed using $E\ [dv \backslash df = 1, v = 1] - E[dv|df = 1, v = 0]$, where v is the dummy variable (ESI, 2007). (***=significant at 1 percent level (p<0.01); **=significant at 5 percent level (p<0.05); *=significant at 10 percent level (p<0.10)).

The major advantage of the bivariate probit model is the explicit appearance of the joint probabilities and the ease with which marginal effects on this can be calculated (Christofides et al. 1997). The marginal effects are presented in Table 7.5. It is the combination of direct and indirect effects of the explanatory variables on the probability of joint adoption of HYV on the adoption of fertilizer $(\{i\ e., E\left[\frac{dv}{df} = 1, Z_{1,}Z_2\right])$. The predicted joint probability of adopting HYV on fertilizer is estimated at 0.54. The table also shows that five variables have a significant related probability for the adoption of HYV, given the farmers have already adopted fertilizer. Consider for example, the farming experience variable; there is a direct effect produced by its presence in the first equation$(i.e., dv)$; but there is also an indirect effect produced in the second equation$(i.e., df)$. Therefore, the total effect of farming experience is the sum of these two parts, numerically; the effect appears to be exerted by the farming experience variable which has a coefficient of +0.011. This variable, however, cannot change by a full unit because it is a proportion (Greene, 2003).This implies, that a one percent increase in one year of farming experience will increase the probability of adopting HYV by +0.011, conditional on fertilizer adoption.

Farm size and distance to extension centre have a significant but negative coefficient on the probability of adopting HYV, given the adoption of fertilizer. The negative coefficient of the farm size (-0.120) implies that large scale farms may be less likely to adopt HYV seeds relative to small scale farms. This may be because as shown in Chapter 9, there are lots of constraints meditating against the availability of far inputs in the study area, especially that of HYV seeds when needed. Given the large farm size of large scale farmers, this may affect their ability to source enough HYV seeds to cover their farm land; thereby leading to them sourcing an alternative source of planting material. These findings are consistent with other studies in Nigeria like Ajibefun et al (1996), Fabusoro et al (2010) and Igwe, (2013) that noted that small-scale farmers produced 90% of food crops in Nigeria, and it is expected that the further a farmer is from the extension centre the more unlikely he is to adopt agricultural technology.

The ranking of farmers' reasons for adopting HYV seeds were included as a variable to account for their influence in their decision to adopt HYVs. It reveals farmers preference on factors that will influence their adoption of HYVs. The high profit (rank) was noted to have the highest positive coefficient of all the significant variables. This indicates that it is the most important factor that influences the probability of adopting HYV, given that the farmer has already adopted fertilizer. This implies that the high profitability of a variety influences the farmer's decision to either adopt the same variety or to switch to another perceived more profitable variety. Ready market (rank) also has a significant but negative probability of adopting HYV by -0.344, conditional on fertilizer adoption. This means that ready market for HYV is not the main factor that influences the adoption of HYV and/or fertilizer.

7.4 A Bivariate Probit Analysis of Determinants of Agricultural Technology Adoption by Rice Farmers

The results of the determinants of adoption of agricultural technology as an estimation of the bivariate probit model for rice farmers are presented in Table 7.6a. The key hypothesis that the correlation of the disturbance term between two equations dv and df is zero $\{p(dv, df)\}$ is not significant; implying that they are not correlated. Therefore a single equation probit model was adopted to analyse the correlation between the decision to adopt the technologies (HYV, Fertilizer) independently by rice farmers and the result is presented in Table 7.6b. The non-correlation may be because of the three crops cultivated by farmers in the study area, rice is the one that most needs irrigation and as shown in Chapter 5, none of the farmers have access to irrigation.

The result shows that only two variables have a significant relationship with the decision to adopt HYV; that is years of farming experience and family size and this is in line with Rahman, (2008) who noted that both the educational level of the farmers and the farming experience have a significant positive relationship to the decision to adopt a diversified cropping system in Bangladesh. Family size has a significant but negative relationship with the decision to adopt HYV. This is not expected but as stated by Obasi, et al. (2013) in his study, large family size has a significant influence on farm productivity only if the family members are directly involved in the farming activities.

On the other hand; the proportion of rented–in land has a significant positive relationship with the decision to adopt fertilizer; it means that the more the proportion of farm land that is rented-in the more likely for the farmer to adopt fertilizer. This may be because most farmers either pay rent, proportion of farm output or in kind for renting-in farm land (Rahman, 2011 and Igwe 2013). Therefore they would like to optimize their farm output from the land to cover the cost of renting-in the land or to account for the proportion of their farm output that needs to go to the land owner.

Table 7.6a: Rice farmers' bivariate probit analysis of the decision to adopt HYV and/or fertilizer

Variables	Adoption of HYV		Adoption of fertilizer	
	Coefficient	t-ratio	Coefficient	t-ratio
Constant	-0.037	-0.049	0.231	0.319
Family size	-0.171**	-2.116	-0.029	-0.421
Farming experience	0.026**	1.957	0.016	1.193
Education of farmer	0.054	1.326	-0.019	-0.497
Farm size	-0.105	-0.514	-0.120	-0.641
Extension distance	0.012	0.346	-0.079**	-2.36
Gender	-0.593	-1.357	-0.139	-0.301
Main occupation	0.108	0.278	0.527	1.402
Farmers training	0.014	0.018	-0.482	-0.7
Proportion of rented-in land	0.194	0.441	1.061*	1.813
Extension contact	-0.135	-0.405	0.096	0.392
High yield rank	-0.647	-0.747		
High profit rank	0.440	0.94		
High quality rank	0.394	0.397		
Ready market rank	-0.276	-0.474		
Model diagnostic				
Correlation between the error terms: p (HYV, Fert.)	-0.158		-0.984	
Log likelihood	-163.876			
Number of respondents	143			

Source: Field Survey 2011

***=significant at 1 percent level (p<0.01) **=significant at 5 percent level (p<0.05)

*=significant at 10 percent level (p<0.10)

This is expected, since the farmer may be paying rent or share of the crop for renting the land and therefore would like to maximize his output. The table also shows that the distance to the extension centre has a significant but negative relationship to the decision to adopt fertilizer. This implies that the further away the farmer is from the extension centre the more unlikely he is to adopt fertilizer. This is expected and is consistent with similar studies like Chirwa, (2005) and the literature review. Other variables do not show any significant relationship to the decision to adopt HYV or fertilizer. For example, variables like farmers' training and number of extension contacts even when available are not adequate enough to make any significant impact, especially in developing countries like Nigeria (Igwe, 2013).

Table 7.6b: Rice farmers single equation probit model analysis of the decision to adopt HYV or fertilizer independently

Variables	HVY Probit		Fertilizer Probit	
	coefficient	t-ratio	coefficient	t-ratio
Constant	-0.053	-0.079	0.209	0.325
Family size	-0.173***	-2.452	-0.030	-0.449
Farming experience	0.026**	2.138	0.017	1.353
Education of farmer	0.054	1.442	-0.017	-0.469
Farm size	-0.097	-0.539	-0.123	-0.749
Extension distance	0.010	0.295	-0.079**	-2.345
Gender	-0.592	-1.448	-0.136	-0.332
Main occupation	0.100	0.288	0.529	1.558
Farmers training	0.015	0.026	-0.480	-0.831
Proportion of rented-in land	0.192	0.51	1.039**	2.361
Extension contact	-0.149	-0.625	0.096	0.457
High yield rank	-0.663	-0.92		
High profit rank	0.389	0.885		
High quality rank	0.461	0.561		
Ready market rank	-0.230	-0.437		
Log Likelihood for HYV	-83.820			
Log Likelihood for Fertilizer	-80.572			
Number of respondents	143			

Source: Field Survey 2011Note: The probit for both HYV and fertilizer were independently determined.

***=significant at 1 percent level (p<0.01) **=significant at 5 percent level (p<0.05)

*=significant at 10 percent level (p<0.10)

The actual and predicted frequency of the adoption of HYV and/or fertilizer is presented in Table 7.7a below. The predictability of non-adoption of both technologies is strong but that of adoption of fertilizer only is even stronger. This becomes weaker when the farmer adopts both HYV and fertilizer and non-existent for farmers that adopt only HYV. But since there is no correlation between HYV adoption and fertilizer adoption, the single equation probit model prediction is presented in Table 7.7b; it shows the same level of predictability for both HYV and fertilizer. Out of the three crops farmed by farmers in this study, rice is the one that needs irrigation the most for optimal productivity (1912 litres/kg), but as shown in Chapter 5, irrigation or irrigation facilities are not available or inadequate in the study area (Pimentel et. al., 1997).

Table 7.7a: Rice farmers actual and predicted frequency of adopting HYV and/or adopting fertilizer

		Adoption of fertilizer		Total
		Non-adopter	Adopter	
Adoption of HYV	Non-adopter	38 (42)	58 (88)	96 (130)
	Adopter	20 (2)	27 (11)	47 (13)
	Total	58 (44)	85 (99)	143 (143)
Accuracy of joint prediction (%)				
Non-adopter of any	(dv=0 and df=0)			55.26
Only fertilizer adopter	(dv=0 and df=1)			77.59
Only HYV adopter	(dv=1 and df=0)			0.00
Adopter of both HYV and fertilizer	(dv=1 and df=1)			29.63

Source: Field Survey 2011Note: (Figures in parentheses are the predicted frequencies). The marginal means in the model are the univariate probabilities that the two variables equal one. NLOGIT-4 analyses the condition mean:

$E[dv\backslash df = 1, Z_1 Z_2] = Prob[dv = 1\backslash df = 1, Z_1 Z_2 \rho]|Prob[df = 1|Z_1]$ $(ESI, 2007)$.

Table 7.7b: Rice farmers single equation probit model prediction

Accuracy of prediction percentage	
HYV Adopters	71.33
Fertilizer Adopters	71.33

Source: Field survey, 2011

The marginal effects are presented in Table 7.8a below; they are a combination of direct and indirect effects of the explanatory variables on the probability of joint adoption of HYV on the adoption of fertilizer ($\{i\ e., E\left[\frac{dv}{df} = 1, Z_{1,} Z_2\right]$). The predicted joint probability of adopting HYV on fertilizer is estimated at 0.28. Consider for example, the family size variable; there is a direct effect produced by its presence in the first equation$(i.e., dv)$; but there is also an indirect effect produced in the second equation$(i.e., df)$. Therefore, the total effect of family size is the sum of these two parts, numerically; the effect appears to be exerted by the family size variable, which has a coefficient of -0.059. It means that an increase of family size by one person will reduce the probability of adopting HYV by -0.059, given that the farmer has already adopted fertilizer. This implies that even though family size has a significant relationship with the decision to adopt HYV and/or fertilizer, it is not a key factor that influences the decision. The table also shows that farming experience has a significant positive probability of adopting HYV of +0.009, conditional on fertilizer adoption. This means that a one percent increase in farming experience by one year will increase the probability of adopting HYV by +0.009, given that fertilizer is adopted.

Since there is no correlation between the adoption of HYV and the adoption of fertilizer, the single equation probit model for marginal effects for HYV adoption and for fertilizer adoption is presented in Table 7.8b. It shows a similar result to that observed in Table 7.8a. That is, a one percent increase in years of farming experience of the farmer by one year will increase his probability of adopting HYV by +0.009. Likewise, a one percent increase in family size by one person will reduce the probability of adopting HYV by –0.062.

On the other hand, a one percent increase in the proportion of rented-in land by one hectare will increase the probability of adopting fertilizer by +0.397 and a one percent increase in the distance to extension centre will reduce the probability of adopting fertilizer by -0.030. This is consistent with the literature and similar studies like Chirwa, (2005) and Rahman, (2008).

Table 7.8a: Rice farmers' bivariate probit total marginal effect of the variables on the decision to adopt HYV conditional on the adoption of fertilizer

Variables	Total Marginal Effect	
	Effect	t-ratio
Family size	-0.059**	-2.151
Farming experience	0.009**	2.04
Education of farmer	0.018	1.287
Farm size	-0.039	-0.563
Extension distance	0.002	0.143
Gender	-0.206	-1.376
Main occupation	0.053	0.396
Farmers training	-0.010	-0.04
Proportion of rented-in land	0.099	0.625
Extension contact	-0.043	-0.378
High yield rank	-0.220	-0.749
High profit rank	0.149	0.938
High quality rank	0.134	0.398
Ready market rank	-0.094	-0.475

Source: Field Survey 2011: Note: The total marginal effect is decomposed into a direct effect produced by the presence of the variable in the first equation (i.e. dv) and an indirect effect produced by the presence of the same variable in the second equation (i.e. df) respectively. The total marginal effects are the partial derivatives of the explanatory variables on the probability of adopting HYV conditional on the adoption of fertilizer: i.e.; $E\left[dv|df = 1, Z_{1,}Z_2\right] = Prob\left[dv = 1|df = 1, Z_{1,}Z_2\rho\right]|\, Prob[df = 1|Z_1]$. The joint probability of adopting HYV conditional on the adoption of fertilizer is 0.28. The effects of the dummy variables are computed using $E\ [dv\backslash df = 1, v = 1] - E[dv|df = 1, v = 0]$, where v is the dummy variable (ESI, 2007).

***=significant at 1 percent level (p<0.01)

**=significant at 5 percent level (p<0.05)

*=significant at 10 percent level (p<0.10)

Table 7.8b: Rice farmers single equation probit model marginal effect

Variables	HYV Total Marginal Effect		Fertilizer Total Marginal Effect	
	Effect	t-ratio	Effect	t-ratio
Family size	-0.062**	-2.46	-0.011	-0.449
Farming experience	0.009**	2.136	0.006	1.355
Education of farmer	0.019	1.442	-0.007	-0.469
Farm size	-0.035	-0.539	-0.047	-0.75
Extension distance	0.004	0.295	-0.030**	-2.344
Gender	-0.227	-1.409	-0.051	-0.339
Main occupation	0.035	0.291	0.205	1.563
Farmers training	0.005	0.026	-0.189	-0.834
Proportion of rented-in land	0.068	0.51	0.397**	2.375
Extension contact	-0.053	-0.626	0.037	0.457
High yield rank	-0.236	-0.921		
High profit rank	0.139	0.886		
High quality rank	0.164	0.562		
Ready market rank	-0.082	-0.437		

Source: Field Survey 2011 Note: The marginal effect were independently determined for both HYV and fertilizer adoption. ***=significant at 1 percent level ($p<0.01$) **=significant at 5 percent level ($p<0.05$) *=significant at 10 percent level ($p<0.10$)

7.5 A Bivariate Probit Analysis of Determinants of Agricultural Technology Adoption by Yam Farmers

The results of the determinants of adoption of agricultural technology as an estimation of the bivariate probit model for yam farmers are presented in the tables below. The key hypothesis is that the correlation of the disturbance term between two equations is the same as that of the overall bivariate probit analysis of the crops (Section 7.3). Table 7.9 shows that three variables have a significant relationship with the decision to adopt HYV, while three variables also have a significant relationship with the decision to adopt fertilizer.

Farming experience, farm size and distance to extension centre are all significantly related to the decision to adopt HYV. This corroborates with the findings of Chirwa, (2005) who notes similar results in his study of adoption of fertilizer and hybrid seeds by smallholder maize farmers in southern Malawi.

Table 7.9: Yam farmers' bivariate probit analysis of the decision to adopt HYV and/or fertilizer

Variables	Adoption of HYV		Adoption of fertilizer	
	Coefficient	t-ratio	Coefficient	t-ratio
Constant	1.178	0.656	0.003	0.007
Family size	-0.169	-1.133	-0.116**	-2.173
Farming experience	0.080***	3.029	0.025***	2.51
Education of farmer	-0.052	-0.8	-0.023	-0.955
Farm size	-2.713***	-3.934	-0.103	-0.396
Extension distance	-0.233***	-3.41	-0.161***	-4.365
Gender	0.537	0.675	0.390	1.305
Main occupation	-0.904	-1.165	0.110	0.415
Farmers training	-0.228	-0.304	-0.514	-1.015
Proportion of rented-in land	-0.080	-0.093	-0.044	-0.151
Extension contact	-5.804	0	0.065	0.212
High yield rank	-0.069	-0.064		
High profit rank	0.447	0.736		
High quality rank	-1.053	-0.728		
Ready market rank	0.080	0.11		
Model diagnostic				
Correlation between the error terms: p(HYV, Fert)	0.713***	4.434		
Log likelihood	-191.949			
Number of respondents	294			

Source: Field Survey 2011 (Note: ***=significant at 1 percent level (p<0.01); **=significant at 5 percent level (p<0.05); *=significant at 10 percent level (p<0.10))

The positive coefficient for farming experience variables (+0.080), implies that farming experience positively influences the decision to adopt HYV. Also farm size and distance to extension centre have significant but negative relationships with the decision to adopt HYV; this means that the further away a farmer is from the extension centre or the larger the farm size of the farmer the more unlikely he is to adopt HYV. This is expected and in line with the literature and studies as discussed before in this chapter.

Furthermore, farming experience significantly and positively influences the decision to adopt fertilizer. Just as stated before, it means that farmers with more experience are more likely to adopt both, since they have more access to capital and land as shown by the literature review. Also distance to extension centre and family size significantly and negatively influence the decision to adopt fertilizer. This finding is consistent with that observed for all the crops (Section 7.3) and the reasons are as discussed before.

Table 7.10: Yam farmer's actual and predicted frequency of adopting HYV and/or adopting fertilizer

		Adoption of fertilizer		Total
		Non-adopter	Adopter	
Adoption of HYV	Non-adopter	177 (206)	46 (17)	223 (223)
	Adopter	9 (0)	62 (71)	71 (71)
	Total	186 (206)	108 (88)	294 (294)
Accuracy of joint prediction (%)				
Non-adopter of any		(dv=0 and df=0)		92
Only fertilizer adopter		(dv=0 and df=1)		17
Only HYV adopter		(dv=1 and df=0)		0
Adopter of both HYV and fertilizer		(dv=1 and dv=1)		94

Source: Field Survey 2011Note: (Figures in parentheses are the predicted frequencies). The marginal means in the model are the univariate probabilities that the two variables equal one. NLOGIT-4 analyses the condition mean:

$E[dv\backslash df = 1, Z_1Z_2] = Prob[dv = 1\backslash df = 1, Z_1Z_2\rho]|Prob[df = 1|Z_1]$ $(ESI, 2007)$.

The actual and predicted frequency of the adoption of HYV and/or fertilizer is presented in Table 7.10; this shows that the predictabilities of both non-adoption and adoption of both technologies are very strong and become weaker for those that adopt only fertilizer and non-existent for those that adopt only HYV. The result is similar to that observed for overall bivariate probit analysis prediction for all the crops and the reasons already discussed (Table 7.4, Page 196).This shows a very robust result for the two extremes (non-adopters and adopters of both technologies) and a very weak one for fertilizer only adopters and non-existent for HYV only adopters underlining the problems and difficulties of accessing farm inputs in Nigeria, as shown in Chapter 9, research interviews and the literature review.

Table 7.11: Yam farmers' bivariate probit total marginal effect of the variables on the decision to adopt HYV conditional on the adoption of fertilizer

Variables	Total Marginal Effect	
	Effect	t-ratio
Family size	-0.017	-1.653
Farming experience	0.010***	2.770
Education of farmer	-0.006	-0.878
Farm size	-0.372	-2.165
Extension distance	-0.023***	-3.888
Gender	0.052	0.99
Main occupation	-0.132	-0.375
Farmers training	-0.002	--0.660
Proportion of rented-in land	-0.009	-0.122
Extension contact	-0.813	0.106
High yield rank	-0.010	-0.064
High profit rank	0.062	0.736
High quality rank	-0.147	-0.728
Ready market rank	0.011	0.11

Source: Field Survey 2011: Note: The total marginal effect is decomposed into a direct effect produced by the presence of the variable in the first equation (i.e. dv) and an indirect effect produced by the presence of the same variable in the second equation (i.e. df) respectively. The total marginal effects are the partial derivatives of the explanatory variables on the probability of adopting HYV conditional on the adoption of fertilizer: i.e.; $E\left[dv|df = 1, Z_{1,}Z_2\right] = Prob\left[dv = 1|df = 1, Z_{1,}Z_2\rho\right]|\ Prob[df = 1|Z_1]$. The joint probability of adopting HYV conditional on the adoption of fertilizer is 0.60. The effects of the dummy variables are computed using $E\ [dv\backslash df = 1, v = 1] - E[dv|df = 1, v = 0]$, where v is the dummy variable (ESI, 2007). (***=significant at 1 percent level (p<0.01); **=significant at 5 percent level (p<0.05); *=significant at 10 percent level (p<0.10)).

The total marginal effect of the decision to adopt HYV on fertilizer is presented in Table 7.11; this is the joint effects of both direct and indirect effects of the explanatory variables on the probability of joint adoption of both HYV and/or fertilizer. The predicted joint probability of adopting HYV conditional on fertilizer adoption is estimated at 0.59. This means that a one percent increase in farming experience by one year increases the probability of adopting HYV by only +0.01, given that the farmer has already adopted fertilizer. Likewise, a one percent increase in distance between farmers and the extension centre will reduce the probability of adopting HYV by -0.023, conditional on fertilizer adoption, which is in line with literature.

7.6 A Bivariate Probit Analysis of Determinants of Agricultural Technology Adoption by Cassava Farmers

The results of the determinants of adoption of agricultural technology as an estimation of the bivariate probit model for cassava farmers are presented in the tables below. The key hypothesis that the correlation of the disturbance terms between the two equations dv and df is zero $\{p(dv, df)\}$ is the same as those observed for the overall bivariate probit analysis for all the crops (Section, 7.3).

Table 7.12: Cassava farmer's bivariate probit analysis of the decision to adopt HYV and/or fertilizer

Variables	Adoption of HYV		Adoption of fertilizer	
	Coefficient	t-ratio	Coefficient	t-ratio
Constant	0.838	1.24	0.114	0.303
Family size	-0.076	-1.49	-0.110**	-2.279
Farming experience	0.025**	2.331	0.015	1.575
Education of farmer	-0.023	-0.952	-0.030	-1.422
Farm size	-0.567**	-2.18	-0.367*	-1.675
Extension distance	-0.119***	-4.701	-0.111***	-5.911
Gender	0.289	1.282	0.425*	1.883
Main occupation	-0.744***	-2.812	0.084	0.378
Farmers training	0.311	1.209	-0.365	-1.051
Proportion of rented-in land	0.005	0.017	-0.425	-1.318
Extension contact	-0.479	-1.813	0.155	0.898
High yield rank	0.366	0.809		
High profit rank	0.934	3.018		
High quality rank	-0.381	-0.758		
Ready market rank	-1.008***	-3.569		
Model diagnostic				
Correlation between the error terms: p(HYV, Fert)	0.376***	3.319		
Log likelihood	-340.7368			
Number of respondents	344			

Source: Field Survey 2011 (Note: ***=significant at 1 percent level (p<0.01); **=significant at 5 percent level (p<0.05); *=significant at 10 percent level (p<0.10))

Five variables (Table 7.12) have a significant relationship with the decision to adopt HYV while four variables have a significant relationship with the decision to adopt fertilizer. This implies that farming experience, farm size, distance to extension centre, main occupation of household head and ready market (rank) decision to adopt HYV are all significantly related to the decision to adopt HYV; while family size, farm size, distance to extension centre and gender are significantly related to the decision to adopt fertilizer.

Therefore, the table shows that farming experience significantly and positively influences the decision to adopt HYV; which means that more experienced farmers are more likely to adopt HYV because they have the means and could afford the risk, as shown in the literature review. Also farm size, distance to extension centre and main occupation of household heads significantly and negatively influences the decision to adopt both HYV and fertilizer; this is consistent with the literature review. Ready market (rank) reason for adopting HYV has a significant but negative coefficient; meaning that even though it influences the decision to adopt HYV, it is not the most important factor.

On the other hand, gender has a significant and positive relationship to the decision to adopt fertilizer, meaning that male farm heads of household are more likely to adopt fertilizer. Likewise, family size, farm size and distance to extension centre have significant but negative relationships with the decision to adopt fertilizer; as mentioned before this is consistent with literature review and similar studies like Ajibefun et al (1996), Chirwa, (2005), Rahman, (2008).

Similar to that observed for both the overall and yam bivariate probit analysis prediction; the actual and predicted frequency of the adoption of HYV and/or fertilizer for cassava farmers is presented in Table 7.13. It shows that the predictabilities of both non-adoption and adoption of agricultural technologies is very strong but becomes weaker for only HYV adopters and non-existent for only fertilizer adopters. This reveals a very strong robust predictability for the two extremes and indicates the state of availability of agricultural inputs in Nigeria and the state of its agricultural extension services.

Table 7.13: Cassava farmer's actual and predicted frequency of adopting HYV and/or adopting fertilizer

		Adoption of fertilizer		Total
		Non-adopter	Adopter	
Adoption of HYV	Non-adopter	175 (240)	30 (1)	205 (241)
	Adopter	69 (32)	70 (71)	139 (103)
	Total	244 (272)	100 (72)	344 (344)
Accuracy of joint prediction (%)				
Non-adopter of any		(dv=0 and df=0)		91
Only fertilizer adopter		(dv=0 and df=1)		0
Only HYV adopter		(dv=1 and df=0)		7
Adopter of both HYV and fertilizer		(dv=1 and df=1)		70

Source: Field Survey 2011Note: (Figures in parentheses are the predicted frequencies). The marginal means in the model are the univariate probabilities that the two variables equal one. NLOGIT-4 analyses the condition mean:

$E[dv \backslash df = 1, Z_1 Z_2] = Prob[dv = 1 \backslash df = 1, Z_1 Z_2 \rho]|Prob[df = 1|Z_1]$ $(ESI, 2007)$.

On the other hand, the total marginal effect of the decision to adopt HYV and/or fertilizer is presented in Table 7.13; this is the combined effects of direct and indirect effects of the explanatory variables on the probability of joint adoption of HYV on the adoption of fertilizer. The predicted joint probability of adopting HYV conditional on fertilizer adoption is estimated at 0.58. Seven variables have a significant predicted joint probability of adopting HYV conditional on fertilizer adoption.

This means that a one percent increase in one year of farming experience will increase the probability of adopting HYV by +0.008, given that the farmer has already adopted fertilizer. Likewise, a one percent increase in either farm size, distance to extension centre or number of extension contacts will negatively increase the probability of adopting HYV by (-0.191, -0.036 or 0.318) respectively, conditional on fertilizer adoption.

Table 7.14: Cassava farmers bivariate probit total marginal effect of the variables on the decision to adopt HYV conditional on the adoption of fertilizer

Variables	Total Marginal Effect	
	Effect	t-ratio
Family size	-0.019	-0.881
Farming experience	0.008**	1.959
Education of farmer	-0.006	-0.592
Farm size	-0.191*	-1.787
Extension distance	-0.036***	-3.073
Gender	0.069	0.729
Main occupation	-0.318***	-2.893
Farmers training	0.172	1.587
Proportion of rented-in land	0.052	0.434
Extension contact	-0.216**	-2.081
High yield rank	0.151	0.81
High profit rank	0.387***	3.02
High quality rank	-0.158	-0.758
Ready market rank	-0.417***	-3.543

Source: Field Survey 2011: Note: The total marginal effect is decomposed into a direct effect produced by the presence of the variable in the first equation (i.e. dv) and an indirect effect produced by the presence of the same variable in the second equation (i.e. df) respectively. The total marginal effects are the partial derivatives of the explanatory variables on the probability of adopting HYV conditional on the adoption of fertilizer: i.e.; $E\left[dv|df=1,Z_{1,}Z_2\right]=Prob\left[dv=1|df=1,Z_{1,}Z_2\rho\right]|\ Prob[df=1|Z_1]$.The joint probability of adopting HYV conditional on the adoption of fertilizer is 0.58. The effects of the dummy variables are computed using $E\ [dv\backslash df=1,v=1]-E[dv|df=1,v=0]$, where v is the dummy variable (ESI, 2007). (***=significant at 1 percent level (p<0.01); **=significant at 5 percent level (p<0.05); *=significant at 10 percent level (p<0.10)).

This underlines the scale of what it will take to make extension services and agricultural inputs readily available and effective in Nigeria as reviewed in the literature.

The table also shows that an increase of one percent in the adoption of HYV because of high profit rank in one year will increase the probability of adoption of HYV by +0.39, conditional on fertilizer adoption. Likewise an increase of one percent in the adoption of HYV due to ready market rank will reduce the probability of adopting HYV by -0.417, given that the farmer has already adopted fertilizer. This means that high profitability of the HYV is the key factor that influences the decision to adopt HYV and even though ready market for HYV influences the decision to adopt HYV, it is not one of the key factors that influence the decision.

7.7 Synthesis of the Determinants of Agricultural Technology Adoption by Farmers

The results show that the key hypothesis that the correlation of the disturbance term between the two equations dv and df is zero $\{p(dv, df)\}$ is strongly rejected at the 10 percent level of significance for all the crops; implying that the use of a bivariate model to determine agricultural technology adoption decisions among farmers is justified. Also, the accuracy of joint prediction of the decision to adopt agricultural technologies is both robust and high for non-adopters and adopters of both technologies for all the crops.

Overall, the determinants of agricultural technology adoption show that except for rice farms, all the correlation coefficients are positive and significant to the decision to adopt agricultural technology across the farm crops. For example, the correlation coefficient between the disturbance term of HYV yam and HYV cassava stem adoption functions is positive, implying that the unobservable factors which increase the probability of adopting HYV yam also increase the probability of adopting HYV cassava stems. Similarly, the unobservable factor that increases the probability of applying fertilizer in yam also increases the probability of applying fertilizer in cassava.

Out of the three main crops grown by respondents in this study, rice has the least significant variables for both the bivariate probit and marginal effects analysis; and the least accuracy of prediction of agricultural technology adoption.

This is because there was no correlation between the adoption of HYV and the adoption of fertilizer for rice farmers; hence a single equation probit model was used to determine the correlation between the adoption of HYV and the adoption of fertilizer independently. This may be due to lack of functional irrigation facilities or non-availability of any irrigation facilities in the study area as discussed in Chapter 5. Of the three main crops grown by the respondents, rice is the one that most depends on water (rainfall and/or irrigation) especially at its early stage of growth (yam, 1000mm/ annum; cassava, 400mm/annum and rice, 1912liters/kg) for optimal result (IITA, 2008, FAO, 2014). The success recorded by the Green Revolution (GR) in Asia in the early 1960s especially for rice, maize and wheat crops (Chapter 2) was mainly due to the adoption of agricultural technology as a package, and irrigation is one of the key components of the package.

Of all the significant determinant variables, farming experience and distance to the extension centre have the most effect on the adoption of both HYV seeds and fertilizer technologies. For example, a one year increase in farming experience is associated with an increase in the probability of adopting HYV seed by approximately 2.9% and fertilizer use by approximately 1.7% relative to the probability of not adopting any technology in any food crops. Wiboonpongse et al. (2012); Rahman, (2008) and Shiyani, et al. (2002) all noted the positive impact of farming experience in modern technology adoption in their respective studies. Likewise, a one kilometre increase in distance to the extension centre decreases the probability of adopting HYV seed by approximately -5.4% and fertilizer use by -10.6% relative to the probability of not adopting any technology in any food crops.

Small scale farms are more likely to adopt both technologies relative to large scale farms; this is consistent with Shiyani, (2002), who noted in his study in India that small scale farmers in comparison to large scale farmers replace local varieties with new varieties at a faster rate if additional gains are substantial. Likewise, farmers closer to an extension centre are more likely to adopt both technologies than those further away. This clearly indicates the importance of extension services in disseminating modern agricultural technologies. The role of extension in influencing modern technology adoption was also noted by Mariano et al. (2012), Uaiene et al. (2009) and Ransom et al. (2003) in their respective studies.

Finally, the overall result of bivariate probit and marginal effects of the determinants of agricultural technology adoption could have been bettered without the effect of the result of rice farmers. But rice farmers were included because it is a very important staple food crop in the study area and the effects shown underline the need for the adoption of agricultural technology as a package, especially for the rice farmer. The study also shows that the majority of the adopters of either HYV or fertilizer or both technologies are small farm size farmers, highlighting the significance of these groups of farmers to agricultural development and productivity in the study area and in Nigeria, and the need for government, NGOs and policy makers to focus more on this group. If developing countries like Nigeria are to emulate the success of the GR in Asia in the 1960s; there is need for them to realise that agricultural technology adoption is most effective if and only if it is adopted as a package.

Chapter Eight

Food Production and Availability of Staple Crops: Composition and Determinants at Farm Level

8.0 Introduction

The issue of food security/availability extensively has been discussed in the literature review (Chapter 2), It implies the provision of safe, nutritious and quantitatively and qualitatively adequate food, as well as access to it by all people; it has three dimensions (UN, 2008):

- Availability of sufficient quantities of food of appropriate quality supplied through domestic production and imports
- Access by households and individuals to appropriate foods for nutritious diet and
- Optimal uptake of nourishment, thanks to a sustaining diet, clean water and adequate sanitation, together with healthcare.

Figure 2.3 in Chapter 2 showed the four key determinants of food security, which are availability, accessibility, acceptability and adequacy (A4) (FAO, 2009a). Of these four key determinants (A4) availability is the key factor underpinning the other factors in the sense that if nothing is available, there would be no need for the other three A4s. Therefore, food availability could be said to be the single most important factor underpinning food security.

Ever since food security became of importance about fifty years ago, many scholars have tried to measure food security or insecurity. Many of these measurements are indirect and based on food balance sheets, national income distribution and consumption data (FAO, 2002). Where international, cross-sectional and national time series comparisons are undertaken, national estimations are based on average per capita availability of staple foods or apparent consumption. The estimates may also be weighted by evidence of food expenditure by income categories for countries where consumer expenditure surveys are available. The international comparison of country estimates of chronic food insecurity therefore reflect cross-sectional patterns and trends in food production, supplemented by what is recorded about trade in basic foodstuffs, as incorporated into national food balance sheets. These comparisons may be true for developed countries where this information is readily and easily available but it is often not the case in developing countries (FAO, 2002). The problem of unreliable data on production and unrecorded trade is unavoidable, but may be serious for many of the most food insecure countries in sub-Saharan Africa, where this is often the case. The recent crisis in Southern Africa highlights this issue. For example, Malawi appears to have been one of the twelve best performing countries since the early 1990s in improving food security. However, there is currently much debate about the reliability of food production data, particularly for roots and tubers in this country. These trends for countries in which these crops are important staples, especially at subsistence level, and comparisons between these and other countries (developed country) are often a source of ambiguity (FAO, 2002b).

An important intra-country gap exists in current analyses of food insecurity which focus on national level, as reflected either in averages derived as a ratio of national aggregates or a national survey estimate. This is most apparent for large countries such as Brazil, India, The Russia Federation or Nigeria where there are substantial intra-country, regional or zonal differences (FAO, 2002). Therefore any investigation or measurement of food security or insecurity that involves cross-country comparisons should be sensitive to the possibly important variability within larger economies (countries).

Taking everything into account, this study is proposing an approach of estimating a national food balance sheet that will take into account the many difficulties associated with developing countries like Nigeria. This approach is based on calculating a national food balance sheet from estimating (calculating) Partial Food Availability (PTA) at the farm level; since Total Food Available (TFA) is a combination of Produced Food (PF), Bought Food (BF) and Imported Food (IF). Out of the three, Produced food (PF) is the most difficult to estimate, but could be achieved by looking at it at farm level, using this to estimate PF, especially in developing countries where reliable records are not available. Farmers can easily provide (remember) records of the proportion of their output that was consumed in the last year, from which national PF can be estimated. In countries like Nigeria, where over 70% of the population is engaged in one form of agriculture or the other, this approach will give a more reliable picture. The methodology for this is discussed in detail in Chapter 3 and for the purpose of this study, farm level Produced Food (PF) will be referred to as Partial Food Availability (PFA), which is the total food available for consumption (calories) from farm output, excluding other sources of food or the nutritional content or value of the food.

Since no data was collected for purchased food or transferred food, PFA only reflects partially the food availability situation as it relates to mainly subsistence farmers in the study area. But this is of paramount importance in developing countries like Nigeria where most of the citizens are engaged in subsistence farming (Rahman, 2011 and Ajibefun et.al 1996). This is also reflected in the data collected, since 81% of the respondents are small scale farmers (subsistence farmers). By ignoring food purchases and food transfer, PFA enabled us in our understanding of the foundation of food security and food availability in developing countries.

This chapter also looks at the partial food availability status at farm level throughout the year and its justification; partial food availability calculation; partial food availability and its relationship with farming categories, technology adoption pattern and food production and availability regression.

8.1 Partial Food Availability Status and Justification

This section discusses how storage capacity of farm households and their efforts to smooth consumption over time (year) is reflected in the Partial Food Availability (PFA) status of the farmers and the justification for the status. Respondents were asked to rank their PFA status over calendar years as surplus, level or deficit and to give their justification for their ranking.

The result is presented in Table 8.1; it shows the percentage of respondents that have surplus, level or deficit PFA in the different months of the year. It reveals a surplus PFA for the months of January, November and December due to it being the start of the storage period and peak of harvest respectively. It also shows that farmers have level PFA in the months of February, March, April, August, September and October and the justification ranges from it being the end of the storage period to start of harvest period. Lastly, it shows that respondents have deficit PFA in the months of May, June and July, with food shortage being most severe in the months of June and July; the justification is because it is the end of the planting period and crops are growing in the field. These findings are in line with the Nigerian food consumption and nutrition survey that indicates that certain food (food crops) is available only during certain periods in a year (NBS, 2010).

Table 8.1: Partial Food availability status and justification

Food Availability Condition	Jan	Feb	Mar	April	May	June	July	Aug.	Sept	Oct	Nov	Dec
Surplus %	69.6	41.3	8.4	1.0	-	-	1.0	5.6	9.7	44.6	83.4	90.6
Level %	28.8	56.9	88.5	80.1	43.9	4.6	4.3	56.4	79.1	54.6	16.6	9.2
Deficit %	1.5	1.8	3.1	18.9	56.1	95.4	94.6	38.0	11.2	0.8	-	0.3
Main Justification Percentage	99.7 (1)	99 (2)	69.2 (2)	99.5 (3)	99.5 (4)	99.7 (5)	99.5 (5)	100 (6)	100 (7)	99.7 (7)	99.7 (8)	99.5 (8)

Source: Field Survey 2011:

Note: Figures in parenthesis are the justification for food availability conditions and are :(1: Start of storage period, 2: End of storage period, 3: Start of planting period; 4: End of planting period; 5: Crop growing; 6: Crop growing to maturity; 7: Start of harvest; 8: Peak of harvest).

8.2 Partial Food Availability Calculation (PFA)

The Partial Food Availability (PFA) is the total food available for consumption by farming households per day per person from one unit of land (calories/D/H/ha). This is different for each farming household depending on the combination of crops produced, area operated and family size A detail of the model is in Chapter 3 and it is as follows:

$$PFA_{Ti} = \left\{ \frac{\sum_0^i f\left[\frac{(TR0_i - TR0S_i)\,C + (TY0_i - TY0S_i)C + (TC0_i - TC0S_i)C}{365}\right]}{ha_i} \right\} / Hi$$

Where:

$PFA_{Ti} = Total\ Partial\ Food\ Availability\ of\ ith\ farmer$

$TR0_i = Total\ Rice\ Output\ of\ ith\ farmer$

$TR0S_i = Total\ Rice\ Output\ Sold\ by\ ith\ farmer$

$TY0_i = Total\ Yam\ Output\ of\ ith\ farmer$

$TY0S_i = Total\ Yam\ Output\ Sold\ by\ ith\ farmer$

$TC0_i = Total\ Cassava\ Output\ of\ ith\ farmer$

$TC0S_i = Total\ Cassava\ Output\ Sold\ by\ ith\ farmer$

$C = Calorie\ for\ the\ crop$

$ha_i = Farm\ size\ of\ the\ ith\ farmer$

$Hi = Family\ size\ of\ the\ \ ith\ household$

This implies that $PFA_{Ti} = 4693.34\ calories/D/H/ha$

This means that in a day, on average, the respondents have 4693.34 calories of food available per person per hectare for consumption from their farm, excluding any other source of food. Therefore the food sufficiency of the household will depend on the size, the ratio of adult males to females and children in the household and their ability to buy additional food they may need. It does not take into account their nutritional requirement. According to FAO, (2002) food and nutrition technical report on human energy requirements, an average adult male required a range of calorie intake per day (2000, 2200-2400; 2400-2800 calories) depending on whether he is sedentary (not active, 2000), moderately active (2200-2400) or active (2400-2800). Whilst for an average female adult, the range is from 1600-1800 calories per day depending if she is active or not active (www.eatright.org; www.webmd.com/diet).

This shows that the respondents only have enough food from their farming to support on the average two adults per day; this is consistent with the literature, reports and other studies on food availability in Nigeria which show that about

60% of Nigerians live on less than one dollar per day (Fabusoro et al 2010 and Igwe, 2013).

8.3 Partial Food Availability and Its Relationship to Farming Categories

Table 8.2 below presents the relationship between food production, partial food availability and farming categories of respondents. It shows that 38.09% of food produced by all the respondents is consumed, and that the mean farm size is 1.27 hectares. It also shows that 81%, 10.75% and 8.25% of respondents are small, medium and large farm size farmers, with mean farm sizes of 0.82, 2.54 and 4.04 hectares respectively. Furthermore, 39.26% of food produced by small scale farmers is kept for their own consumption; 27.01% and 24.34% of that produced by medium and large farm farmers is also kept for their own consumption.

The table also indicates that small scale farmers are more efficient in terms of output per hectare and have more calories per day per household per hectare of land. This supports the hypothesis of inverse farm size – food productivity and inverse farm size – food availability (subsistence farming) relationships. This is a very important finding because agricultural production (farming) in developing countries is dominated by small scale subsistence farming households (Rahman, 2011 and Ajibefun et.al 1996). Understanding the relationship between subsistence farmers, food production and food availability will help in the overall understanding of food security issues and pattern in developing countries.

In addition, percentage food availability decreases as you go from small scale farmers to large scale farmers, indicating that small scale farmers keep more of their output for consumption and emphasising the fact that large farmers can supplement their food availability, thereby keeping less of their output for consumption (Baiphethi and Jacobs 2009). These findings are consistent with literature and similar studies like Igwe, (2013) and Fabusoro et al (2010) that show that about 90% of food produced in Nigeria is by small scale farmers. The table also shows a positive significant F-value for food production and food availability, implying that their means are statistically different across the farm categories.

Table 8.2: Partial Food Availability and its relationship with Farm categories

Farm Size Category	% of Farmers	Farm Size Hectares	Food Production Calories/D/H/h	Food Availability Calories/D/H/h	% Food Availability
Small farm	81	0.82	13873.10	5446.36	39.26
Medium farm	10.75	2.54	6124.33	1654.22	27.01
Large farm	8.25	4.04	5177.71	1260.14	24.34
All Sample (400)		1.27	12322.74	4693.34	38.09
ANOVA F-value (2,397)			18.177***	11.928***	

Source: Field Survey 2011 Note: *** significant at 1% level (p <0.01)

It is important to note that if a complete measure of food availability (including purchases and transfer from public programmes or other households) were to be considered in the analysis, the picture would be significantly different (Ruel et al., 1998). According to Baiphethi and Jacobs (2009) and similar studies, large scale farmers are in a position to supplement their food availability status from either purchases from the market or transfer from other households since they are financially better off than the small scale farmers. If this is taken into consideration, the inverse farm size – partial food availability (subsistence farming) relationship that exists in the study area will not hold when the complete food availability is considered. The large scale farmers will always have better food security/ availability because they are financially able to supplement their subsistence food availability from other sources like purchase from market or transfer from other households.

8.4 Partial Food Availability by States

Table 8.3 shows partial food availability as it relates to Ebonyi and Anambra states; it shows that 64.75% and 35.25% of the respondents are from Ebonyi and Anambra states respectively, with mean farm sizes of 1.52 and 0.83 hectares. The table also shows a similar level of food availability in the two states which are both close to that of the whole sample (38.09%).

Table 8.3: Partial Food availability at state level

State	% of Farmers	Farm Size Hectares	Food Production Calories/D/H/h	Food Availability Calories/D/H/h	% Food Availability
Ebonyi	64.75	1.52	12797.05	4927.13	38.50
Anambra	35.25	0.83	11451.49	4263.90	37.23
All Sample (400)			12322.74	4693.34	38.09

Source: Field Survey 2011

8.5 Partial Food Availability by Crop Types

Table 8.4 below present's partial food availability as it relates to crop combinations of the respondents; it shows that 6.25%, 5.25% and 18.0% of the respondents are practicing mono-cropping (rice, yam, and cassava only) with mean farm sizes of 0.79, 0.68 and 0.53 hectares respectively. Cassava is the most efficient in terms of output per hectare (23563.60 calories/D/H/ha) and 49.11% of the output is kept for consumption by the farmers. Yam has the least percentage available for consumption (0.07%), indicating that the farmer sells off most of his yam output and keeps about 30% of his output to be used as seed yam; this may be due to the high value of yam when compared to the value of rice and cassava. This is consistent with reports and studies that show that cassava (fufu, garri, abacha cassava flour etc.) is the most staple food crop in southern Nigeria.

The table also shows that 2.5%, 2.25% and 41% of the respondents are rice & yam, rice & cassava, or yam & cassava farmers, with mean farm sizes of 1.20, 1.24, and 0.99 hectares respectively. Of the combinations, yam & cassava is the most efficient in terms of output per hectare (12707.34 calories/D/H/ha) and has 35.54% of its output available for consumption; followed by rice & yam (29.71%) and rice & cassava (16.56%) respectively. 24.75% of the respondents grow all three of the crops (rice, yam and cassava) with a mean farm size of 2.54 hectares; of which 33.35% of output is kept for family consumption. These findings are in line with similar studies that highlight the importance of cassava as a major staple crop in Nigeria and are reflected in my interview with the country representative International Fertilizer Development Centre (IFDC) that emphasised the effects of their CASSAVA PLUS project in Nigeria (Appendix 2, Section A). The table also showed a positive significant F-value for food production and food availability, implying that the variations between the means are statistically different across the crop combinations.

Table 8.4: Partial Food availability as it relates to crop combinations

Crop Combination	% of Farmers	Farm Size Hectares	Food Production Calories/D/H/h	Food Availability Calories/D/H/h	% Food Availability
Rice	6.25	0.79	9127.67	2494.49	27.33
Yam	5.25	0.68	7355.91	4.79	0.07
Cassava	18.0	0.53	23563.60	11571.67	49.11
Rice + Yam	2.5	1.20	6615.73	1965.26	29.71
Rice + Cassava	2.25	1.24	7867.44	1302.47	16.56
Yam + Cassava	41.0	0.99	12707.34	4516.05	35.54
Rice+Yam+ Cassava	24.75	2.54	6352.36	2118.24	33.35
All Sample (400)		1.27	12322.74	4693.34	38.09
ANOVA F-value (6,393)			25.970***	25.751***	

Source: Field Survey 2011 Note: *** significant at 1% level (p <0.01)

8.6 Partial Food Availability Level in Relation to Respondents Agricultural Technology Adoption Pattern

This section will analyse how Partial Food Availability (PFA) relates to the technology adoption pattern of the respondents; this will be done by evaluating how the different elements of the adopted technology (fertilizer or HYVs), adopters of technology as a package and those who adopted none of the technology relate to the PFA of the respondents. It has already been revealed in Section 6.2.1 of Chapter Six that fertilizer application has a positive effect on yield and that all the respondents who used fertilizer used a level that is below the recommended application level. Hence, the impact of fertilizer application on yield is not as effective as expected. Also Table 7.1 (Chapter Seven) shows that large scale farms are more likely to adopt fertilizer than small scale farms. Given this background, effect of technology adoption of PFA is shown in Table 8.5.

The table reveals that in all, farmers who applied no fertilizer set aside more of their output for household consumption than farmers who applied fertilizer. This is expected, due to the resultant impact of the cost of fertilizer; most of the farmers may have borrowed money to purchase fertilizer and will be under pressure to sell most of their farm output. A more detailed analysis across the farm categories shows that small scale farmers who do not apply fertilizer set aside far more of their farm output for household consumption than those who applied fertilizer. This shows the importance of affordable credit facilities especially for this group of farmers as a means of increasing food availability (Baiphethi and Jacobs, 2009).

Table 8.5: Partial food availability of respondents in relation to their agricultural technology adoption pattern

Farm Category	Respondents Agricultural Technology Adoption Pattern; Partial Food Availability Level (Calories/D/H) and Percentage of Respondents								
	No Fertilizer	Fertilizer Application	All Farmers	No HYV	HYV	All Farmers	Non Adoption	Both Technologies	All
	Food Availability	Food Availability	Food Availability	Food Availability	Food Availability	Food Availability	Food Availability	Food Availability	Food Availability
Small **324 (81)**	4549.38 (56)	2475.84 (44)	3627.80 (100)	3573.40 (63)	3719.08 (37)	3627.80 (100)	4600.81 (35)	2829.31 (17)	3715.06 (52)
Medium **43(11)**	4242.53 (47)	4191.16 (53)	4215.05 (100)	3540.83 (47)	4801.34 (53)	4215.05 (100)	3570.18 (19)	4921.97 (26)	4246.07 (44)
Large **33(8)**	3884.30 (30)	5310.47 (70)	4878.29 (100)	5368.82 (67)	3897.23 (33)	4878.29 (100)	3682.11 (15)	3739.52 (18)	3710.81 (33)
Total **400**	**4488.48 (53)**	**3026.62 (47)**	**3794.10** (100)	**3731.96 (61)**	**3892.31 (39)**	**3794.10** (100)	**4499.72 (32)**	**3224.88 (18)**	**3862.30 (50)**

Source: Field Survey 2011 (The figures in parenthesis are percentage of respondents)

For large scale farmers, the effect is quite the opposite; those who applied fertilizer set aside far more of their farm output for household consumption than those who did not apply any fertilizer. This may be because they have more financial capacity to cushion and absorb the impact of the cost of fertilizer than the small scale farmers (Igwe, 2013). For medium scale farmers, the effect is not as extreme as in the case of small and large scale farmers. Even though those who applied no fertilizer relatively set aside more of their farm output for household consumption the difference is not very significant. This implies that they are not financially pressured like the small scale farmers and can afford to set aside more of their farm output for household consumption.

Section 6.2.2 (Chapter Six) reveals that HYVs have a mixed effect on yield and that the relationship is mostly negative due to enormous constraints associated with the availability and quality of HYVs as discussed in Chapter Nine. Table 8.5 shows that in all, farmers who used HYVs relatively set aside more of their farm outputs for household consumption. The same trend was noted for both small and medium scale farmers but not large scale farmers. This may be due to the cost of HYVs relative to that of fertilizer, farmers' especially small scale farmers who used HYVs can afford to set aside more of their farm output for household consumption. In the case of large scale farmers, Chapter Seven (Section7.1) shows that small scale farmers are more likely to adopt HYVs relative to large scale farmers because of the cost, scarcity of HYVs when needed and other constraints. The negative effect of HYVs on yield may have reflected on PFA especially for large scale farmers.

Lastly, the table shows that in all, farmers who do not adopt any technology reserve more of their farm output for household consumption than those that adopted technology as a package. This is expected, due to the cost implication of technology adoption. Some of the farmers, especially the small scale farmers may have borrowed money to fund their technology adoption. Hence they may be under pressure to sell most of their farm output to offset the cost of adopting the technology. Across the farm categories, the same trend was noted especially for small scale farmers where it is very prominent but for medium and large scale farmers, those who adopted both technologies (as a package) relatively set aside more of their farm output for household consumption than those who do not adopt any technology.

Overall, this section highlights the pressure on small scale farmers, due to technology adoption and its effects on PFA of the farm household. It also highlights the importance of making affordable credit facilities as an integral part of any technology adoption intervention program being designed for the study area. As discussed earlier (Chapter Six), agricultural technology, where adopted is far below the recommended level hence its impact on yield is not as effective as expected. This in turn affects the PFA of the household and discourages farmers from adopting agricultural technology; more needs to be done to educate farmers on the need to adopt technology as a package and at the recommended level.

8.7 Determinants of Food Production and Partial Food Availability

This section will look at the correlation between food production and food availability with the socio-economic characteristics of the respondents. A detail of the regression model was discussed in Chapter 3. The dependent variables Food Production (FP) is the total food produced (output) in calories per household per day per hectare, and the Partial Food Availability (PFA) is the total food available for consumption at farm level in calories per household per day per hectare of land. The variables used for this regression are family size, age of household head (HHH), farming experience of HHH, educational level of HHH, farm size, gender, main occupation, farmer's training, proportion of rented-in land, number of extension contacts, distance to extension centre, yam share of food availability, cassava share of food availability and chemical fertilizer used.

Since Partial Food Availability (PFA) at the farm level is dependent on Food Production of the household, it is necessary to evaluate the effect the same set of variables has on both independently. The regression analysis allows us to evaluate if FP and PFA is determined by the same set of variables, and the level of effects of the variables on both. It is expected that the same set of variables that have an effect on FP will also have some effects on PFA, but the level of effects may be significantly different.

Table 8.6 shows that six variables are significantly correlated to food production; they are family size, educational level, farm size, proportion of rented-in land; distance to extension centre, and cassava share of food. It also shows that the effect of educational level, farm size, cassava share of food and distance to extension centre are positive, implying that they positively influence food productivity. Except for distance to extension centre, signs on the other variables are expected; this is due to the low level of extension services in the study area and the ratio of extension agents to farmers, as revealed in Chapter 9 and research interviews. In the words of one of the respondents, "The problem is not the distance to the extension centre; rather it is that there are not enough extension agents to go round".

Likewise, it shows that family size and proportion of rented-in land are negatively correlated to food production; this implies that larger family size does not necessarily increase food production, especially if the family is not directly actively engaged in the family farm. Also, due to the cost (output-share) associated with rented-in land, it is very important for the farmer to evaluate if this is a necessary step to take. These findings are consistent with similar studies like Muhammad-Lawal and Atte, (2006) and Obasi et.al, (2013) that indicate similar findings in their various studies. The adjusted-R^2 value is low (0.23), implying that only 23% of the variations in the dependent variable (FP) are explained by the joint action of the independent variables; but this is balanced by a positive and significant F-value (9.74***).

On the other hand, the table also shows that four variables are significantly correlated to Partial Food Availability (PFA); they are, family size, farming experience, farm size and cassava share of food. It also show that farm size and cassava share of food are positively correlated to food availability, meaning that the larger the farm size, the more likely the respondent is to have food available for consumption, and that they are more likely to keep their cassava output for consumption than any of their other farm output. This is consistent with the literature that indicates that cassava (Garri), which is one of the most important staple foods in Nigeria, is primarily produced by farmers for family consumption rather than selling.

Furthermore, it shows that family size and farming experience are inversely correlated to food availability; that of farming experience is not expected but indicates that most of the farmers may be older and therefore not able to actively engage in strenuous farming activities (yam, cassava, rice farming). It is important to note that partial food availability as it relates to the family size could significantly be different if it was analysed using adult equivalent in the household; unfortunately, given the limitation of the data this was not possible.

Table 8.6: Determinants of food production and partial food availability at farm level

Variables	Food Production		Food availability	
	Coefficient	t-ratio	Coefficient	t-ratio
Family size	-623.82**	-2.33	-244.07**	-2.21
Age HHH	17.19	0.24	4.66	0.16
Farming Experience of HHH	-103.25	-1.56	-48.74*	-1.79
Educational Level of HHH	197.27*	1.73	53.74	1.14
Farm Size	3958.56***	7.67	1251.38***	5.89
Gender	299.61	0.26	342.65	0.72
Main Occupation of HHH	-142.13	-0.12	-54.90	-0.11
Farmer's Training	46.18	0.03	357.74	0.55
Proportion of Rented-in Land	-2607.73**	-2.1	-524.85	-1.03
Number of Extension Contact	-109.30	-0.12	-407.11	-1.05
Distance to Extension Centre	256.60*	1.93	30.72	0.56
Yam share of food	952.55	0.51	555.99	0.73
Cassava share of food	4183.44**	2.43	1336.17*	1.88
Fertilizer used	-0.97	-0.18	-2.63	-1.2
Constant	5784.75*	1.74	2516.39*	1.83
Adj. R square for Food Prod.	0.23			
F (14,385) for Food Prod	9.74***			
Adj.R square for Food Availability	0.133			
F (14,385) for Food Availability	5.38***			
df.	(2,398)			
Number of respondents	400			

Source: Field Survey 2011 Note: The regressions are independently determined for both food production and food availability. ***=significant at 1 percent level (p<0.01), **=significant at 5 percent level (p<0.05), *=significant at 10 percent level (p<0.10)

Also, productivity tends to decrease if some of the family members are not actively engaged in the family farming, and the household size adds more to production costs than it adds to the value of output. This is consistent with Obasi et.al (2013) who indicated similar findings in his study on factors affecting agricultural productivity among arable crop farmers in Imo state, Nigeria. The adjusted R^2 value is low (0.133) and implies that only 13.3% of the variations in the dependent variable (PFA) are explained by the joint actions of the independent variables; this effect is balanced by a positive and significant F-value (5.38***).

The marginal effects of the regression are presented in Table 8.7 below; which shows the decomposed (direct and indirect) effects of the explanatory variables on the probability of the joint effects of the independent variables on the dependent variables (Christofides et.al. 1997). It indicates that six variables are significantly correlated to food production; this implies that a one percent increase in educational level, farm size; distance to extension centre and cassava share of food will increase the probability of food production by 0.23, 0.43, 0.08 and 0.17 respectively. Apart from distance to extension centre, other variables are expected and in line with similar studies like Muhammad-Lawal and Atte, (2006); Obasi et.al (2013); Benin et.al; (2004) and Rahman, (2008) that show similar findings in their studies. The issue with distance to extension centre as explained earlier may be due to the poor ratio of extension agents to farmers.

Family size and proportion of rented-in land are significant but negative; indicating that a one percent increases in them will reduce the probability of food production by -0.21 and -0.04 respectively. This means that an increase in family size or proportion of rented-in land will decrease food production, especially if family members are not actively engaged in farming and the additional land is not effectively used (Obasi et.al; 2013).

The Table also shows that four variables are significantly correlated to food availability; this implies that a one percent increase in farm size and cassava share of food will increase the probability of food availability by +0.42 and +0.17 respectively. However, a one percent increase in family size and farming experience will reduce the probability of food availability by -0.25 and -0.25 respectively; this is consistent with similar studies as explained earlier but that of farming experience is not expected and may be due to the age of the respondents.

Table 8.7: Total Marginal effects of food production and partial food availability regression

Variables	Food Production		Partial Food Availability	
	Effects	t-ratio	Effects	t-ratio
Family size	-0.206**	-2.32	-0.249**	-2.2
Age HHH	0.071	0.24	0.060	0.16
Farming Experience	-0.175	-1.56	-0.254*	-1.78
Educational Level	0.132*	1.73	0.111	1.14
Farm Size	0.431***	7.41	0.420***	5.69
Gender	0.021	0.26	0.073	0.72
Main Occupation	-0.006	-0.12	-0.007	-0.11
Farmer's Training	0.0003	0.03	0.008	0.55
Proportion of Rented-in Land	-0.037**	-2.09	-0.023	-1.02
Number of Extension Contact	-0.001	-0.12	-0.012	-1.05
Distance to Extension Centre	0.080**	1.92	0.029	0.56
Yam share of food	0.026	0.51	0.047	0.73
Cassava share of food	0.173**	2.42	0.170*	1.87
Fertilizer used	-0.004	-0.18	-0.037	-1.19

Source: field survey 2011 Note: The marginal effects are independently determined for both food production and food availability. ***=significant at 1 percent level ($p<0.01$), **=significant at 5 percent level ($p<0.05$), *=significant at 10 percent level ($p<0.10$)

Overall, Chapter Eight evaluated the determinants of food production and availability (Section 8.6); six variables were found to be significantly correlated to food production and four variables for food availability. The food availability status of the farmers was discussed in section 8.1 and it was found that farmers only have surplus food availability in three month of the year (January, November December). The PFA of the respondents was described in Section 8.2 and the relationship between food availability and other factors was discussed in Sections (8.3 – 8.5). One of the key findings is that cassava is the food crop that is most reserved (49%) for food in the study area.

Chapter Nine

Constraints Affecting Agricultural Technology Adoption, Production Practices and Credit Availability

9.0 Introduction

Arising from the set of questionnaires for Agricultural Development Programmes (ADP) staff/officers, the main agricultural extension outlet in Nigeria, this chapter will discuss the constraints affecting agricultural technology adoption in the study area. It will approach this from both the perspective of the ADP staff/officer, and then move on to present the responses of farmers in the study to these issues.

Section A

This section will addresses the constraints affecting agricultural development and agricultural technology adoption in the study area from the perspective of ADP staff in the study area.

9.1 Agricultural Development Program (ADP) in the Study Area

The Agricultural Development Program (ADP) is the main agricultural extension agency in Nigeria. Its history, evolution, objectives and organisational structures have already been discussed in the literature review in Chapter 2. Sixty questionnaires were sent out to ADP staff in the study area (30 in each state); of those that were returned, 96.7% (58) were found to be useful. Details of the data collection process are discussed in the methodology chapter (Chapter 3).

9.1.1 Socio-economic Characteristics of Agricultural Development Program Staff

This section seeks to establish a picture of the basic characteristics of ADP staff in the study area, covering important details including age, gender, work history and proportion of respondents in the range of roles.

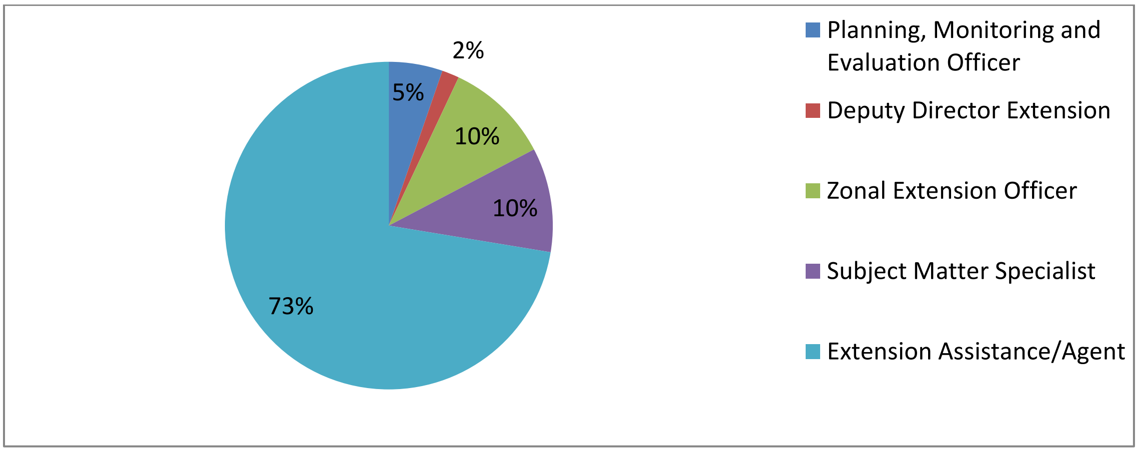
9.1.2 Age, Gender, Work History and Job Description of Respondents

The age of the respondents is a very important factor; it indicates how fit and mature they are to carry out their duties. The age of the respondents in this study ranges from 31 to 57 years, with a mean age of 44 years. A more detailed analysis shows that the mean ages of respondents in the states are Ebonyi state (47 years) and Anambra state (42 years), and that 65.5% of the respondents are ≤ 45 years, with the remaining 34.5% ≥ 46 years. These findings are consistent with Madukwe, et al. (2002) that noted a similar level of age and age range among staff, in their study of the comparison of the ADP and University agricultural technology transfer system in Nigeria.

60.3% of the respondents are male and 39.7% are female, which is expected and consistent with literature. This indicates inadequate female agro-technology transfer workers in the study area and may bias agro-technology transfer efforts towards male farmers. Also this has been identified as a limiting factor in transferring agro-technology to female farmers, especially in northern Nigeria (Sokoya, 1998). The years of working experience of the ADP staff in the study area range from 5 years to 25 years, with the mean years of working experience as 16 years. In Ebonyi state, the mean period of working experience is 17 years, marginally higher than the 16 years for those in Anambra state. A detailed analysis shows that 20.7% of the respondents have worked with ADP for ≤ 10 years, 63.8% have worked for 11 – 20 years and the remaining 15.5% have worked with ADP for ≥ 21 years. This is expected and in line with Madukwe et al. (2002) findings among ADP and University extension staff in their study. This implies that most of the respondents have more than 10 years of working experience with ADP and are in a good position to give an insight about the working of the organisation. Therefore their perspective and suggestions about the state of agriculture and agricultural technology adoption in the study area has to be taken seriously.

The job description of the respondents is presented in Figure 9.1. It shows that the majority of the respondents are extension agents, while a few of them are management officers. This finding is consistent with (ibid) that noted a ratio of supervisor to extension agents to be 1:8, among ADP staff in their study. The position of extension agents in the organogram of ADP was discussed in Chapter 2, and it shows that they are in close contact with farmers and in a better position to give an informed perspective about the state of agricultural technology adoption in the study area.

Figure 9.1 Job Descriptions of ADP Staff



Source: ADP Field Survey, 2011

9.2 Perceptions of Agricultural Development Program Staffs and the State Of Agriculture in the Study Area

Having established the key characteristics of ADP officers, this section moves on to discuss the perceptions of such staff on the state of agriculture in the study area. As these employees serve as a link between the government and the farmers they are the ones mostly in touch with farmers. The section also assesses perceptions of the constraints on the adoption of agricultural technology and overall agricultural development in the study area, a key element of this thesis.

9.2.1 State Of Agriculture in the Study Area

With regards to perceptions of the state of agriculture, Table 9.1 shows that overall, by far the majority of respondents said that agriculture in the study area is developing but still predominantly small scale farmers. Others (21%) registered a degree of development beyond due to the works of donor agencies and NGOs. A small share of respondents responded to this question, referring to the lack of farm inputs and credit facilities as still major constraints

Perhaps not surprising, the respondents in Ebonyi state, all reported agriculture as in a state of development and still predominantly small scale farmers. In Anambra state, a small proportion of the respondents said that agriculture was in a state of development; with lower proportion suggesting that it has improved due to the works of donor agencies and NGOs.

Table 9.1 Respondent perception of the state of agriculture in the study area in relation to their years of experience and the study area

Study Area	Years of Experience	State of agriculture in study area			
		Developing but predominantly Small scale Farmers (%)	Improved due to donor agency and NGOs (%)	Lack of Input and credit facility (%)	Total (%)
Ebonyi 28	≤ 10	14.29	-	-	14.29
	11- 20	67.86	-	-	67.86
	≥ 21	17.86	-	-	17.86
	All	**100.0 (28)**	**-**	**-**	**100.0 (28)**
Anambra 30	≤ 10	15.38	33.33	40.0	26.67
	11- 20	76.92	41.67	60.0	60.0
	≥ 21	7.69	25.0	-	13.33
	All	**43.33 (13)**	**40.0 (12)**	**16.67 (5)**	**100.0 (30)**
All Areas 58	≤ 10	14.63	33.33	40.0	20.69
	11- 20	70.73	41.67	60.0	63.79
	≥ 21	14.63	25.0	-	15.52
	All	**70.69 (41)**	**20.69 (12)**	**8.62 (5)**	**100.0 (58)**

Source: ADP Field Survey, 2011 Note (The figures in parenthesis are frequency)

9.2.2 What Could Improve the State of Agriculture and Constraints Affecting Agricultural Technology Adoption in the Study Area?

Table 9.2 below is a multi-section table showing the respondents perceptions of the state of agriculture in the study area and barriers/constraints affecting agricultural technology adoption.

Section I: - This section provides suggestions on what could improve the state of agriculture in the study area. Overall, the respondents felt that key areas of improvement could be made in farm inputs and irrigation (most important) and the provision of credit facilities. Almost of equal importance was the value adding opportunities in the supply chains. Lying further behind in priority, but still of significance was the provision of training for farmers and getting more young people interested in agriculture.

Table 9.2: Respondent perception of state of agriculture and barriers to adoption of agricultural technology in the study area

Study Area	What could Improve the state of agriculture in Percentage (Respectively)				
Section I	Credit facility	Farm input and irrigation	Value adding Chain for farm produce	Training of farmers	Getting more young people into agriculture
Ebonyi 28	89.29	89.29	75.0	67.86	46.43
Anambra 30	93.33	100.0	90.0	66.67	56.67
All Areas 58	**91.38**	**94.83**	**82.76**	**67.24**	**51.72**
Section II	**Constraints affecting adoption of agricultural technology in Percentage (Respectively)**				
	Credit facility and farm input	**Lack of support for ADP**	**High level of illiteracy**	**Bad Government policies**	**Land tenure system**
Ebonyi 28	100.0	100.0	39.29	85.71	35.71
Anambra 30	100.0	86.67	50.0	93.33	36.67
All Areas 58	**100.0**	**93.10**	**44.83**	**89.66**	**36.21**
Section III	**What could improve agricultural technology adoption in Percentage (Respectively)**				
	Credit facility and farm input	**Increasing the ratio of extension workers to farmers**	**Ready market for farm produce**	**Adequate training for farmers**	**Land reform and making agricultural land easily available**
Ebonyi 28	100.0	92.86	50.0	71.43	53.57
Anambra 30	100.0	93.33	23.33	90.0	73.33
All Areas 58	**100.0**	**93.10**	**36.21**	**81.03**	**63.79**

Source: ADP Field Survey, 2011 Note :(The underline figures are the number of respondents in the respective states and all areas. The percentages are against the number of respondents in the respective states and all area)

These findings are consistent with Ayansina, (2011) who suggested similar steps in his study of farmers' perception of public and private extension services in south-western Nigeria.

Section II: - The second elements of inquiry in this section concern the respondents' perceptions of the constraints affecting the adoption of agricultural technology specifically. Table 9.2 shows that overall the respondents again identified the non-availability of credit facilities and farm inputs as the main constraint, alongside the lack of support for ADP and perceived deficiency in government policies. Of lower relative importance are the high levels of illiteracy among farmers and the land tenure system (Land ownership system in Nigeria). All these findings are consistent with the recommendations in FMARD, (2011) agricultural extension transformation agenda report.

Section III: - Thirdly, the respondents' suggestions of what could improve the adoption of agricultural technology are presented in this section. Again Table 9.2 shows overall, that improved provision of credit facilities and farm inputs for farmers is of fundamental importance; followed by suggestions to increase the ratio of extension workers to farmers and to improve the provision of adequate training for farmers. This is followed in relative importance by land reform and making agricultural land more easily available. Of lesser importance is the aspect provision of ready markets for farm produce, perhaps, less relevant to agricultural technology adoption.

Overall, then the provision of credit facilities and farm inputs stands out as a serious and continuing issue. Without good availability and accessibility to these key prerequisites, the ready adoption of agricultural technology will continue to be a serious challenged. Other areas requiring attention include increasing the ratio of extension workers to farmers, better training for farmers, land reform and improved relevant government policies. Perhaps, on their own, the impact of each of these is likely to be less strong but if they are proposed as a package solution of improvements targeted at specific group of farmers (small scale farmers).

9.2.3 Is the Government Doing Enough to Encourage Adoption of Agricultural Technology in the Study Area?

Finally, in this area of analysis, respondents' were asked for their response to the question, "Is the government doing enough to encourage the adoption of agricultural technology in the study area?" According to 37.9% of respondents, the government is 'doing their best', while 62.1% said, "No they are not doing enough". The latter, 48.3% said that the government needs to do more to encourage the adoption of agricultural technology in general. 17.2% suggested they should do more to encourage and support extension workers in their difficult job and 34.5% suggested that they should do more, specifically to encourage and support farmers to adopt agricultural technology. These findings are consistent with the recommendations of Madukwe et al. (2002) and Ayansian, (2011) in their respective studies.

9.3 Attitudes towards Development of Agriculture in the Study Area and Constraints Affecting their Work

This section explores the contribution of ADP staff towards agricultural development in the study area and the constraints and challenges affecting their job.

9.3.1 Frequency of Visits to Farmers and Approach from Farmers in the Last 12 Months

About 96.6% of respondents said that they had visited farmers in the last 12 months, of which 62.1% said their purpose of visit was to conduct a field study/survey and 89.7% recorded that it was for farmers' technology application training. The mean number of visits to farmers in the last 12 months in the study area by extension officers/agent was 42; this implies that on average, extension officers/agent make only 4 visits to farmers per month. This finding is consistent with Madukwe et al. (2002) that noted low level of ADP extension agents visits to farmers due to the low ratio of extension agent to farmers (1:5000) in their study. This underlines the issues and constraints affecting agricultural technology adoption in the study area, given the ratio of extension agents to farmers in the study area (Research interviews with ADP program managers' transcripts Appendix 2 Section C & D).

In terms of farmers' initiative, 87.9% of respondents said that they had been approached by farmers in the last 12 months, of which 84.5% and 46.6%, respectively, said that they were approached by farmers for the purpose of clarification concerning some of their programs/projects, and to ask for information about the availability of farm inputs. The mean number of approaches by farmers to extension officers/agents in the last 12 months was 36; this implies that on average, extension agents were approached by farmers 3 times per month. This finding is in line with that noted by Ayansina, (2011), in his study of farmers' perception of public and private extension services in south-western Nigeria.

9.3.2 Constraints Affecting the Effectiveness of Respondents (ADP Staff) Work

The respondents were asked to list the constraints affecting the effectiveness of their work and to rank them in order of their importance. The results are presented in Table 9.3, showing that overall across all areas, the lack of facilities (transportation, internet etc.) was reported as the topmost constraint affecting the effectiveness of their work. This is followed by poor remuneration, poor infrastructures (road network, electricity), lack of training and lack of inputs for farmers respectively; with the non-payment of counterpart funding by the government being the least important constraint.

Similarly, in Ebonyi state, the trends observed follow the same pattern as those across all areas, while in Anambra state, poor remuneration is ranked as the topmost constraint followed by lack of facilities and lack of inputs for farmers.

In general, these findings are in line with the constraints affecting the effectiveness of respondents work (Figure 9.2), but here the respondents identified lack of facilities and poor remunerations as their topmost constraints. A constraint like lack of inputs for farmers which was expected to be highly ranked is only ranked 5th in all areas and Ebonyi state and 3rd in Anambra state. This reflects that the respondents think first of themselves and their welfare before that of the farmers. This highlights the issues with agricultural extension services and agricultural technology adoption in the study area.

Table 9.3: Constraints affecting the effectiveness of respondents (ADP Staff) work and their ranking

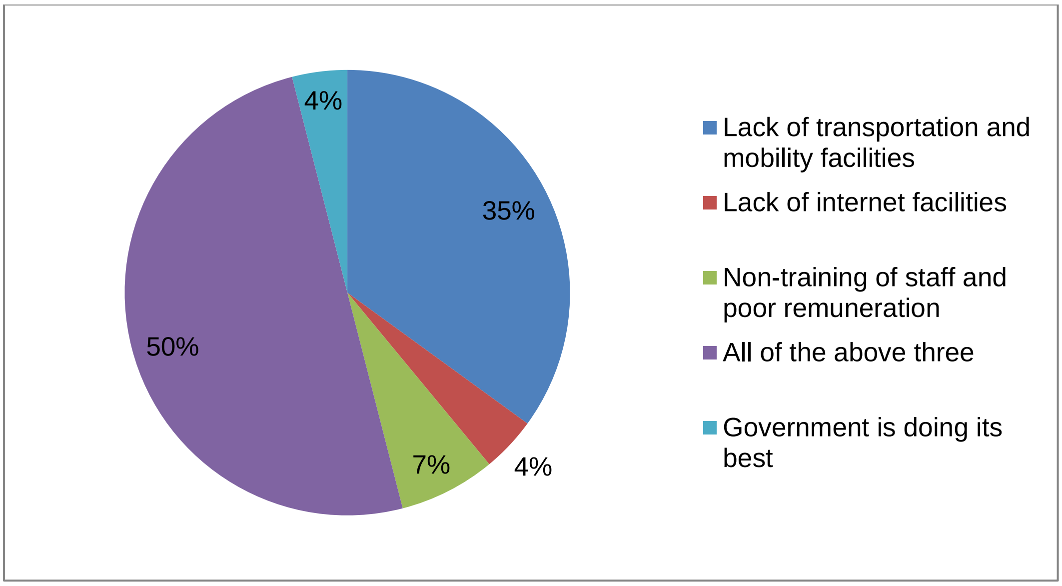
Constraints Affecting The Effectiveness Of ADP Work	Ebonyi State		Anambra State		All Area	
	Ranking Index	Rank	Ranking Index	Rank	Ranking Index	Rank
Lack of Facilities	0.81	1	0.74	2	0.77	1
Poor Remuneration	0.71	2	0.76	1	0.74	2
Poor Infrastructures	0.5	3	0.29	5	0.39	3
Lack of Training	0.34	4	0.31	4	0.33	4
Lack of Inputs for Farmers	0.25	5	0.37	3	0.31	5
Non-Payment of Counterpart Funding	0.21	6	0.04	6	0.12	6

Source: ADP Field Survey, 2011

9.3.3 Do You Have the Right Facilities to do Your Work?

Only 3.5% of the respondents said that they had the right facilities to do their work, with the vast majority (96.5%) stating that they do not have the right facilities to do their work. This is a major issue in terms of the development of the adoption of agricultural technologies in the future. Follow up quartier revealed details of the problem experienced (Figure 9.2). 50% of the respondents indicated that all three constraints are limiting their work, whilst 35.2% of the respondents said lack of transportation and mobility facilities are major constraints affecting their work. 7.4% said non-training of staff and poor remuneration and 3.7% said lack of internet facilities are a main issue.

Figure 9.2: Constraints affecting the respondents' ability to do their work



Source: ADP Field Survey, 2011

9.3.4 Adequate Training of ADP Staff

31% of the respondents said they have the right training to enable them do their work, while 69% said they do not have enough training to enable them do their work. Of the latter, 63.2% of them said that lack of a training program is a major constraint preventing them from doing their work; 31.6% of the respondents said that they have the training they needed. The remaining 5.3% said that there are political influences in selection of people for training.

Of those that said yes, they have all the training they needed, most of them said they have had the following training in the last 5 years; monitoring and evaluation training, farmers' training school, technology transfer techniques training and subject matter agent training.

9.3.5 Perceptions of What Could Improve Their Work and Enable Them to Reach Out to More Farmers

When respondents were asked their perception on what could improve their work and allow them to reach out to more farmers; 69% said that if all the constraints (poor infrastructures, training programs, input availability etc.) mentioned above are addressed, it would enable them to reach out to more farmers. 20.7% said that the provision of transportation and reliable/efficient mobility (motorcycle) would enable them to reach more farmers, especially those in difficult, isolated and inaccessible rural terrain. The remaining 10.3% said good remuneration and provision of internet facilities would motivate and allow them access to the latest information about agricultural technology, thereby enabling them to reach out to more farmers.

Generally, it is the view of ADP staff that they are constrained by a number of factors like the inadequacy of resources, poor remuneration and other things discussed in this chapter. There is need for thoughtful solution especially as a package since no single policy is capable of resolving all the constraints identified in this study. The role of ADP in agricultural development and agricultural technology adoption in Nigeria cannot be over-emphasised; they are the main agricultural extension outlets in Nigeria with offices in all the states and almost all the Local Government Areas in Nigeria. As a result, their perceptions of and suggestions on the state of agriculture in the study area and how to improve agricultural technology adoption is paramount if Nigeria is to attain its aspiration of achieving food security.

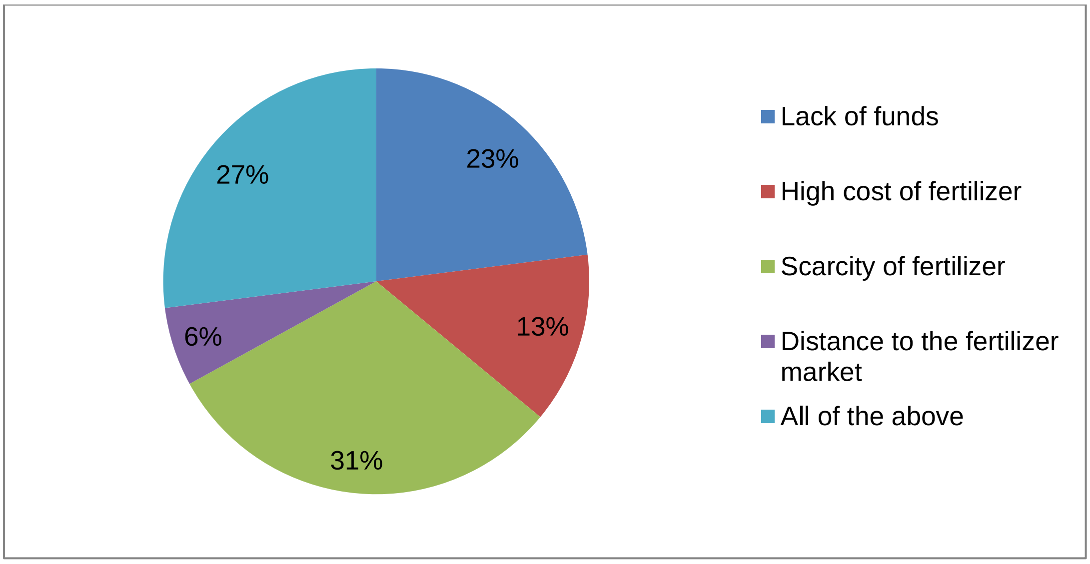
Section B

This section deals with the perspective of farmers as key stakeholders in this study. It reports on their perception of key constraints affecting their farm production practice and their adoption of agricultural technology in the study area.

9.4 Farm Production Practices

This section evaluates the constraints affecting respondents' farm production practices in the study area; it discusses issues around fertilizer and pesticide applications and High Yielding Varieties (HYV). None of the farmers used and/or have access to irrigation for their farming and issues around lack of irrigation facilities have already been discussed in Chapter 5, Section 5.2.7.

Figure 9.3: Constraints affecting the use of fertilizer

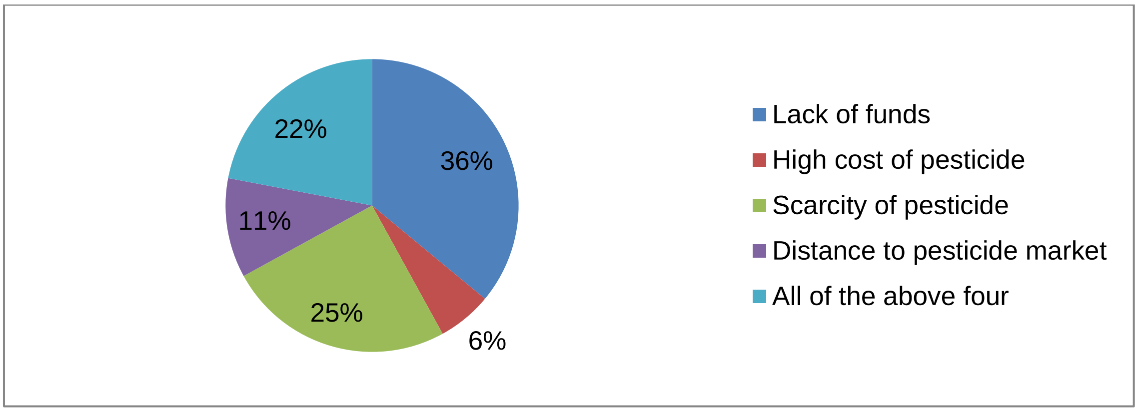


Source: Field Survey, 2011

Fertilizer usage constraints: - Only 60% of respondents use any kind of chemical fertilizer for their farming in the study area, of which 20% and 31.5% respectively said that they do not apply enough fertilizer and that they have problems in buying fertilizer for their farms. Figure 9.3 shows that most of the respondents said that scarcity of fertilizer when needed is the topmost constraint affecting fertilizer usage. This is closely followed by lack of funds and high cost of fertilizer respectively; while 27% of the respondents said a combination of all of the above constraints are the main issues affecting fertilizer usage in the study area. This finding is consistent with Madukwe, et al. (2002) and Anyasina, (2011) who noted lack of farm inputs as a major constraint in their respective studies.

Pesticide usage constraints: - Likewise, only about 50% of the respondents use any kind of pesticide for their farming in the study area, of which 31% and 16% respectively said that they do not apply enough pesticide and that they have problems in buying pesticide for their farm. Figure 9.4 shows most of the respondents said that lack of funds are the topmost constraint affecting pesticide usage. This is followed by scarcity of pesticide when needed and distance to pesticide market respectively; while 22% said that a combination of the above mentioned constraints are the main factors affecting pesticide usage in the study area. Just like in fertilizer usage, these findings are consistent with similar studies (ibid).

Figure 9.4: Constraints affecting the use of pesticide



Source: Field Survey, 2011

High Yielding Variety Constraints: - Most of the respondents said that they have used HYV for their farming in the last 3 years and have used mostly high yielding cassava and rice varieties. Most of them source their variety from their reserve and/or buy from the open market. Almost all the respondents said that their main constraint is that they are not sure of the quality of the varieties they buy from the open market, since it is difficult to get HYV from ADP. Almost all the respondents said that they prefer to use HYV for their farming if it is readily available, and in the words of one of the farmers, "The main issue is not us not wanting to use HYV but the non-availability of it when needed, and we are not sure of the quality of the ones we buy from open market".

9.4.1 Reasons for Growing High Yielding Varieties (HYV)

Table 9.4 below shows the ranking of respondents' reasons for growing HYV in the study area. It shows that across all areas, the topmost reason for growing HYV by farmers is the high yield of the variety. This is followed by high quality of the variety, short maturity period of the variety, ready market for the variety and high profitability of the variety respectively; with the variety commanding high price in the market being the least ranked reason.

Overall, the ranking index of the reasons why farmers grow HYV is significantly close for the topmost ranked reasons. High yield of the variety and high quality of the variety produce are consistently the topmost reasons why farmers grow HYV in the study area. Some differences were noted between the two states, and the difference between the ranking index of the topmost rank and lowest rank reasons is very significant. This reflects the weight of importance attached to the different reasons. This implies that these key factors are the ones that extension agents should communicate more to farmers to convince them to adopt and grow any new HYV in the study area.

Table 9.4: Ranking of respondents reasons for growing High Yielding Varieties (HYV) in the study area

Reasons why farmers grow HYV	Ebonyi State		Anambra State		All Areas	
	Ranking Index	Rank	Ranking Index	Rank	Ranking Index	Rank
High yield of the variety	0.88	1	0.79	1	0.85	1
High quality of the variety	0.83	2	0.76	2	0.81	2
Short maturity of the variety	0.62	4	0.71	3	0.65	3
Ready market	0.63	3	0.55	5	0.60	4
High profitability of the variety	0.48	6	0.61	4	0.53	5
High price	0.52	5	0.43	6	0.48	6

Source: Field Survey, 2011

9.4.2 Constraints Affecting Agricultural Technology Adoption in the Study Area

Table 9.5 is a multi-section table showing respondents perception of constraints respectively affecting the adoption of agricultural technology in the study area.

Section I: - This section discusses farmers' perception of the constraints affecting agricultural technology adoption in the study area. Table 9.4 shows that in the study area, the farmers identified lack of extension agents and inadequate contacts of farmers with extension agents as the topmost constraints affecting the adoption of agricultural technology. Almost of equal importance are the lacks of credit facilities and farm inputs, and lack of basic infrastructures, while lack of well-articulated government policies and land tenure system are the least important constraint.

Table 9.5: Respondents' perception of constraints affecting agricultural technology adoption in the study area

Study Area	Constraints affecting the adoption of agricultural technology in percentage (Respectively)				
Section I	Lack of extension officers/agents and inadequate extension contact with farmers	Lack of credit facilities and farm inputs	Lack of basic Infrastructure	Lack of good Governance and policies	Land tenure system
Ebonyi 259	84.94	61.39	49.81	22.39	21.62
Anambra 141	100.0	53.90	24.82	17.02	5.67
All Areas 400	**90.25**	**58.75**	**41.0**	**20.50**	**16.0**
Section II	**Constraints affecting agricultural technology training in percentage (Respectively)**				
	Inadequate training/contact of farmers with extension agents (ADP)	**High level of Illiteracy**	**Lack of extension officers/agents**	**Government lack of interest in agriculture**	**Young people's lack of interest in agriculture**
Ebonyi 259	50.58	68.34	43.63	24.32	40.54
Anambra 141	60.99	36.17	56.03	22.70	9.93
All Areas 400	**54.25**	**57.0**	**48.0**	**23.75**	**29.75**
Section III	**Factors that will facilitate respondents adoption of agricultural technology in percentage (Respectively)**				
	Adequate training and well-motivated extension agent	**Availability of credit facilities and farm inputs**	**Availability of basic Infrastructure**	**Good Governance and policies**	**Subsidization of cost of technology and the use of credit vouchers as subsidy**
Ebonyi 259	33.20	56.37	49.42	49.42	7.34
Anambra 141	52.48	33.33	28.37	25.53	32.62
All Areas 400	**40.0**	**48.25**	**42.0**	**41.0**	**16.25**

Source: Field Survey 2011 Note :(The underlined figures are the number of respondents in the states and all areas respectively. The percentages are against the number of respondents in the respective states and all areas)

These constraints are similar to those identified by ADP staffs in Table 9.2, and consistent with those identified by Madukwe et al. (2002) and Anyasina, (2011) in their respective studies. This emphasises how important it is to address them and in the words of one of the farmers; “Even if I want to adopt a technology, I do not have the money; they should teach us the technology and give us the credit (money) to enable us to adopt them”.

Section II: - This section discusses the respondents’ perception of the constraints affecting agricultural technology training in the study area. Across all areas, the farmers identified high levels of illiteracy and inadequate contact of farmers with extension agents as the topmost constraints affecting agricultural technology training in the study area. Almost of equal importance is the lack of extension agents and of least importance are young people’s lack of interest in agriculture and government lack of interest in agriculture.

Overall, some differences were noted between the two states, which may be due to the apparent differences between them as discussed in Chapter 4. Inadequate contacts of farmers with extension agents, high level of illiteracy and lack of extension agents were identified as the topmost constraints affecting agricultural technology training in the study area. These constraints are similar to the ones identified by ADP staffs (Section 9.3.2), and in line with similar studies (ibid) that noted the same findings in their respective studies. This underlines how important it is to address them if agricultural technology training is to improve in the study area. In the words of one of the farmers, “How could I be trained if I could not find an extension agent when needed; more needs to be done to increase the ratio of extension agents to farmers and motivate them to do their work”?

Section III: - This section discusses farmers' perception of factors that will facilitate their adoption of agricultural technology in the study area. Table 9.5 shows that in the study area, the respondents suggested the availability of credit facilities and farm inputs as the topmost factors that will facilitate their adoption of agricultural technology. Almost of equal importance are the availability of basic infrastructures, good governance and policies and adequate training and well-motivated extension agents respectively. While the use of credit vouchers as subsidy was identified as the least important factor that would facilitate their adoption of agricultural technology.

Some differences were noted between the two states and the reasons have already been discussed before. Overall, these findings are in line with the suggestions of ADP staff and consistent with the recommendations of FMARD, (2011) report on agricultural extension transformation in Nigeria and similar studies such as Madukwe, (2002) and Ayansina, (2011).

9.4.3 Main Sources of Agricultural Technology Adoption Information

Table 9.6 below shows respondents ranking of their main source of agricultural technology adoption information. It shows that across all areas, information from co-farmers is the topmost ranked source of agricultural technology adoption information. This is followed by farmers' co-operatives and Media/TV/Radio respectively; with LGA extension agents being the least ranked source of agricultural technology adoption information.

The same trend was observed in Ebonyi state, while in Anambra state, information from co-farmers was the topmost ranked, followed by LGA extension agents and farmers' co-operatives respectively. Media/TV/Radio is the least ranked source of agricultural technology adoption information.

The ranking index of the sources of information is very close but information from co-farmers is consistently the topmost ranked source of information in the study area. The fact that information from LGA extension agents is ranked 2nd most important in Anambra state and least important in Ebonyi state gives an insight into the state of agricultural extension services in the two states respectively. These findings are consistent with that of Anyasina, (2011) who investigated farmer's perception of public and private extension services in south-western Nigeria.

Table 9.6: Ranking of respondents on the main sources of agricultural technology adoption information

Respondents main source of agricultural technology adoption information	Ebonyi State		Anambra State		All Area	
	Ranking Index	Rank	Ranking Index	Rank	Ranking Index	Rank
Co-farmers	1.0	1	0.99	1	0.99	1
Farmers' co-operative	0.9	2	0.70	3	0.86	2
Media/TV/Radio	0.85	3	0.65	4	0.82	3
LGA extension officers/Agents	0.78	4	0.74	2	0.76	4

Source: Field Survey, 2011

9.4.4 Respondents Distance to Extension Office and Contact with Extension Agents

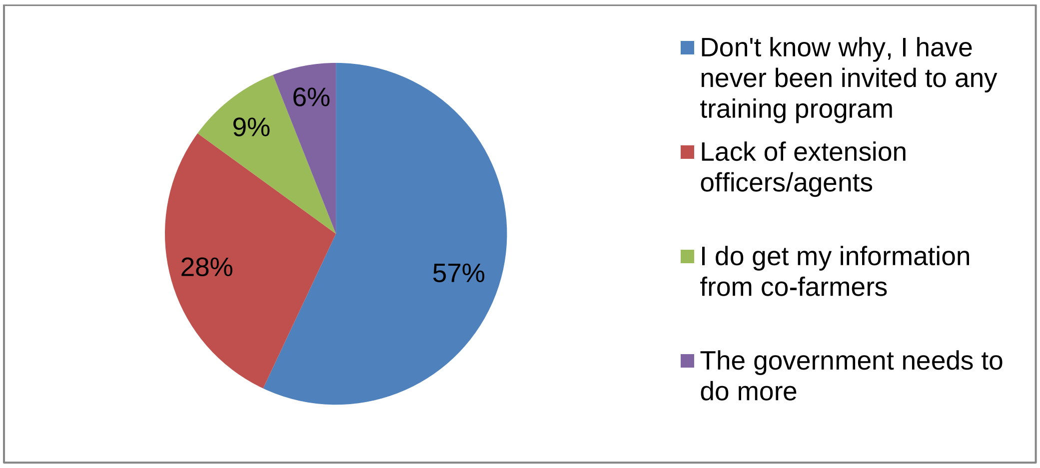
Only 71.5% of the respondents stated their distance to their nearest extension office, and the mean distance in the study area is 5.01 Km in inaccessible and rural terrain.

Also only 1.5% of the respondents said that they had been visited by extension agents in the last 12 months, mainly to teach them how to apply pesticide and fertilizer. Likewise, only 6% of the farmers said that they have visited an extension office in the last 12 months to ask about the availability of fertilizer and pesticides. This underlines the key issue (lack of extension agent contact with farmers) undermining the adoption of agricultural technology in the study area. Notwithstanding the low level of response, these findings are consistent with studies such as Ajayi, (1996), Madukwe, et al. (2002) and Ayansina, (2011) that noted low levels of contacts between farmers and extension agents in their respective studies.

9.4.5 Agricultural Technology Adoption Training Information

Only 8.5% (34) of the respondents said that they had received any agricultural technology adoption training in the last 3 years, while the remaining 91.5% said they had not. Of the small number that had received training, 87.5% reported that the focus of this had been on the use and application of pesticides, whilst, 12.5% had received training on fertilizer application. Almost all the training had been provided by ADP officers backed up by contributions from members of international NGOs.

Figure 9.5: Respondents reasons for not having any training



Source: Field Survey, 2011

Of those that said they had not received any training (Figure 9.5), most of them said that they don't know why they have never been invited to any training program. While a reasonable number of them said it may be due to lack of extension agents and a few of them said that they get information from co-farmers and that the government needed to do more to reach out to more farmers respectively. These findings are consistent with those noted by Madukwe et al. (2002) and Ayansina, (2011) in their respective studies and underline the issues of inadequate contact of farmers with extension agents as discussed in Section 9.3.1.

9.5 Credit Availability Constraints

Farmer's credit availability constraints, loan information and loan influence; and their farm produce marketing constraints are evaluated in this section.

9.5.1 Credit Availability Information of Respondents

Credit availability information of the respondents and their constraints is presented in Table 9.7. It is a multi-section table showing respondents responses to some key qualitative questions about their finance, credit availability and perspective of the government and government policies.

Section I: - This section deals with the question, of whether the respondents have enough finance to run their farm throughout a farming calendar year. Only 86.50% of the farmers responded to this question of which 66% said no they do not have enough finance and 34% said yes they have enough finance to run their farm.

Table 9.7: Credit availability information of respondents

(Section I) Enough finance for farming calendar	Reasons in percentage					
	Revenue from last planting season	Money from family member	Small time farmer	Need loan but cannot afford one	Set back due to poor harvest	Total
Yes	56.30 (67)	15.13 (18)	24.37 (29)	4.20 (5)	0	34.39 (119)
No	8.81 (20)	11.01(25)	12.78 (29)	65.20 (148)	2.20 (5)	65.61 (227)
Total	25.14 (87)	12.43 (43)	16.76 (58)	44.22 (153)	1.45 (5)	346

(Section II) Government Provision of Credit Facility	Reasons in percentage					
	Corruption	Bad government	Bad government and corruption	High cost of credit when available	Poor management and policy implementation	Total
Yes	83.61 (51)	0	14.75 (9)	0	1.64 (1)	17.78 (61)
No	52.48 (148)	19.15 (54)	21.28 (60)	3.55 (10)	3.55 (10)	82.22 (282)
Total	58.02 (199)	15.74 (54)	20.12 (69)	2.92 (10)	3.21 (11)	343

(Section III) What to do to Improve Credit Availability	Reasons in percentage					
	Use farmers’ co-operative	Credit as subsidy voucher	Well managed agricultural Bank	Use of traditional leaders	Good leadership and government	Total
	54.57 (191)	18.86 (66)	6.0 (21)	0.86 (3)	19.71 (69)	350

Source: Field survey 2011 Note: (The figures in parenthesis are predicted estimated frequency)

Of those that said yes, most of them said they use revenue from their last season's farming, others said that they used money for their family members and that they are small time farmers and do not need much money to farm. On the other hand, of those that said no, the majority of them said they need a loan but cannot afford one. This implies that the non-availability of credit is a major source of constraint in the study area. This finding is consistent with Madukwe, et al. (2002) who noted similar findings in their study.

Section II: - This section discusses respondent response to the question whether they think the government is doing enough to make credit available to farmers. Only 85.75% of the farmers responded to this question and their reasons are shown in the Table 9.7.

Of those that responded, 17.78% said yes and 82.22% said no they do not think the government is doing enough to make credit available to farmers. Of those that said yes, most of them said that more needs to be done to address corruption issues within the government. Others said that more needs to be done to address bad government and corruption problems and very few of them said that even though the government is doing its best, it should address poor management and policy implementation issues.

Similarly, of those that said no the government is not doing enough, almost all of them said it was due to corruption, bad government and a combination of both while the rest said it was due to high cost of credit and poor management and policy implementation respectively.

Section III: - This section discusses respondents perspective on what should be done to improve the availability of credit to farmers. Only 87.50% of farmers responded to this question of which most of them suggested the use of farmer co-operatives to distribute credit to farmers. Others respectively suggested that good leadership and government and the use of credit vouchers as subsidy will help to improve the availability of credit to farmers. These findings are consistent with the recommendations of FMARD, (2011) on their agricultural extension transformation agenda report.

9.5.2 Loan Information of Respondents

Table 9.8 is a multi-section table of loan information of respondents; the results are presented in sections.

Section I: - Shows that only 11.75% (47) of respondents acknowledged that they have one form of loan or another; of which most of them said they obtained their loan from their age group organisation, others from a welfare organisation, family and friends respectively.

Section II: - Shows the collateral type used by respondents and only 6.25% of respondents' state their collateral type. It indicates that most of the respondents used land, while others paid interest on their loan and used a motorcycle as collateral for their loan respectively.

Section III: - Deals with the purpose of the loan and only 11.75% farmers responded to this question. It shows that most of them use their loan for general farming purposes while the remaining uses theirs specifically to buy fertilizer.

Section IV: - Shows that most of the farmers have loan duration of more than 12 months and the remaining have loan duration of less than 12 months.

Overall, few farmers provided information about their loan in this study; therefore, one has to be careful not to draw conclusive inference from the findings. But that notwithstanding, the key findings which are non-availability of loans when needed, the requirement of collateral for a loan and duration of loan are consistent with literature and similar studies (ibid)

Table 9.8: Loan information of respondents

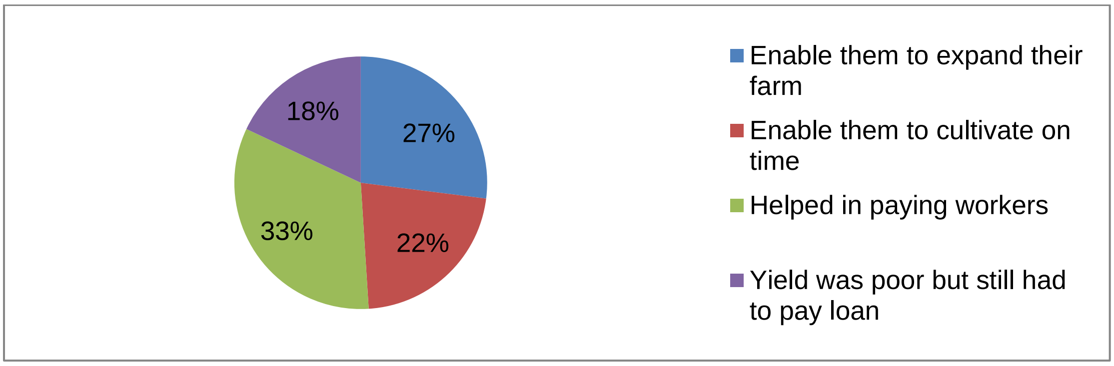
Section I: Source of Loan Percentage			
Age grade	Family and Friend	Welfare Organisation	Total
48.94	14.89	36.17	11.75 (47)
Section II: Collateral Type Percentage			
Land	Motorcycle	Interest	Total
60.0	12.0	28.0	6.52 (25)
Section III: Use of Loan Percentage			
Farming		Fertilizer Purchase	
97.87		2.13	11.75 (47)
Section IV: Loan Duration Percentage			
Less than 12months		More than 12 months	Total
19.15		80.85	11.75 (47)

Source: Field survey, 2011 Note: The figures in parenthesis are frequency

9.5.3 Loan Influence

Only 11% of the respondents said that the presence of a loan influenced their farming decisions, of which most of them said it enabled them to pay their workers. Others said it enabled them to expand their farming and to cultivate on time respectively; while 18% said even though yield was poor they still had to pay their loan (Figure 9.6). This further highlights the need to include credit in any agricultural technology adoption package being designed for farmers.

Figure 9.6: Influence of a loan on farming decisions

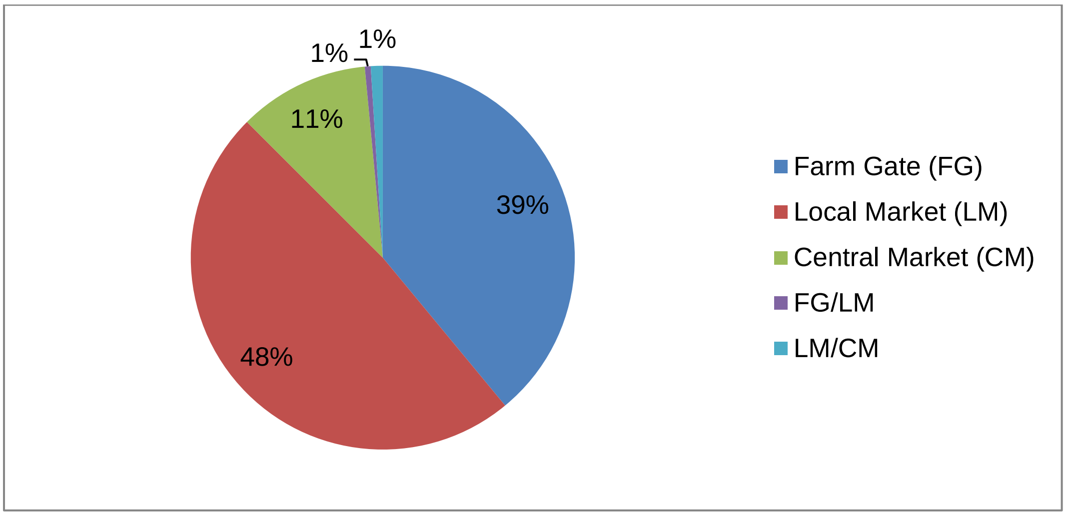


Source: Field Survey, 2011

9.5.4 Marketing Information of Respondents and Constraints

This section evaluates the constraints around respondents marketing of their farm produce. 52% of the respondents said they have problems marketing their farm produce; of which 28.41% said they have problems marketing their farm produce due to distance to the market and state of local roads; 20.30% said they have problems because middle-men do not want to pay market value for their farm produce and most of them want to buy on credit. 19.19% said high transportation cost is a major constraint; 2.21% said the fact that the local market is periodic makes it difficult for them to sell when they want, and 29.89% said that due to all the above constraints, they have to sell their farm produce by arranging with buyers to come to the house and buy.

Figure 9.7: Respondents point of farm produce sales



Source: Field Survey, 2011

The respondents mean distance to their local market is about 6.71 Km. Most of the farmers sells their farm output in their local market; others sell theirs at the farm gate and central market where they get the best price. The remaining sells theirs at a combination of other points of sale.

In general, Chapter Nine evaluated the constraints of agriculture and agricultural technology adoption from both the perspective of ADP staff and that of farmers. Section (9.1 – 9.3.5) covered the detailed analysis of the perspective of ADP staff and some of the key findings are that lack of facilities (vehicles), poor remuneration and the state of infrastructures among others are the constraints affecting the effectiveness of ADP staff work. Whilst the farmers (Sections, 9.4 - 9.4.5) noted that lack of credit facilities and farm inputs and the poor ratio of extension agents to farmers among others are the main constraints affecting agriculture and agricultural technology adoption in the study area. Other issues described in this chapter are the credit and loan information of the respondents and their farm produce marketing (Section 9.5 – 9.54).

Chapter Ten

Discussion, Summary of Findings and Conclusions

10.0 Introduction

This chapter summarizes the research and key findings. It recaps the context of the research, highlights survey design and methodologies applied to achieve the aims and objectives, which includes a combination of qualitative and quantitative approaches. Next, the chapter highlights the contribution of this research in the extant literature and then draws policy implications based on the key results. Finally, some shortcomings of the study and areas for further research are discussed.

10.1 Background and Rationale

The broad aim of this study is to identify the range of socio-economic factors influencing adoption of modern agricultural technology in multiple food crops and its corresponding impact on productivity and food availability from farm production in South-eastern Nigeria. This is because agriculture remains an important source of income and employment for the mass rural population in Nigeria but the high potential of the agricultural sector is not being realised and productivity is low and basically stagnant (Aigbokhan, 2002). The farming system is mostly small scale, characterised by low levels of modern technology adoption and is largely dependent on the vagaries of the weather (Ehui and Tsgas, 2009). Cassava, yam and rice are the three main staple food crops in Nigeria where the former two have a wide range of industrial and commercial uses as well. Nigeria is one of the leading producers of cassava in the world (Ayoade and Adeola, 2009; Knipscheer et al., 2007; Nweke, 2004). Nigeria also accounts for 68% of global yam production and yam ranks highest as an important source of dietary calories for its people (Asiedu and Maroya, 2012). Rice is also another major staple which is growing at an annual rate of 14% by mainly substituting other coarse grains, roots and tubers use for consumption (Erhabor and Ojogho, 2011). But productivity as well as growth performance of these major staple crops is very poor in Nigeria (Nkonya et al., 2010; Liverpool-Tassie et al., 2011).

Farmers generally produce multiple crops while selectively adopting modern technology in some or all of the crops in order to meet their consumption and various other needs, depending on their socio-economic circumstances. Therefore, it is important to know: (a) which food crops are grown by the farmers, (b) what level of technologies are used in each of those chosen crops, (c) whether technologies are adopted as a package or only selected elements are adopted and why, (d) what are the range of socio-economic factors which influence the choice of applying modern technologies in those crops, (e) what are the impact of adopting modern technologies as a package or specific elements on productivity of these crops, and finally (f) what are the influence of adopting modern technology adoption on food availability from farm production at the farm level. It is also important to identify what constraints exist in the agricultural sector with respect to adoption of modern technology, productivity, and food availability at the farm. It is also important not to concentrate only on the farmers, the ultimate producer and provider of food, but also the status and constraints faced by the service providers to farmers, specifically the ADP staff and extension agents.

The present research attempts to address all of these questions in a coherent manner using detailed information generated from a cross-section of

400 farmer households from Ebonyi and Anambra state of South-eastern Nigeria and 58 questionnaires from ADP staff; including in-depth interviews with key stakeholders, i.e., ADP Program Manager and NGOs. Analytical procedure includes cross-tabulation and inferential statistics to explore key demographic and socio-economic characteristics and production practices of surveyed farmers by farm-size categories (i.e., small, medium and large farm size categories) and by location (i.e., Ebonyi and Anambra states); profitability analysis from growing food crops including testing the key hypotheses of farm size-technology adoption; farm size-productivity and farm size-food availability relationships; farm size-profitability; econometric tools such as bivariate probit model to identify factors influencing the decision to adopt modern agricultural technology, allowing farmers to choose any or all elements of the technology package (i.e., either HYV seed or inorganic fertilizer or both); regression to identify factors influencing food production and food availability from farm production at the farm level, including impact of modern technology adoption as well as share of multiple food crops grown on food availability. The results are presented sequentially from Chapter 5 through 8. The detailed examination of constraints regarding adoption of modern agricultural technology, productivity and food availability and support services are presented in Chapter 9. Chapter 4 describes the study areas.

The literature search (reported in Chapter 2) revealed that the success of the Green Revolution in Asia is adoption of full technology as a package, HYV seed, fertilizer and water control and drainage taken together. Also, the diffusion of Green Revolution technology was facilitated by priorities from the government, subsidized provision of main inputs and building of infrastructure and services (e.g., irrigation equipment, extension services, R&D investment in developing HYV seeds suited to specific location and circumstances), which resulted in a high level of success in Asia.

10.2 Summary of Key Findings

Among the demographic characteristics, the age of the sample farmers ranges from 25 – 76 years; with mean age of 49 years, implying that these are more experienced farmers. The results show that in terms of years of experience, the average years of farming experience of respondents is 19.78 with 76% of them having 10 years or more years of farming experience, which is commensurate with the age profile of the respondents. The majority of the respondents are male (81%) and the mean family size of respondents is four. The average number of years of schooling of respondents was 7.84 which is relatively high but 60% of farmers have ≤ 6 years of schooling. Education is considered as one of the crucial factors influencing the attitude of farmers towards the adoption of agricultural technology; it helps a person to have day to day information about agricultural technology (Miah, 2001).

The sample respondents are dominated by small scale farmers owning land less than 1 ha of farm size. The distribution of farm size categories is: 81% are small farms (0.01 < 2.00 ha), 10.8% are medium farms (farm size 2.01 < 3.00 ha), and 8.3% are large farms (3.01 ha and above). The average farm size is small, estimated at 1.27 ha. This study found that farmers grow multiple crops instead of a single crop as 68% of the surveyed farmers grew at least two food crops. Three major staple crops are observed in this study. These are: rice, cassava and yam. The level of modern technology adoption is low and mixed and farmers selectively adopt components of technologies, as expected. The technology elements identified are use of HYV seeds, inorganic fertilizers (i.e., combination of NPK fertilizers), and pesticides, but no irrigation, although it is very important for raising productivity, particularly for rice crops. The highest percentage of farmers applied fertilizer in rice production (59.4%) followed by 36.73% of farmers in yam production and only 29.07% of farmers in cassava production. In contrast, the application rate of fertilizer is highest in yam at 153.78 kg/ha against 125.21 kg/ha in cassava and 119.23 kg/ha in rice. The implication is that those who apply fertilizer in yam apply much more because this crop is mainly destined for sale in the market. Application rate of fertilizer in general is highest for small farms compared to the other two categories of farmers. For those that used technology, their usage is below the recommended level, thereby making it not very effective.

The study also reveals that small scale farms have significantly higher yield for rice and yam in the study area. This confirms the hypothesis of inverse farm size – productivity relationship in Nigerian agriculture. The yield levels of rice, yam and cassava crops are 3137 kg/ha, 5616 kg/ha and 12511 kg/ha for small farms (Table 6.1). Results also show that years of farming experience have a positive relationship with yield. It also found that distance to extension centre has a negative relationship with yield in the study area. Also, a positive relationship exists between yield and fertilizer and pesticide application, human and ploughing labour and seed rate usage in the study area.

The profitability of the farm enterprises was extensively evaluated and discussed in Chapter 6 (Section 6.3, Tables 6.16 and 6.17). This study found that yam and rice enterprises are the most profitable. But when the return to investment was evaluated (profitability index), rice enterprise was found to give the highest return to investment (2.21), followed by yam (1.65) and cassava (1.12). This implies that for every one naira invested in rice farming, the return is 2.21 naira (Table 6.16). However, Table 6.17 shows that large farms are more profitable in producing these major food crops, which is in contrast with expected inverse size – profitability relationship. In other words, although small farms are producing significantly higher yield, they are not being able to produce these crops with maximum possible profits. However, it is very important to note that return to investment for all crop enterprises is positive, which implies that they all provide positive returns to investment.

The adoption pattern of the respondents was discussed in Chapter 7 (Section 7.1, Table 7.1). It was found that only 29% of the respondents adopt agricultural technology as a package in the study area, of which 30.9% of them were small scale farms and 11.6% and 27.3% respectively were medium and large scale farms. This therefore shows inverse size – technology adoption relationship when adoption of technology as a complete package is considered. Interestingly, when we consider adoption of any one element of the technology (i.e., either fertilizer or HYV seeds); then the results show a positive relationship between farm size and technology adoption. That is, large farms adopt single elements of technology relatively more than the small farms (Table 7.1).

One of the main aims of this study was to jointly identify the determinants of modern agricultural technology adoption in multiple staple crops by farmers in South- eastern Nigeria using a bivariate probit model. Explicitly, the probability of adopting HYV seed and/or fertilizer technologies in three staple crops (rice, yam and cassava) was investigated. The model diagnostic revealed that the choice of bivariate probit approach is more appropriate than the univariate approach that is commonly used in the literature. Also, the accuracy of joint prediction of the decision to adopt agricultural technologies is both robust and high for non-adopters and adopters of both technologies for all the crops. Overall, the determinants of agricultural technology adoption show that except for rice farms, all the correlation coefficients are positive and significant to the decision to adopt agricultural technology across the farm crops. This implies that the probability of adopting HYV technology in one crop increases the probability of adopting fertilizer for the same crop. The implication is that there is significant synergy in the decision to adopt modern technology in all the food crops investigated. Such finding is not commonly reported in the adoption literature and is a contribution of this research to the existing literature. This study found five variables which each have a significant relation with the decision to adopt HYV and the decision to adopt fertilizer respectively; they are extensively discussed in Chapter 7 (Section 7.3 & Table 7.3, 7.5). The positive influences in HYV seed adoption model are: farming experience and high profit motive, and negative influences are farm size, distance of extension office and ready market motive. In the fertilizer adoption model, the positive influences are farming experience and gender of farmer, and negative influences are education of farmer, distance of extension office and training. Of all the significant determinant variables, farming experience and distance to the extension centre have the most effect on the adoption of both HYV seeds and fertilizer technologies.

The advantage of bivariate probit model is that one can derive the total effect of a variable conditional on adopting any of the two elements of technology. The marginal effect of the model result is presented in Table 7.5. In terms of the marginal effects, this study found that the predicted joint probability of adopting HYV seed conditional on fertilizer technology adoption is estimated at 0.58. A one percent increase in years of farming experience by one year will increase the probability of adopting HYV by +0.008, given that the farmer has already adopted fertilizer. Likewise, a one percent increase in either farm size, distance to extension centre or number of extension contacts will negatively increases the probability of adopting HYV by (-0.191, -0.036 or 0.318) respectively, conditional on fertilizer adoption. Similarly, an increase of one percent in the adoption of HYV seed because of high profit rank in one year will increase the probability of adoption of HYV seed by +0.39, conditional on fertilizer adoption.

The food availability status of the respondents was discussed in Chapter 8 (Section 8.1, Table 8.1). This study found that the respondents have surplus food status in the months of January, November and December due to it being the start of storage period and peak of harvest. It was also found that the farmers have level food availability in the months of February, March, April, August, September and October and the justification ranges from it being the end of storage period to start of harvest period. Lastly, this study found that respondents have deficit food availability status in the months of May, June and July; the justification is because it is the end of the planting period and crops are growing in the field.

Full discussion of the PFA model and calorie conversions are in Chapter 8 and it is very important to reiterate the following:

- ❖ This only refers to staple food availability at the farm level
- ❖ This does not take into account the nutritional consideration of the available food
- ❖ This does not take into account if the available food is the preferred food

Therefore the findings from this study about the level of food produced and food available for consumption was discussed in Chapter 8, section 8.2 – 8.5; but the specific findings are as follows:

- ❖ Mean food produced in the study area by each farming household is 12322.74 calories/ha/H/D

- Mean food available for consumption for each farming household in the study area is 4693.34 calories/ha/H/D
- Mean percentage food availability for each farming household in the study area is 38.09%
- Small scale farms produce the highest food (13873.10 calories/ha/H/D) and have the highest food availability (5446.36 calories/ha/H/D) and have the highest percentage food availability (39.26%) in the study area
- Cassava farming respondents have the highest food availability (11571.67 calories/ha/H/D) in the study area and the highest percentage food availability (49.11%)
- Yam farming respondents have the least food availability (4.79 calories/ha/H/D) in the study area and least percentage food availability (0.07%).
- Yam and cassava crop combination gives the next best food availability (4516.05 calories/ha/H/D) and next best percentage food availability (35.54%) in the study area

Table 8.2 presents the analysis of farm level food production and food availability per ha by farm size categories. Results clearly show that there are inverse farm size–food production as well as inverse farm size-food availability relationships, which conforms to our research hypothesis. This is expected because small farms are producing at a significantly higher level (Table 6.1).

Regression analysis was used to identify socio-economic factors influencing food production and food availability including the impact of technology adoption (i.e., fertilizer used) on food production and food availability. The result shows that six variables are significantly correlated to food production; they are family size, educational level, farm size, proportion of rented-in land; distance to extension centre, and cassava share of food. It also shows that the correlation for educational level, farm size, cassava share of food and distance to extension centre are positive, implying that they positively influence food production. Except for distance to extension centre, other variables effect are expected; these were extensively discussed in Chapter 8, (section 8.5). Likewise, it shows that family size and proportion of rented-in land are negatively correlated to food production; this implies that larger family size does not necessarily increase food production, especially if the family are not directly actively engaged in the family farm. Also, due to the cost (output-share) associated with rented-in land, it is very important for the farmer to evaluate if this is a necessary step to take.

Four variables were found to be significantly correlated to food availability; they are, family size, farming experience, farm size and cassava share of food. Farm size and cassava share of food are positively correlated, meaning that the larger the farm size, the more likely the respondent is to have food available for consumption, and that they are more likely to keep their cassava output for consumption than any of their other farm output. Family size and farming experience are inversely correlated to food availability; that of farming experience is not expected.

Interestingly, the constraints affecting agriculture and agricultural technology adoption in the study area was evaluated from both the perspective of ADP staff and farmers. This study found among others, the following to be the topmost constraints;

- Lack of extension agents and support for ADP
- Lack of credit facilities and farm inputs
- Corruption and poor government and ineffective government policies

- ❖ Lack of value adding chain for farm produce
- ❖ Lack of irrigation facilities

Farmers identified lack of enough contact with ADP staff, credit facilities and farm inputs as the topmost constraints affecting their adoption of agricultural technology. The farmers' main source of information about agricultural technology is from co-farmers. They identified the availability of credit facilities and farm inputs as the main factors that will facilitate their adoption of agricultural technology. The majority of the respondents stated that they do not have enough money for their farming and that the government is not doing enough to make credit available for farmers due to bad government and corruption. The majority of the farmers suggested the use of farmers' co-operatives to distribute loans to farmers and few of them suggested the use of credit vouchers as subsidy. Few of the respondents acknowledge that they have a loan for their farming and most of the farmers sell their farm produce in their local market or at the farm gate.

10.3 Summary of Key Findings from Qualitative Research Interviews

This section will highlight the key findings from qualitative interviews with key stake holders like program managers of ADP in both states, country representative, International Fertilizer Development Centre (IFDC) and representative from United Nations Development Program Nigeria (UNDP). Full extracts of the interviews were included in Appendix two (Sections A-D) and the key findings are as follows:-

- ❖ IFDC Nigeria has about 10 programs/projects on the ground in Nigeria which includes pioneering projects like the fertilizer voucher program and Cassava plus Projects.

- IFDC Nigeria is in the process of expanding these pioneering projects to cover all the states in Nigeria, which will help to reduce the level of corruption in the fertilizer market in Nigeria.
- That the 10% cassava inclusion policy of the government, which equates to 400,000 tons of cassava flour, will lead to an increase in cassava production and productivity.
- That corruption, inconsistent government policies, poor private sector participation in agriculture among other things are the main constraints affecting agriculture in Nigeria (IFDC, UNDP).
- That UNDP Nigeria is helping the government to maintain and strengthen key institutions.
- UNDP Nigeria are involved in international model exchange and help in pointing out to the Nigerian government some internationally accepted models that could be adopted, modified to suit the Nigerian context.
- The need for agriculture to be sustainable and environmentally friendly; UNDP Nigeria is helping the government to develop policies in these areas.
- That before the fertilizer voucher program only 11% of allocated farm inputs got to actual farmers (ADP, Anambra state)
- That the ratio of extension agents to farmers in Anambra state is 1:9000 instead of the FAO recommended 1:800-1000; while in Ebonyi state the ratio is 1: 2417 farmers.
- Agriculture in the study area is still rural and dominated by small scale subsistence farmers (ADP, Ebonyi and Anambra states).
- The government is trying but their policies need to be consistent and there is the need to get the private sectors more involved in agriculture.

- There is urgent need for the government to provide adequate facilities like transportation for ADP field staff (ADP, Ebonyi and Anambra states)

10.4 Policy Implication of the Research

Based on the findings of this study, several policy suggestions can be proposed to address the main aim of the study, which is the factors influencing adoption of agricultural technology in food crops and its impact on productivity and food availability. Since the level of adoption of technology as a package is very low and mixed, therefore the government and NGOs that have an interest in agriculture should promote the adoption of modern agricultural technologies as a package. The package should be comprehensive and must include provision for credit and farm inputs. Irrigation in the study area is non-existent, since none of the respondents used/has access to irrigation facilities. The government should map out areas that could benefit from having irrigation facilities and plan to provide them.

Profit motive was a dominant incentive in the adoption of HYV seed technology. Therefore, price policies to keep output prices high will promote HYV seed technology adoption in food crops, as this would induce farmers to invest in HYV seeds, which in turn will increase productivity. This can be achieved by improving market and marketing infrastructure so that it works effectively and benefits all relevant stakeholders including the farmers.

The study showed that although small farmers are more productive they are not profitable. This is because most small farmers take farming as a way of life and are not familiar with treating farming as a business. Therefore, training should be targeted at the small farmers to train them in business skills.

Next, targeted investment in extension infrastructure and services will significantly increase modern technology adoption and deserves particular attention. Aye and Mungatana (2011) concluded that the extension services in Nigeria in general have not been effective, especially after the withdrawal of the World Bank funding from the Agricultural Development Project, which is the main agency responsible for extension services.

The study also identified some constraints affecting agriculture and agricultural technology adoption, such as lack of extension agents, lack of credit facilities and farm inputs, lack of infrastructures, ineffective government policies among others. Provision of credit services can be achieved through effective dissemination of credit through formal banking institutions and/or facilitating non-governmental development organizations (NGOs) targeted at the farming population. These constraints need not be just one solution but a comprehensive, well-co-ordinated inter/intra departmental designed policy package to address them.

Concerning the issues of food availability, status and general food availability, this study identified that cassava is the most important staple food crop in the study area. There is a need for the government and NGOs to continue to encourage and support policies and programmes like the Cassava Plus project and Cassava flour inclusion policy. Also the area of value adding chain for most of the farm produce needs to be address.

Generally, since agriculture in Nigeria is still predominantly dominated by small scale farms, most of these policies and packages should be designed with small scale farmers in mind. In order to increase agricultural productivity and for Nigeria to meet her aspiration of food security; there is the need to support and strengthen ADP systems in Nigeria, especially in the area of providing transportation (mobility) and increase in the ratio of extension agents to farmers.

10.5 Shortcomings and Area for Future Research

This research based its findings on data collected during the farm household survey that lasted for five months (October 2011 – February 2012) and research interviews that took place in October 2011 and October 2012. This required the respondents to give detailed accounts of their farming activities for the past twelve months based on what they could remember, since most of the farmers do not have formal farm record books. Since this study is based on a cross sectional data, a panel data is more likely to give a more accurate and reliable result.

Also the study based its findings on data collected from two states in south-eastern Nigeria. It would be worthwhile to extend the study to other regions of Nigeria, since differences exist between the regions. This would have given a more comprehensive picture of what happens in the country.

On the basis of the findings of this research, there are prospects for further research work, in areas such as evaluation of economic impact of adoption or non-adoption of agricultural technology. Also there is an opportunity for more investigation in the area of food availability and partial food availability calculation. Finally, there is the need for future research on the way the food security index is determined and calculated for developing countries.

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Appendix 1

Table: 1 Age, Education and Years of Schooling of Respondents

Age			Years of education			Years of farming experience		
Years	Frequency	%	Years	Frequency	%	Years	Frequency	%
25-35	**75**	**18.8**	**0**	**39**	**9.8**	**0-4**	**31**	**7.8**
36-45	**89**	**22.3**	**1-3**	**44**	**11.0**	**5-9**	**86**	**21.5**
46-55	**122**	**30.5**	**4-6**	**158**	**39.5**	**10-15**	**75**	**18.8**
56-65	**80**	**20.0**	**7-12**	**115**	**28.8**	**16-24**	**64**	**16.0**
66-76	**34**	**8.5**	**13-18**	**44**	**11.0**	**25-50**	**144**	**36.0**
Total	**400**	**100**		**400**	**100**		**400**	**100**
Mean	**48.54**			**7.84**			**19.78**	
Std. Dev.	**12.143**			**1.728**			**13.618**	
Variance	**147.442**			**22.354**			**185.453**	

Source: Field survey, 2011 (N.B: The mean, Std. Deviation and variance were calculated from the real value of the data and not the range value)

Table 2: Irrigated area in Nigeria

Irrigated area	Year	Number of hectares (ha)
Surface irrigation equipped	2004	238.07
Sprinkler irrigation equipped	2004	50.00
Localized irrigation equipped	2004	0
Equipped lowlands (wetlands, flood plains and mangroves etc.)	2004	5.10
Non-equipped flood recession area	2004	681.91
Total water management area	2004	975.08

Source: Aquasat, 2005

Table 3: Percentage of population undernourished in developing countries

Region	Percentage undernourished				
	1969-1971	1979-1981	1990-1992	1996-1998	2000-2002
Sub-Saharan Africa	34	37	35	34	33
Near East and North Africa	25	9	8	10	10
East and southeast Asia	43	29	17	13	13
South Asia	38	38	26	23	22
Latin America and Caribbean	19	13	13	11	10
All Developing Regions	37	29	20	18	17

Source: FAO, 2005

Table 4: Agricultural indicators by region

Agricultural indicators	Africa	Sub-Sahara Africa	Near east and north Africa	South Asia	East Asia and Pacific	Latin America and Caribbean	Middle income Countries	High Income Countries	World
Proportion of arable land irrigated	7.0	3.8	28.7	39.3	31.9	11.6	19.9	11.9	20.0
Added value per worker (USD/year)	416	285	1859	412	461	3028	335	17956	645
Per capital cereal production (kg/ha)	147	128	128	224	336	259	339	746	349
Cereal yield (kg/ha)	1225	986	1963	2308	4278	2795	2390	4002	2067
Livestock production (kg/ha)	164	128	147	121	150	198	191	248	193
Fertilizer use (kg/ha)	22	9	69	109	241	85	111	125	100

Source: FAO, 2005

Table 5: Government Agricultural development Initiatives in Nigeria

Policy and programs	Description	Weakness
Co-operatives (1935 to date)	The Nigeria co-operatives ordinance was promulgated in 1935 to regulate co-operative activities in the country. In 1974, a law was enacted establishing the department of co-operatives.	Policy inconsistence and administrative dislocations of the federal departments in charge of co-operatives.
Commodity Boards (1947 to 1986)	Commodity marketing boards started during the colonial era with the establishment of the first marketing board in 1947. Palm produce, groundnut and cotton marketing boards were formed in 1949. The second generation of boards was established in 1954 and were regional marketing board which serves as buyers of last resorts at fixed prices and held buffer stocks.	Inability to pay farmers the subsisting market price and was then scrapped in 1986 under the structural adjustment programs.
Agricultural Research Institutes (1964 to date)	Four research institutes namely cocoa, oil palm, rubber and Trypanosomiasis were established in 1964. In 1975, the ARI decree came into effect establishing additional research institutes.	Instability of the research institutes as a result of their constant movement from one ministry to another and there were major funding issues.
National Accelerated Food Production Program (1970s)	Objectives were to increase the yield of seeds varieties, enhance fertilizer use and promote extension and credit services. Number of national crop centres was established at different locations: Ibadan for rice, Zaria for sorghum, millet, wheat and Umudike for cassava.	Started very well but the wheat program was affected by a basic withdrawal of political support and the lifting of the ban wheat imports.

Policy and programs	Description	Weakness
Nigeria Agricultural and Cooperative Bank (1973 to date)	The main specialized institution for agricultural credit delivery in the country.	Directed to provide subsidized credit at single digit interest rate without the corresponding government subsidy. Needs to be reformed for greater efficiency and effectiveness.
Agricultural Development Project (ADP) (1975 to date)	World Bank Funded at inception, they were set up to provide extension services, technical input supports and rural infrastructural services. They now assume a permanent status and are now recognized as a major agricultural development institution in the country.	The decline in oil price that started in 1982 affected the funding for ADP. Also ADP focus on high input technology for solo cropping system which are not used by majority of small holder farmers who prefers mixed/ relay cropping system as a rational strategy to reduce risks.
River Basins Development Authority (RBDA) (1977 to date)	They are major instrument for water resources and irrigation policy and were established in1977. Their main aim is to develop, manage and take advantage of available water bodies in the country for agricultural, fishing and other purposes.	RBDAs failed due to unnecessary political interference and managerial problems resulting from socioeconomic cleavages which permeated the nation's socio-political, economic and cultural institutions. Also lack of qualified manpower to provide effective leadership at the departmental levels.
Operation Feed The Nation (1976 – 1979)	This was a mass awareness and mass mobilization program created in 1976 through 1979 in reaction to the first real food crisis in the country.	Lack of continuity and shift in approach by successive governments led to the failure of the program.

Policy and programs	Description	Weakness
Green Revolution (1979 – 1983)	This focused on food production, input supply and subsidy; special commodity development, review of agricultural credit guarantees schemes and increase resource allocation to RBDAs	Lack of continuity and shift in approach by successive governments were the reasons for the failure of the program.
Directorate Of Food And Road And Rural Infrastructure (DFRRI) (1986 – 1993)	DFRRI was established to accelerate the rate of infrastructural development in rural areas. It was designed as a supra-ministerial body for channelling the proceeds of the liberalized foreign exchange market for rural development.	Lack of funds and commitments limited the extend of infrastructural provision in the rural areas. Also the program was embarked upon without effective planning and without institutional arrangements for their execution.
National Agricultural Land Development Authority (NALDA) (1991 – 1999)	Their objectives include providing strategic public support for land development, promoting and supporting optimum use of Nigeria's rural land resources.	NALDA approach increased rather than reduce the direct public provision of goods and services. Most of their works were duplications of work done by ADP and other agencies.
Presidential Initiative On Cocoa, Cassava, Rice, Livestock, Fisheries And Vegetables (1999 – 2007)	These were initiated by past administrations in an effort to improve Nigeria's food production in line with vision 2020. The strategy is to attract the attention of the highest level of political authority for special intervention in the commodity sector.	Poor funding and lack of institutional arrangements for its implementation.

Source: Report of the National Program for Food Security, (2008) in Akinyele (2009)

Table 6: Differences between quantitative and qualitative research approach

Differences with respect to	Quantitative Research	Qualitative Research
Underpinning philosophy	Rationalism: that human beings achieve knowledge because of their capacity to reason (Bernard 1994:2)	Empiricism: the only knowledge that human beings acquire is from sensory experiences (Bernard 1994:2)
Approach to inquiry	Structured/rigid/predetermined methodology	Unstructured/flexible/open methodology
Main purpose of investigation	To quantify extend of variation in a phenomenon, situation, issue etc.	To describe variation in a phenomenon, situation, issue etc.
Measurement of variation	Emphasis on some form of either measurement or classification of variables	Emphasis on description of variation
Sample size	Emphasis on greater sample size	Fewer cases
Focus of inquiry	Narrows focus in terms of extend of inquiry, but assembles required information from greater number of respondent	Covers multiple issues but assembles required information from fewer respondents
Dominant research value	Reliability and objectivity (value-free)	Authenticity but does not claim to be value-free
Dominant research topic	Explains prevalence, incidence, extent, nature of issues, opinions and attitude; discovers regularities and formulates theories	Explores experiences, meanings, perceptions and feelings
Analysis of data	Subjects variables to frequency distributions, cross-tabulations or other statistical procedures	Subjects responses, narratives or observation data to identification of themes and describes these
Communication of findings	Organisation more analytical in nature, drawing inferences and conclusions and testing magnitude and strength of relationship	Organisation more descriptive and narrative in nature

Source: Kumar, (2005)

Table 7: Advantages and disadvantages of questionnaire/interviewing method of data collection

Questionnaire		Interviewing	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
It is less expensive	Application is limited	It is useful for collecting in-depth information	It is time consuming and expensive
It offers greater anonymity	Respond rate is low	Questions can be explained	The interviewer may be biased
The researcher is unable to influence the response of the respondent	Opportunity to clarify issues is lacking	Information can be supplemented	The quality of data may vary when many interviewers are used
It is a very convenient method of data collection	It is possible for the respondent to consult others	This method is more appropriate for complex situations	The quality of data depends upon the quality of the interviewer
	The respond to a question may be influenced by the response to other question	It has a wider application	The quality of data depends upon the quality of the interaction

Sources: Atkinson, (1998), David and Sutton (2007) and Kumar (2005)

Appendix Two

Section A

International Fertilizer Development Centre (IFDC) Nigeria PhD Research Interview (October 2011)

C: Good day, my name is Chima Chidiebere Daniel, am a PhD student with University of Plymouth United Kingdom. Am here to conduct interview with the country representative IFDC in Nigeria Mr Scot Wallace; my research is on socio-economic determinants of modern agricultural technology adoption in multiple food crops and its impact on productivity and food availability at the farm-level: a case study from South-eastern Nigeria. The research has two aspects, one is the use of questionnaire to collect information from farmers and ADP staff and the other is interviewing NGOs and ADP program managers in Nigeria.

R: Is this your first interview?

C: Yes this is my first

R: So I am your guinea pig

C: Yes, hahahha please would like to find out more about your organisation and what they do, especially their mandate and the stand of your organisation and your view on the adoption of agricultural technology in Nigeria.

R: I am the country rep of International fertilizer Development Centre (IFDC), we are an international NGO, and currently we have approximately 10 projects on ground. We got the fertilizer voucher program that is working to remove the government away from the procurement and distribution of fertilizer; allowing the private sector to be involved. The other side is ensuring that the subsidy that the government uses for fertilizer reaches the target farmers and not going to politicians.

We are also working with agro dealers, supporting the agro dealers, that is people that sells HYV seeds, fertilizer and other farm inputs. We have activities working on policies, value chain activities working on rice, cassava and other commodities. So we are here as NGO to work on debottleneck various areas of the agricultural sector.

C: Please could you expand more one any one of your projects?

R: The Cassava plus Project (CPP) is one of the projects which am fully involved in, it is a partnership funded by the Dutch government, there is a new technology for cassava processing that has been developed by our private sector partner. Cassava as you know takes about 48 hours after harvesting to start deteriorate; this company has developed a mobile 46 ft. container that can process 40 tons of cassava out to the farmers production area. So this is quite a lot of cassava for small scale farmers, we happen to link currently subsistence farmers with the company and develop a system that allows the farmers access to the processing units. We currently operate in Northeast, South-south and Southwest Nigerian where processing units are being built now or already operating.

C: Please if I may ask, why none is in south-eastern Nigeria, is there any reason.

R: The current reason is our project goes to where ever our private sector partner goes, so there is a foot print of factory in Rivers state being build, there is a factory in Taraba and another in Osun state.

C: So if any of the state governments in south-eastern Nigeria should show interest, will your organisation or private sector partner work with them; because I know that cassava is one of the most important staple food crop in the zone.

R: Our private sector partner is currently stepping back; the federal government is going back to supporting 10% inclusion of cassava flour to go into wheat flour import. That inclusion has now been accepted by bread makers (wheat lovers); that will equate to about 300,000 tons of cassava flour annually. Currently there is only 50-60 thousand capacity of high quality cassava product, so there is huge demand to start building up local processing centre, so our partner is looking to building one to two factories per year. It must not be government; it could be private individual, so we are looking to expand very soon.

C: Thank you, one of the key areas of your organisation is fertilizer, do you import, manufacture or source your fertilizer locally here in Nigeria.

R: We are an NGO, so we don’t get involve in the trade of fertilizer; we are supporting the development of the fertilizer sector and support the utilization of fertilizer. Currently the largest urea fertilizer plant in Africa is based here in Nigeria, it was used to be a government company the was dead and later privatised; it is now up and running. There are 3 other factories that are current in the process of being constructed; one of them will be three times larger than the current largest one. So we expect that Nigeria will soon become able to satisfy its domestic requirement for fertilizer and even export fertilizer.

The reason why, is Nigeria is flaring gas close in the dark in Niger Delta; to make urea or nitrogen fertilizer, you need to go from the gas to ammonia. 70% of the cost of making urea or nitrogen fertilizer is ammonia. Basically, we have all the ammonia that could be used to make fertilizer currently being burn away at a high cost to the environment.

C: Thank you, when I was at the field one of the constraints that came across from the farmers is the cost and unavailability of fertilizer, is there anything your organisation is doing to overcome this problem.

R: Because of the close linkage between the cost of fertilizer and that of petroleum, globally in the last couple of years, fertilizer cost has been going up. To look at the reasons behind the major constraints here in Nigeria, it is initially linked to corruption. If I were to compare a government contract to make a power plant, if you don't make the power plant, somebody can go and investigate and say the plant is not there. But if the government we spend our money on fertilizer, if someone comes to inspect it and ask where the fertilizer is; the government people will say it is in the farmer's field. There is no way you can trace the fact that the product was not used by the farmers. Fertilizer has become a corrupt political tool, which has been used by politicians for corrupt proposes.

We are working on a fertilizer voucher scheme, basically we go out and does a census of farmers group, from that census, that individual have a discount coupon. So instead of the subsidy going on truck load to corrupt politicians; each individual goes to their local agro dealers and exchange their voucher for a discount on fertilizer and pay the balance. So the government is no longer involved in the procurement and distribution of fertilizer. All they need is once the redemption term has verified they are true vouchers and that the true farmers received the fertilizer; then an e payment is made to the agro dealer.

This was started last four years with 5,000 farmers up to 500,000 farmers; the new minister of agriculture has been a supporter of the program and is on board. We are planning to move on to 5 million farmers next year and to add 5 million farmers each year for the next four years. So that will than allow for approximately 40% discount on the price of fertilizer; thereby ensuring that at least 5 million farmers get their fertilizer at the discount rate.

C: Most of your interventions are they available in south-eastern Nigeria

R: For the fertilizer voucher project, the minster is meeting with state governors; he has received inducement on this plan from the minister of finance and the governor of the central bank and the economic adviser to the cabinet. So the programme is going to be rolled out nation-wide next year and the states could sign up for it if they agree to the terms. We are also working with the fertilizer companies to develop a new blend of fertilizer that is appropriate for tuber crops as there is none now. Hopefully, the south-east states will endorse and become part of the programme.

C: I know your agency is interested in rice, and Ebonyi state is well known for their rice, do you have any program on rice that you can link-up with Ebonyi state government to promote the Abakaliki rice and farm inputs.

R: Most of our activities are led by state commitments and donor funding, we don't have our own resources to go in and do any intervention. Rice has many complications, the seed sector in Nigeria is very weak, the seed inspection is very weak and there is the major problem of red rice which is a weed. When you buy seeds you cannot tell if it is red rice or real rice, you have to open up the seed to see if it is true rice. Planting rice that is mixed up with red rice reduces productivity and the quality of the output.

So the main issue with rice in Nigeria is the importation of foreign rice from Asia, most of these rice have been in storage for a long time over there and they ship it to Nigeria at a reduced price, thereby making local production cost ineffective. So the key is to create a level playing field for the local farmers to give them the chance to succeed. And the seed sector needs to be improved and regulated better than it is now. We have recently been in contact with large rice farmers in Kenya that want to come into Taraba state in partnership with the state government; we are helping to facilitate this. Nigeria is importing 2.5 million tons of rice every year, while they have the capacity to be exporting rice to other countries. The main problem with the Abakaliki rice is the quality in terms of it not being de-stoned and that they have large number of small scale millers; so the need to come together to make any impact.

C: Another area am interested in is the area of technology adoption, is there anything your NGO is doing to encourage the adoption of agricultural technology as a package.

R: The Green revolution succeeds in Asia because they grow almost homogenous crop (rice, maize, wheat) but in Africa, farmers here grow more of diversified crops (cocoa, palm tree, rice, cassava etc.). So it is difficult to get a package that will fit all farmers, rather we are working on packages for individual crops. Like for cassava, a typical cassava farm in Nigeria is less than 1 ha and if the farmers want to go commercial, they will need to grow at least 3 ha. We are doing things like the blend of fertilizer for tuber crops; we are also introducing smallholder's mechanization packages and we are working with the central bank to facilitated credit for the farmers; for if they need to go commercial they will need credit for labour and other cost.

We are also working with subsistence farmers to showcase how they could rotate the crops with legumes to put back nitrogen to the soil. Otherwise, what happen in Thailand when they went into commercial cassava farming, overnight the soil became poor due to lack of nitrogen, so we are developing packages to go with our interventions.

C: Please what is your view on factors affecting agricultural technology adoption in Nigeria?

R: I will put it in a simple way; "CRUDE OIL" with the discovery of oil agriculture became a welfare state, it is not look at as something that could be profitable, it is not seen as a business especially by the small scale famers, rather they view it as a way of life.

So the money that has been put into agriculture is just like the government intervening into private sector business. For example we have very few tractor farmers ratio in Nigeria, this is because the private sectors cannot come in and sub contract tractors to the farmers because most state government will buy them from Chain and give them out for free, thereby discouraging private sector participation in the sector. The same for fertilizer, seeds and other farm input and this will not change until this issue is rectified. This has hampered Nigeria ability to attend the level of agricultural productivity it is capable of, just as the minster for agriculture said the other day, if anyone can bottle air it will be imported to Nigeria and people will buy it. So he does not want to be a minister that over sees the importation of everything into Nigeria but one that help and encourages the local farmer.

C: Thank you, why despite all the efforts of organisations like yours, towards the improvement of agriculture in Nigeria and other African countries. Africa is still believed to be the only continent not to meet the MDG goal one of halving poverty and hunger by 50% by the year 2015, what do think is the reason behind this.

R: Think each country has its own unique factor but in the case of Nigeria, it has to do with issues of good governance, level of corruption, the crude oil factor and private sector not participating in the agricultural sector, these are some of the constraints Nigeria has. That said I do see that the present minister for agriculture has a good vision for the agricultural sector, he is not interested in the contracts but rather in making positive impact.

C: Thank you another area I am interested in is food availability; most of the food crop grown in Nigeria are in abundant during the harvest period and become scarce thereafter. In there anything your organisation is doing toward value chain adding in the food crop sector in Nigeria.

R: Well, cassava is one that we are spearheading its development and help in making it more of a cash crop than food crop. The technology that our partner has developed (Cassava Plus Project) is a game changer in the sector not just for Nigeria but for the continent. It has a process that takes the cassava into cake that can then be preserved for up to 2 years without losing any of its quality. The cassava cake can then be used in making bread, biscuit, spaghetti (etc.) and serves as replacement for wheat and the produce still test the same if not better. Nigerians like the texture (bread) of the one with cassava flour than the wheat, so you not only reducing the cost of production, you are also improving the quality. So this seems to be a game changer; so for yam am not so much concern about because you can store yam longer than cassava and use them during the off season period.

As far as food security goes, Nigeria is very lucky they relatively have steady replacement for off season food crops and do not have too much food deficit period like you have in other countries like Somalia etc. The perishability are mostly in vegetables, tomatoes and fruits, we are not involved in it too much at present because we do not have funding to intervene but there is the case to put tomatoes plants and fruit juice plants close to the production areas. But there are many factors that need to be in place for it to be a success, infrastructures like electricity, good road (etc.)

C: Thank you, you may not be the right person to ask this, but all the same what do you think about lack of irrigation facilities in south-eastern Nigeria

R: It may be because the dry season in the south-east is shorter than in the northern part of the country. Don't know much about irrigation but such projects should be cost effective for it to be useful, you may be better off talking to an irrigation expert.

C: Thank you, lastly, on the issue of food availability in Nigeria, do you think Nigeria has the capacity to produce enough food to feed her growing population and even export to other African countries.

R: At first we should not be looking at export given that we import 2.5 million tons of rice annually. The priority should be domestic food availability, take for example the cassava, we are importing millions of tons of wheat. With the 10% cassava flour inclusion policy, which is about 400,000 tons of cassava flour that could be included which equates to 1.6 million tons of cassava tubers. We have other crops like sorghum, groundnut (etc.) that could be used in beer, Maggi, toothpaste making; there is so much potential for import substitution policy that will be of benefit to Nigerian farmers and improve/widen their cash crop base. I think the opportunities are extremely high especially if the policies are right and the bottleneck and constraints are eliminated or reduced especially with the cost of production and farm input availability.

C: Lastly, on a lighter note, you have been in Nigeria for a long time, what is it that you like most about Nigeria and Nigerians.

R: Beside the people, the comradely and the friendliness of the people, from work perspective, you have a range of challenges here that you will not find anywhere else in the world. This linked with the opportunities and potential, when you talk of about 150 million people; one small change in Nigeria has the potential to affect potentially lots more people than in any other African country. That what drives me to be here and to continue doing what am doing. There are good people in the private sector, government and NGOs that wants to make positive changes and we are in the process of achieving that especially with the fertilizer voucher program. When we started the program there were lots people that said it will never work in Nigeria, but it is succeeding now and people are coming round to supporting the program.

C. Thanks a lot and thank you for your time.

Section B

United Nation Development Program (UNDP) Nigeria PhD Research Interview (October 2012)

(C): Good afternoon and thank you for granting me this interview

(C): My name is Chima Chidiebere, a PHD student with University of Plymouth United Kingdom. I am here in Nigeria for an interview with a representative of UNDP Nigeria as part of my PhD research.

(R): Thank you very much am Victor Oboh, I am the National Economist for UNDP in Nigeria. I have been mandated by the country director upon your request for an interview; it is a pleasure meeting you.

(C): Thank you, please what is the mandate of UNDP in Nigeria, what do they do?

(R): Thank you, UNDP is a development flagship of the United Nations and as you know the United Nations has several other agencies. But our duty is to support developmental issues, ensuring that development is human centred and to make sure that there is significant reduction in poverty. Also we ensure that there is significant improvement in welfare of people around the word, these are the mandate of UNDP

(C): Thank you sir, you made mention of poverty reduction, please could you expand on that as it affects the MDG of the UN

(R): Thank you, globally some countries have made tremendous achievement, with respect to MDGs, we already have some countries and regions that have achieved MDG goal one. For Africa it has been an issue of mixed results, this is because while some countries are making progress, others are not making any progress. Unfortunately, Nigeria happens to be among those countries that are not likely to achieve the MDG goal one which has to do with halving hunger and poverty by the year 2015. Nigeria have been making progress but the rate of progress has been very slow, so the country in not likely to achieve the MDG goal one.

(C): In your own opinion, what do you think are the reasons behind Nigeria inability to achieve this MDG one?

(R): Thank you, you know poverty have a multi-dimensional character, taken Nigeria as a case study, poverty in Nigeria have many faces and dimensions. If you look at the poverty mapping in Nigeria, you will discover that it is mostly predominate in the rural areas, which means that majority of the poor lives in the rural areas. There are lots of constraints preventing them from having access to economic opportunities, issues like infrastructural deficit, electricity, good road network, poor access to market among others. This limits the potential of the rural dwellers that play host to the majority of the poor in Nigeria.

Also inconsistent government policies, until recently, Nigeria did not have a long term policy plan. But good enough, we now have the vision 2020 policy plan document, in which Nigeria proposes to be among the largest 20 economics in the world by year 2020. The first implementation stage of the plan will come to an end in 2013, so the government is trying to put together another term of experts. Even though the implementation has its own challenges, like monitoring and evaluation of project, the capacity to manage the program and the linkage with other arms of government since Nigeria is a federal structured country. Also lack of institutional capabilities to articulate and manage poverty reduction initiatives and civil unrest like the issues of Boko Haram in the north, all these challenges have made achieving MDG goal one very difficult.

(C): Follow up to your comments, my research interest is food availability, and since poverty leads to hunger and food unavailability is leads to hunger. What is UNDP doing to address issue of food availability?

(R): Thank you, UNDP Nigeria is really fighting to address poverty and hunger. But in the area of hunger, we are trying to assist Government to develop policies that will fast track agricultural transformation. Recently UNDP provided some agricultural input to the federal government and we have a project called facilities for inclusive market and it is being hosted by federal ministry of agriculture. The essence of that project is to ensure that the Agricultural Transformation Agenda (ATA) of the present administration gets adequate value chain capacity to be able to drive the transformation agenda. There is need for agricultural growth to be inclusive; in fact what we have in Nigeria is growth due to farm land expansion and not productivity increase. Return on investment is still very low; UNDP is liaising with the federal ministry of agriculture to ensure the value chain aspect of the transformation agenda of the government. Also to make sure that the gains from this gets to the rural farmers. Also have secured a program/project with Bill and Melinda Gate on capacity support which UNDP is managing; we found out that the ministry do not have the capacity to drive the transformation agenda, so through the help of The Bill Gate Foundation, UNDP is managing the capacity support for the program.

(C): Thank, just as a fellow up to your comment, when I did my field work, it came across that farmers have problem accessing farm inputs and they tend to adopt agricultural technology not as a package. Is there any initiatives form UNDP aim at brings these issues to the attention of the federal government.

(R): I agree with you, it is purely the major constraint with agriculture in Nigeria, but we are not directly dealing with farmers, we do support the government in their efforts in overcoming these constraints. I know that within the framework of the ATA, they have a package called Growth Enhancement Scheme (GES); the essence of that scheme is to ensure that technological inputs are made available to farmers when needed. Also, the extension service system in Nigeria is very weak, and I know that the federal government is collaborating with state governments to revitalize the extension system in the various states. Also of most important is that I know some private agro dealers are now providing such service, which is technology as a comprehensive package.

(C): Do you think that Nigeria will ever meet the MDG goal one?

(R): Yes as I speak, UN has started looking at the post 2015 agenda; they are now looking at what happens after 2015. They know that many nations may not meet the goal one and even those that achieve the goal still need to sustain it. There are lots of consultations going on and if Nigeria is able to achieve even one or two of the other agenda, there is still need to carry on after 2015.

(C): Thank you, just as you said, UNDP are into advising the government on policies, as an insider and a Nigerian, what do you think are the bottlenecks that makes policy implementation very difficult in Nigeria because from history we have had lots of good policies that failed at the stage of implementation.

(R): Thank you, Nigeria as a developing country has its own fair share of development related challenges that is common across almost all the developing countries. But the key bottlenecks include inconsistent government policies formulation and implementation. Each new government comes up with their own new idea of doing things with disregard to all the efforts of the previous government. This is a major problem and act as disincentive for private sector engagement in the agricultural sector in Nigeria. Also the issue of corruption, more needs to be done to ensure that public fund is used for the good of the society and not ending up in the pocket of individuals. Also there is need to build institutions and not individuals, so that they can provide adequate check and balances in the system. There is need to develop infrastructures (electricity, good road network etc.); there are lots of wastage of farm produces due to lack of good access road network to enable farmers convey their farm produce to the urban area where they are more likely to get better price. Also recently, insecurity has become a major source of concern, more needs to be done to address these issues for without peace there will be no development.

(C): Thank you, finally, UNDP/UN are involve in many developing countries, do you think there is any already made policies model that the federal government can adopt from their experience to implement in Nigeria.

(R): Thank you, just as I said before, UN is a very large family, we have what we call international model exchange; we borrow model that has worked in other countries and adapt them because each country has its own peculiar socioeconomic characteristics. Even the facilities for the inclusive maize market model are a new idea in Nigeria, which is one area we are working on. There is need for growth not just in agriculture to be inclusive, Nigeria have been recording growth in the economy over the past 10 years but this have not translate to reduction in poverty or job creation. Even though the economy has been growing, so are poverty, unemployment and hunger over the same period. The situation is a paradox; the inclusive market model is saying we want to see the growth translated to poverty reduction and employment for the people. This is occurring because the growth is only benefiting just few individual and due to high level of corruption in the system. The economy is not open to the poor so they cannot reap the benefit of the economic growth. Another aspect that may interest you is our work on climate change; we have developed a climate change policy in Nigeria that has been adopted by the federal government. We also have other areas that we are advising the government and helping them in developing policies.

(C): Thanks, for the last time, you mentioned something that interests me. In the area of sustainability, what is your view on the best way to increase agricultural productivity and still maintain environmental sustainability?

(R): Yes it is possible, I know there is lots of challenges, but agriculture can still be done in a sustainable way, this can be done be planting trees, inter planting crops and other local developed ways of doing things to prevent erosion

(C): I know in other parts of the world, the government even pays farmers to manage their land in sustainable way or for the land to be left green.

(R): It is already happening here in Nigeria somewhere in Cross River state the community is preserving a whole forest but I am not sure if they are being paid. But I would assure you there is high level awareness of the consequences of not managing the land but we have not gotten to the level they have in the UK where the farmers are paid to leave their land fallow.

(C): What do you think is the future of agriculture in Nigeria?

(R): I believe the future is bright, there are lots of programs on going that will ensure that, but there is need for sustaining the present policies of the current government and the impact of all the program will be felt in the next couple of years. The key is maintaining and sustaining government policy direction.

(C): Thanks a lot for you time.

(R): Thanks and my regard to your team of supervisors.

Section C

Agricultural Development Program (ADP) Anambra State PhD Research Interview (October 2012)

Interview with Program Director ADP

(C): My name is Chima Chidiebere Daniel a PhD. student from University of Plymouth, United Kingdom

(R): What brought you to Nigeria?

(C): Am here to have a chat with program director ADP Anambra state as part of my PhD. research, which is on socio-economic determinants of modern agricultural technology adoption in multiple food crops and its impact on productivity and food availability at the farm-level: a case study from South-eastern Nigeria. So am here to have an interaction and a chat with the program director ADP Anambra State Nigeria to find out what they do, the problems and challenge they are facing and how they cope with them.

(C): Please Sir; I would like you to generally paint the picture of Agriculture in your state.

(R): Well! I will start by saying that presently the current Anambra State Government. Mr. Peter Obi is Agriculture friendly in the sense that he has taken some concrete efforts, steps in boosting the production of agriculture in the State. The Governor has been forth coming with the Government cash capital contribution in most of the agricultural projects like the roots and tubers expansion program, the national program for food security, Proofing and other donor assisted projects that Anambra State is implementing. So generally I will say He has made some efforts to mechanize agriculture in the state. And you know without the mechanization of agriculture; the production of food crops in the state still will remain at the level our fore fathers were doing it. But if agriculture is mechanized, then I think Anambra state will be able to feed the population of the state. Thank you very much.

(C): Thank you very much I have done my field survey and I have spoken to some of the farmers here in Anambra State, and one of the problems I came across is the issue of availability of inputs, when I talk of input am talking of improved varieties, fertilizers, chemicals. Most of the farmers said that they are not available when the need it, or when it is available, the affordability is a problem. What is your agency doing to help in alleviating these problems?

(R): You know, on the issue of availability of agricultural inputs in the state, before now, the State Government was sourcing inputs like fertilizer, the grains and maize and rice, even cassava cutting, but presently what we have on ground is what the Federal Government calls the agricultural transformation agenda where Federal Government introduced the (GES) Growth Enchantment Support Scheme that is where the state government and federal government subsidies agricultural inputs like fertilizer and HYV seeds by 25%. But you know this is the first year of this scheme so there are some teething problems that the farmers are encountering with subsequent years, there will be an improvement in sourcing and in distribution of agricultural inputs to farmers. So where ADP comes in, especially in the area of agriculture extension service delivery; we have our technical services sub program that is in charge of that. What they normally do is we have four agricultural zones in the state, and they have the forth nightly training for the extension agents. What the extension agents do is, they live right there in the community with the farmers, they avail them of the latest agriculture practices that will lead to yield in production. So ADP, more or less has extension delivery service as its mandate. The extension agent serves as the linkage between the farmers and ADP central office and research institute.

(C): Thank you, on the issue of farm inputs, I recently had an interview with one of the international NGOs (IFDC), they mentioned that one of their key program is the fertilizer voucher program, they are the pioneers in Nigeria and I wonder why such program have not been adopted in Anambra state or the south-eastern Nigeria.

(R): The policy has been adopted in Anambra state, but as I said earlier, this is the first year of the program. What actually happen in that the federal government conducted a survey and they found out that of all the agricultural inputs procured over the years for farmers, only 11% of them got to real farmers; while about 89% of them where cornered by the middle-men. When the fertilizer gets to the middle-men, they inflict the price of the inputs, thereby making them too expensive for the poor farmers. This invariably affects the prices of farm outputs. Also most of the service providers do not have enough capital to procure enough farm inputs to distribute to farmers when needed. Also there are problems with the service providers redeeming the vouchers collected from the farmers. The program is a very good one and will help in eliminating corruption in the system, but the teething problems in its implementation needs to be address.

(C): Thanks, also still on the issue of inputs, while talking to NGOs, I came across the Cassava plus program, where they have mobile cassava processing units which the move close to farmers, to enable them process their cassava farm produce. Know they have the program in the northern Nigeria and in Rivers state. My question is why such good program is yet to be adopted in south-eastern Nigeria.

(R): Am aware of the policy / program it is integrated in the federal government agricultural transformation program and now covers many crops. In the case of cassava, there was a time we have blot in the harvest of cassava, a lot of farmers have raw cassava and can't process them. That is why the federal government is now laying much emphasis in value chain. Here in Anambra state, there is need for the establishment of processing centres with flash dryers, this policy has been recommended to the state government by the federal ministry of agriculture. This will enable farmers to process their farm produce and encourage more farmers to go into cassava farming in the state.

(C): Okay Thank you, I would like to speak on availability, when I spoke to the farmers; one of the problems they are having is throughout the year there are certain period of the year when they don't have enough food, while during harvest period they have lot of food. so is there anything ADP or the state government is doing to address this problem, especially in the area of processing, cause I know in other countries, the Government buy off any excess farm output and bring them out during period of scarcity, therefore making sure food is available throughout the year. This also helps in stabilizing the price, through its not perfect but it helps in addressing the food availability problem.

(R): I think there are some of the projects that are already in the State that would take care of that, like the Fadama Training Project, you know Fadama is a Hausa Language and what it means is, you know in the North they plant their crops all through the year. And when you talk of Fadama, you are talking of developing irrigations for our farmers to be able to plant from January to December.

So Fadama Project is an elevation project introduced by the State Government to address the issue of hunger and starvation, then again like presently you might have heard it over the radio, that there is a lot of flooding in part of the country and even in Anambra State presently so you find out that our farmers are horridly harvesting some of their crops, like the communities around the riverine areas: Ogbaru, Anambra North, Anambra East. The farmers in the state are harvesting their crops early because of the problem of flooding. Then again, like what I told you in the area of processing, the establishment of flash dryers will help our farmers to plant their crops, harvest and add value to these crops instead of selling raw tubers. You find that out in the Western State, like Ogun State and part of Oyo State, they have gone further than Anambra state in area of processing. Some of these farmers have gone into adding values to their products, you can get high quality cassava flour, and you can get some of this semolina. These cassava products in powder forms, they are now even targeting the export market with it. This is what we have in mind, for the agriculture sector in Anambra State with the assistants of the State Government and the Federal Government.

(C): I will focus my attention now on ADP, do you think you have the all the necessary tools to enable you reach out to farmers, or to do your job comfortable. That is in the area of transportation, internet facilities, computers etc.

(R): Well presently, let start from staffing, there is an accepted standard of the ratio of EAs (Extension Agents) to the farmers, and the ideal thing is one EA per one thousand farmer, but we found out that in entire AD camp we don't have up to 30 EAs (Extension Agents) in the state. So it's a major problem you can see now that the EA farmer ratio in the State is too high. Then again when you come to the area of planning we are also under staffed as regards the number of enumerators in the State. We have 21 local Government in Anambra State, the ideal thing is to have at least 2 enumerators per Local Government and that would translate to 42 enumerators for the State, but its quiet unfortunate that presently we have just 7 enumerators covering the entire state. So there is need for the State Government to employ more staff especially EAs and enumerators area that is under staff. When we look down to the areas of Logistics, we have some computers but they are not enough, we need more motor bikes because the EAs that would be employed, they need motor bikes for them to be able to give full coverage of the community and deliver our mandate to the State.

(C): Thank you, just as we were talking I was thinking of, do you people have the mandate to partner with some of these NGOs because I know it would be a good idea if you could partner with most of them that are into agricultural and developmental issues, because most of the issues you people are dealing with are similar issues. So what plans does ADP have to collaborate with them?

(R): We have some NGOs that we are collaborating with presently, but you know NGOs are private concerns and normally we have our technologist to disseminate to the farmers and in doing this thing its requires funding,, the NGO's are not forth coming with the funding aspect, but we collaborate with them. If they want us to come and teach them some agricultural technologies, we do partner with them, but you know without funding there is little one can do?

(C): Thank you, finally I just want your view, I know you may not be the right person to ask, but I will still like your own personal view and observation. What do you think will be the state of agriculture in the next 2 or 3 years in Anambra state? What do you think; I should expect ADP to have achieved within that period?

(R): Well I think for the agricultural sector in Anambra state to move forward, there is a need to mechanize agriculture in the State. What I mean by mechanization, is making tractor services available to farmers. There are some parts of the state that are land constraint, but in areas like Anambra East, they have vast of lands that are yarning for development. The State Government should go in with the tractors to develop these areas and make them okay for the farmers; this will help in boosting the agriculture in the State. And then there is equally the need for, like I had earlier said employing EAs Extension Agents in the State. And again the issue of the GES we had said or talked about, the issue of a voucher scheme, there is need for Anambra state to fully key in into that scheme so that farmers at least would be getting subsidized agricultural inputs that will help them in their production. And again finally, I want the state Government to look at the area of processing in the state. If the Government is able to establish some processing centres with flash dryers in the state it will help us, and it will help the farmers and when this is done, you find that there will be that incentive for none farmers to come into agriculture and even the already existing farmers to expand the scope of their operations. Thank you very much

(C): Thank you, thank you for your time.

Interview with Program Manager (PM) ADP Anambra State

(C): Good afternoon my name is Chima Chidiebere and I am from University of Plymouth. I am here to interview the program Manager ADP, in Anambra state. Sir thank you for granting me this interview

Sir, please may we know your name?

(R): I am comrade Leo Eloka. The Program Manager ADP, Anambra State

Thank you Sir!

(C): Sir, Generally, I would like to know what your organization does.

(R): Okay, Anambra State ADP is a sub division under the state ministry of agriculture; we are actually the extension arm of the ministry of agriculture. We get agricultural technologies from the research institutes and transfer same to farmers. We also offer placement for university undergraduates, we liaise with donor agencies and NGOs and help them in their intervention efforts and programs.

(C): Thank you, sir I would like to know, do you have the logistic and human resources to enable your organisation carry out their very important role to their optimal best, by this I mean thinks like computers, transportation etc.

(R): Just like in any other system, we have our shortcomings, in terms of human resources, we are far from the FAO recommended ratio of extension agents to farmers (1:800-1000) but here in Anambra state you are talking of a ratio of 1:9000. We need about 300 more extension agent to be able to cover the state effectively. We are doing the best we can with the little we have. We also have problem with mobility, we need vehicles and motorcycles to enable extension agents get around especially in the rural areas.

(C): Finally, please will like to know your vision for ADP in future and that of agriculture in Anambra state since your organisation is a key player in this area.

(R): Our vision is aligned with that of the state ministry of agriculture, which is to be self-sufficient in food production, food processing, value chain program of the federal government which we have keyed into. We hope to be able to perfect on them and be able to achieve the goals 1-7 of MGD by 2015. Also we need to export some of food crops like rice etc. and help the government to reduce the importation of food produce which we can produce here in the country. Also our main mission is to be in the top 5 ADPs in the country and the best in south-eastern Nigeria.

(C): Well to add to that, I have visited lots of ADP across the south-eastern Nigeria and when I came here, it was very lively with lots of activities which are signs that things are moving in the right direction. Thanks for your time and I hope to come back and see how things have gone in the next few years.

Section D

Agricultural Development Program (ADP) Ebonyi State PhD Research Interview (October 2012)

Interview with Program Manager (PM) ADP

(C): My name is Chima Chidiebere I am a PhD Student with University of Plymouth, United Kingdom, and am here in Nigeria to conduct some interviews and field survey for my PhD research, and I will be talking with acting Program Manager ADP, Ebonyi State Nigeria.

(C): Good morning Sir! Please can we know you?

(R): Good morning, my name is Eje Boniface, the Director Planning, monitoring and evaluation ADP, Ebonyi state; I am equally doubling presently as the acting program manager of ADP in the state

(C): Sir, to start with I would like you to just briefly tell us about ADP Ebonyi state, what your organization does and the mandate given to your organization.

(R): Well, Ebonyi State ADP is just one out of the ADPs in Nigeria; we have ADP in all the States of Nigeria. Here in Ebonyi state, the ADP has the mandate to ensure increase of agricultural products in the state, in order to ensure food security not just for Ebonyi people, but all Nigerians. We do this through liaising with research institute, to get the latest technology in agriculture, we transfer this to our rural farmers to enable them improve on the way they carry out their agricultural activities. We also have the mandate to render extension service to the rural farmers in the State, so basically that is what we do.

(C): Thank you, I have done my field survey already and have spoken to some of the farmers in the state. One of the things I came across in my interaction with them was there inability to get farm inputs like HYV seeds and fertilizer especially when needed. Also the issue of their affordability, please what's your organization doing to address this problems.

(R): Well before now, farm input supply to farmers is somehow highly regulated by the Government. It is not so much open and that is why there appears to be scarcity of fertilizers in the mist of plenty so, but this time around there has been a shift because there is a program I believe it's from the Federal Government which we in the state have keyed in, it is called Growth Enhancement Support Scheme (GESS), which is under the agricultural transformation agenda of the federal government. Under this subsidy on fertilizer is being gradually reduced, using the E wallet; where by registered farmers can redeem fertilizers vouchers directly with registered agro dealers, who are in the private sector. This time around majority of the farmers got the fertilizers at the right time. Though the Scheme still has its lapse, we still believe that as we go on there will be improvement.

(C): Just in line with what you have just said, some time ago I was with one of the NGO's that were the pioneers of the fertilizer voucher program and I spoke with them and I asked them since the program has been going on in Northern Nigeria for the past five years and there is nothing like that in South-eastern Nigeria. They said that the Federal Government was test running the program, but from what you said, it seems the program has been expanded. Personally I think it's a very good initiative.

(C): Also as an Extension Agent from the Government? Do you think you have the all necessary logistics and human resources that you need to enable you reach out to more farmers in the state?

(R): Actually, Government is doing its best but we still have some challenges in the extension services delivery to farmers. One is that extension is something that has to do with constant visit to the farmers, interact with them the farmers; but here we are still lacking in the basic equipment's and even the needed funds to enable us perform optimally. We in the State we have currently about 180 extension agents covering over 435,000 farm families, when you look at it, you see that extension agent family ratio is still very low (1:2417). So I think there is serious need for Government to recruited more extension agents, train them so that we will be able to cover the farmers effectively. Equally, the issue of mobility is a serious challenge for us in the extension, we don't have vehicles and the extension agents don't have motorcycle to enable them move around from one farmer to the other, so that we can do the job effectively. Be that as it may we are doing our best.

(C): Just in line with what you said, do you have regular training program on how to related information to the farmers.

(R): Well, the type of training we are currently having is a kind of in-house training what we call fortnightly training, when we get some research findings; we bring in extension agents to our in-house fortnightly training. But ideally most of the extension agents are supposed to even be involved in outside training that would expose them and better enrich their knowledge. So the level of training we are having now is not adequate for us to perform as expected.

(C): Thank you, in your own view what do you think is the state of agriculture is in Ebonyi state?

(R): The State of agriculture in Ebonyi State is still very much at the subsistence level, but we are making effort to see if agriculture in the state can be taken to the next level. Currently the Federal Government came up with the Agricultural Transformation Agenda Program. This involves value chain where by you develop a particular commodity through value chain from production to processing, marketing and consumption. So along the line every stage of the value chain we are trying to develop them, so the agriculture will be seen as a business, as a good enterprise that is profitable instead of being seen as a way of life, which has been the case in the past.

(C): In line with what you have just said, I know Ebonyi State and Abakalika is well known nationwide for its rice production, and the quality of rice they produce here. What effort is your agency or the Government doing to highlight Abakalika rice as a brand? I know if it’s well packaged, it has the capacity to do well as a brand. The little problems it has like stones are things that can easily be taken care of and the quality improved upon. Is there anything your organization (ADP) is doing maybe to draw the attention of the Government to the positive quality of Abakalika rice?

(R): Thank you very much for the question. I think we are doing a lot in that direction. The Government has taken it upon itself to improve rice processing and ensure the quality of rice. Before now if you go to the Abakaliki rice mill, there used to be lots of stones in the rice but now most of the processors now has de- stone machines. The state government through our efforts is establishing three gigantic rice mills in the three zones in the state. The project is near completion and one of the centers has the capacity to mill 25 metric ton per hour.

(C): Sorry while in Abuja I came across the Ebonyi Gold Rice, I was very impressed, and think more needs to be done to push the product forward. What do you think is the future of agriculture in Ebonyi state, do you think we will make any progress.

(R): If all the stake holders in the sector show serious commitments, there is a very bright future for agriculture in the state. We have good arable land, good climate, so it's just the question of everybody playing their own part; hopefully we will get to where we want to be.

(C): Thank you, finally what area do you think the government need to improve on their effort or what more do you expect from the government.

(R): Firstly is on the level of funding for agriculture, it is still very low; if you look at the state or the federal government budget, the percentage allocated to agriculture is still very low still below 5% level. They should invest more on training people on the field, develop the infrastructure level of the state, provides the enabling environment for people that has the money to invest into agriculture, in other words, agriculture should be treated as a business not as a way of life. If all these are done, in the next ten years agriculture will be at the top in the state.

(C): Thank you very much for your time.

Appendix Three

Section A

Socio-economic determinants of modern agricultural technology adoption in multiple food crops and its impact on productivity and food availability at the farm-level: A case study from South-eastern Nigeria

UNIVERSITY OF PLYMOUTH, DRAKE CIRCUS, PLYMOUTH, PL4 8AA, UNITED KINGDOM

To be filled by the interviewer or the researcher.

Name of Farm/Farmer...

State..LGA..

Name of Interviewer...

Date of Interview...

One set of Questionnaire is to be used for one household

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NB: This is to clarify that the information generated from this survey/research will only be used for academic purposes and that any comments that you make will not be directly attributed to you individually or personally. Also you have the right to withdraw at any time during completion of this questionnaire. Please could you tick the consent box below?

Consent given Yes____ No____

SECTION A: HOUSEHOLD INFORMATION

1. Please use the table below to provide information about the Head of the household (HHH) and other members of the household.

Members of household starting from (HHH) Names	**Gender M= Male F = Female M=1 F=2**	**Age (years)**	**Marital Status 1=Married 2=Divorced 3=Widower 4=others specify**	**Years of Farming Experience**	**What is your main occupation?**	**Do you work away from the farm Yes=1 No=2 If yes where**	**Years of schooling completed**	**Is the HHH or any Member of household a member of any agricultural social organisation Yes=1 and No=2 If yes, please name the organisation**

SECTION B: FARMING INFORMATION

B 1: Land Ownership / Tenure Structure

2. How much is your Total owned land in the following categories (hectares)?

Cultivated Land	Non Cultivated Land	Rented-out Land	Leased-out Land	Mortgaged-out Land	Total Owned Land

3. What is your farm size in the following categories? Last year(hectares)

Owned Cultivated Land	Rented-in land	Leased-in Land	Mortgaged-in Land	Total farm size

4. What rental arrangement do you have for your different categories of land

Arrangement	**Rented-in land**	**Leased-in land**	**Mortgaged-in land**
Fixed rent system Naira/Yr.			
Cash (Naira)			
Kind (specify)			
Crop sharing system (specify both in % and Value)			
Labour sharing system (specify both in man-day and value)			
Others (specify)			

B 2: Crop Production Information

5. When does your farming year run from? _______________ to _______________

6. What types of crops did you grow in the last immediate farming year? Please provide the details in the table below

Name of crop	Variety	Area cultivated (hectares)	Total Production (kg)	Use of Total Production (kg)		
				Qty. Sold (kg)	Price (naira/kg)	Value of sale

7. Please could you detail the cost of production for your crops in the table below

Name of crop	**Seed cost**			**Ploughing cost**			**Fertilizer cost**	
	Own (kg)	**Buy (kg)**	**Price (N/kg)**	**Own (A. day)**	**Buy (A. day)**	**Price (Naira)**	**Qty (Kg)**	**Price (N/kg)**

Name of crop	Manure cost			Labour cost			Irrigation cost (N)	Pesticide cost (N)		Other equipment hiring cost (N)
	Own Qty (kg)	Purchased Qty (kg)	Price (N/kg)	Own (Man days)	Hired (Man days)	Wage (N/man-day)		Qty (kg)	Total cost	

B 3: Fertilizer / Pesticide Used Information

8. What type of fertilizer / pesticide do you use in your farm? Please provide details in the table below

Name of crop	Type of fertilizer			Number of Application	Where do you buy your fertilizer from?	Distance from your village (km) to fertilizer market
	Type	Qty (kg)	Value			
Name of crop	**Type of pesticide**			**Number of Application**	**Where do you buy your Pesticide from?**	**Distance from your village (km) to Pesticide market**
	Pesticide	**Qty**	**value**			

9. Do you think you apply enough fertilizer for your farm? Yes____ No____ if No, how much more do you need Type__________________________ Qty________
10. Do you have problem in buying your fertilizer? Yes____ No____ if yes, what are those problem please specify______________________________________

____

____

____

11. Do you think you are applying enough pesticides for your farm? Yes___ No___ if No, how much more would you like to use Type__________ _Qty.___
12. Do you have any problem in buying pesticides? Yes___ No___ if Yes please explain____

____

____

____

____

B 4: Irrigation Facility Information

13. Have you ever used modern irrigation facility for your farming? Yes____ No___ if Yes, when (Year)________ and for which crop__________________

____

14. If available, would you use modern irrigation facility for your farming? Yes__ No___ if Yes/No, please explain______________________________________

____

____ and which crop would you like to use it on? ____________________________

____

15. Which of the following is the major obstacle to the use of modern irrigation, please rank them from 1 – 5 with 5 being the most important obstacle and 1 the least important obstacle

Obstacles	**Rank (1 – 5)**
Non availability of irrigation facility	
Cost of setting up modern irrigation facility	
Knowledge of how to use or operate it	
Lack of electricity to power it	
Cost of generator and cost of fuel to power the modern irrigation facility	
Others please specify	

B 5: Improved Variety Information

16. Have you ever used High Yielding Variety (HYV) or Improved Variety (IV) for your farming? Yes___ No___ if Yes, which Year____________ and which HYV____
17. What is the source of your HYV? Own___ Purchase___ Government___ ADP___ NGO____ Others____
18. What is your opinion on the availability of HYV when you want it in your state

19. Please provide your opinion on the following questions. Why do you grow HYV? What is the most important factor regarding these HYV? If you do not grow HYV, please provide your reasoning for that too. (Spell out all the “reasons for growing HYV” first and ask to **rank** these reasons over a **five- point scale**. Then repeat the procedure with “reasons for not growing HYV”).

Reasons for Growing HYV	**1 = Yes** **2 = No**	**If “Yes”** **Then Rank**
High yield		
High price		
Ready market		
Short maturity period		
High quality		
Higher profit		
Others (specify)		

Reasons for not growing HYV	**1 = Yes** **2 = No**	**If “Yes”** **then Rank**
Seed unavailability		
Unreliable yield		
Lack of irrigation		
Fertilizer shortage		
Pesticide shortage		
Low price		
Poor quality		
Disease/Pest prone		
Labour intensive		
No fodder output		
High production cost		
Others (Specify)		

SECTION C: ADOPTION INFORMATION

20. Have you received any training on the use of any modern technology in the past 3 years? Yes____ No___ if Yes, please provide details in the table below

Training Type	Duration	When (Year)	Organisation

If No, why not? ____

____

____

21. What are the main barriers to modern agricultural technology training, in your opinion?

    ____

    ____

    ____

    ____

    ____

22. In your opinion, what are the main barriers towards adoption of modern agricultural technology?

    ____

____

____

____

____

23. In your opinion, what factors will facilitate your adoption of modern agricultural technology?

    ____

____

____

____
___

24. From where are you getting information on modern technology for your crop (Please rank them on a scale of 1 to 5, 1 least important source and 5 most important source)

Type of technology received

Co-farmers	☐	______________________________
Farmers Co-operatives	☐	______________________________
LGA Extension Officer	☐	______________________________
District Extension Officer	☐	______________________________
Demonstration Plot	☐	______________________________
Media/TV/Radio	☐	______________________________
Field Day	☐	______________________________
Others (Specify)	☐	______________________________

25. How far is the nearest Agricultural Extension Office from your Village? ____________ km
26. How many times has the Agricultural Extension Officer visited you in the past 12 months? ______ Times and Why? ________________________________
____
27. How many times have you visited your nearest Agricultural Extension officer in the past 12 months? ________ Times, why__________________________
____
____

SECTION D: FINANCIAL/SOCIAL FACTORS AND FOOD AVAILABILITY INFORMATION

D 1: Food Availability Information

28. How much of your total annual food requirement you grow in your farm (percentage) ____________________

29. In the table below please tick your home grown food availability for the past 12months and justify why you have surplus, level and deficit food availability

Food Availability Condition	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Surplus												
Level												
Deficit												
Justification												

D 2: Financial/Social Factors Information

30. Do you have enough finance to run your farm throughout a farming calendar Yes____ No____ if Yes/No please explain______________________________

____

____

31. Do you think that the Government is doing enough to make credit facility available to farmers Yes___ No___ if Yes/No Please explain ______________

____

____

____

32. In your opinion, what do you think should be done to improve the availability of credit facility to farmers? ____

____

33. Do your (HHH) or any member of your household have a loan for farming purposes which is still unpaid? Yes___ No___ if Yes, please provide details

Person	Source of loan	Duration of loan	Use of loan	Amount of loan	Collateral Given	
					Type	Value

34. Has the presence of this loan affected or influenced your farm decision in any way? Yes___ No___ if Yes/ No please explain

SECTION E: LINKAGE AND MARKETING INFORMATION

35. Do you have problem marketing your crops? Yes____ No____ if Yes please explain

36. Where do you sell your crops? Please provide details in the table below

Place	Distance from your village (km)	Carrying cost (include labour cost Naira/ton)	Transportation cost (Naira/ton)
At the Farm Gate			
Nearest Market			
Central Market			
International Market (Export)			
Others (specify			

Thank you very much for your patience and time

Section B

Socio- economic determinants of modern agricultural technology adoption in multiple food crops and its impact on productivity and food availability at the farm-level: A case study from South-eastern Nigeria

UNIVERSITY OF PLYMOUTH, DRAKE CIRCUS, PLYMOUTH, PL4 8AA, UNITED KINGDOM

To be filled by the interviewer or the researcher.

Name of ADP staff...

Phone Number...

State...

Name of Interviewer...

Date of Interview...

One set of Questionnaire is to be used for one member of staff.

Final DRAFT COPY

NB: This is to clarify that the information generated from this survey/research will only be used for academic purposes and that any comments that you make will not be directly attributed to you individually or personally. Also you have the right to withdraw at any time during completion of this questionnaire. Please could you tick the consent box below?

Consent given Yes____ No____

Section A: Personal Details and Work Information

1. Age of respondent_____________ Years

2. Sex of respondent Male____ Female_____

3. How long have you been working in ADP? _____________ Years

4. What is your job description?, please explain_________________________

____
____
____
____
____

Section B: Agriculture in the State

5. What do you think about the state of Agriculture in your state? ___________

____
____
____
____
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____
____

6. What do you think can be done to improve the state of agriculture in your state? ____

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____
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____
____
____

7. In your opinion, what are the barriers toward effective adoption of agricultural technology in your state? ____

8. In your opinion also, what do you think could improve and help with the adoption of agricultural technology in your state? ____

9. Do you think the government is doing enough to encourage the adoption of agricultural technology? Yes___ No___ if Yes/No please explain_________ ____

Section C: Your Contribution to Improvement in Agriculture in the State

10. Do you have the right facilities (i.e. Internet, transportation) to do your work to the best of your ability Yes____ No__ if Yes/No please explain_________ ____

____
____
____

11. Do you have the right training you need to enable you do your work effectively Yes__ No___ if Yes/No please explain_____________________

____
____
____
____
____
____

12. If Yes/No please list the training you have had or would like to have in the last 3 year

Training Type	**Year**	**Description of Purpose**

13. How many times did you visit farmers in the last 12 months? _______ times and please explain the purpose of your visit
____

____
____
____
____
____
____

14. How often have you an approach (by letter, telephone, internet, face to face etc.) from farmer or some other form of interaction with farmers in the last 12 months? _____ times and what are the purpose of their visit________

____
____
____
____
____
____
____

15. Please could you firstly list the factors affecting the effectiveness of your work and secondly rank them on a scale of 1 – 5, with 5 being the most important factor and 1 the least important factor

Factors Affecting the Effectiveness of your work	**Rank**

16. What do you think need to be done to improve your work and enable you reach out to more farmers?

Thank you so much for your time

Research Pictures

Country Representative IFDC Nigeria

Interview with Country Representative IFDC Nigeria

Field Research Assistant Training

Field Research Assistant Team

Typical Yam Farm In Nigeria

Yam Farm Harvesting In Nigeria


Cassava Farm in Nigeria


Rice Field in Nigeria


Typical Rice Field in Nigeria