COMPARATIVE ANALYSIS OF HOUSEHOLD FOOD SECURITY AMONG SMALLHOLDER IRRIGATION AND NON-IRRIGATION FARMERS IN KADUNA STATE, NIGERIA

BY

Monday Edward AHMED
(M.Sc./Agric./01147/2010-2011)

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY,
FACULTY OF AGRICULTURE,
AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY, FACULTY OF AGRICULTURE
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DECLARATION

I hereby declare that this thesis titled **"Comparative Analysis of Household Food Security among Smallholder Irrigation and Non-Irrigation Farmers in Kaduna State, Nigeria"** has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another degree or diploma at any institution. All borrowed ideas have been duly acknowledge in the text and a list of references provided.

_____ _____

Monday Edward AHMED **Date**
Student

CERTIFICATION

This thesis titled **"Comparative Analysis of Household Food Security among Smallholder Irrigation and Non-Irrigation Farmers in Kaduna State, Nigeria"** by Monday Edward AHMED meets the regulation governing the award of the degree of Masters of Science (Agricultural Economics) of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

Prof. S. A. Rahman Chairman, Supervisory Committee	**Date**
Prof. Z. Abdulsalam Member, Supervisory Committee	**Date**
Prof. Z. Abdulsalam Head of Department Agricultural Economics and Rural Sociology	**Date**
Prof. A. A. Joshua Dean, School of Postgraduate Studies Ahmadu Bello University, Zaria.	**Date**

DEDICATION

This thesis is dedicated to Almighty God.

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ABSTRACT

In recent times, the global focus has been on eradicating food insecurity by various international organizations and governments of developing nations. In consonance of the above, this study examined issues of food security among smallholder irrigation and non-irrigation farmers in Kaduna State, Nigeria. The study utilized a combination of purposive and random sampling techniques to obtain a sample of 260 farm households to include 112 irrigation farmers and 148 non-irrigation farmers adjacent the selected irrigators. Descriptive analysis was carried out to describe the socio-economic characteristics of the households. Econometric tools were used to determine factors affecting the food security status of households. Using the recommended calorie required approach; the study revealed that 57% and 43% of the irrigation households were food secured and food insecured respectively, while 42% and 58% of the non-irrigation households were food secure and food insecure respectively. The Shortfall/Surplus index for irrigation households showed that the food secure households exceeded the recommended calorie intake by 60%, while the food insecure households fell short of the recommended calorie intake by 26%. Shortfall/Surplus index for non-irrigation households showed that the food secure households exceeded the recommended calorie intake by 64%, while the food insecure households fell short of the recommended calorie intake by 29%. A logit regression model made up of seven regressors was specified. education, cooperative, per capita income, technology adoption and access to market were found to determine the food security status of irrigation farming households in the study area while age, education, per capita income and farm size were found to have significant effect on the food security status of non-irrigation farmers. Irrigation has obvious advantages in that it increases farmer's yields, promotes diversified farming, enhances household food security and increases household incomes. Farmers who are on irrigation schemes are more food secured than non-irrigation farmers. . It is concluded that the design of food security strategies should include irrigation programmes and be multi-dimensional such that would focus on and address the identified constraints. With concerted support from government, and all stakeholders to improve irrigation facilities, food security can be enhanced at the household levels

CHAPTER 1

INTRODUCTION

1.1 Background to the Study

Access to irrigation water is the key to reduce the impacts of climate variability and change on food security and regional economies (IFPRI, 2001). Irrigation farming is one of the most important rural development investments that can have both direct and indirect impacts on poverty and food security in semi-arid tropical countries (IFPRI, 2001; Bhattarai and Narayanamoorthy, 2004). At the moment, climate change represents an additional challenge to rain-fed farming in Kaduna State which subsequently calls for additional concerns and investment in irrigation farming. In view of their limited adaptive capacity, smallholder farmers and pastoralists are among the most vulnerable to the impact of climate change (KADP, 2011).

Dependence on rain fall represents a major constraint on agricultural productivity and rural poverty reduction in Kaduna State (KADP, 2011). The vulnerability of rural people remains considerable owing to a combination of cultural and poor development of hydraulic infrastructure. Without investment in irrigation, it will be difficult to increase food production, reduce the financial burden of agricultural food imports and increase food security in the country. The lack of investment in irrigation contributes to the expansion of rain-fed agriculture on to marginal lands with uncertain rainfall. This is forcing millions of impoverished people to farm in ecologically fragile areas (FAO, 1997). Without adequate capital, farmers have little incentive to invest in quality seed and inputs. The high water resources in Kaduna state offer great potential for irrigation, especially using simple and inexpensive technologies (KADP, 2011). Hence, there is need to assess whether or not

irrigation farming forms a significant proportion of the farmers income to create strong reliance on it as a source of livelihood, or whether it is merely a supplement to other important income sources.

Food insecurity and poverty are part and parcel of the same destructive cycle. Poverty is the leading cause of food insecurity, and food insecurity is a major contributor to the continuity of poverty. Several studies e.g. IFPRI (2001); Mano (2003) and FAO (1997) have been carried out to assess household food insecurity in the semi-arid areas of Africa. Most of these studies have shown that there are many factors that are involved in enhancing food security such as irrigation, land quality, incomes, size of household, wealth of farmers and land size Mano (2003) and Guveya (1995). Obadire *et al*. (2010), identified low level of managerial and technical skills and inadequate training as the major determinants of low level of productivity and household food insecurity. On the same vein, FAO (1997) singled out among these factors water as the most limiting factor to food security in rural communal areas.

Irrigation has long played a key role in feeding expanding populations and is undoubtedly destined to play a still greater role in the future (FAO, 1997). It not only raises the yields of specific crops, but also prolongs the effective crop-growing period in areas with dry seasons, thus permitting multiple cropping (two or three, and sometimes four, crops per year) where only a single crop could be grown otherwise. With the security provided by irrigation, additional inputs needed to intensify production further (pest control, fertilizers, improved varieties and better tillage) become economically feasible (FAO, 1997). Irrigation reduces the risk of these expensive inputs being wasted by crop failure resulting from lack

of water. More recent assessments of the sector have all come to the conclusion that the success of smallholder irrigation has been limited (Bembridge, 2000; Crosby *et al*., 2000). Factors that contributed to their modest performance were poor infrastructure, limited knowledge of crop production among smallholders, limited farmer participation in the management of water, ineffective extension and mechanization services and lack of reliable markets and effective credit services (Bembridge, 2000; Crosby *et al*., 2000).

The contention of this work is that, irrigation is neglected and that improved irrigation farming could significantly contribute to the reduction of urban and rural poverty and enhance adaptability to vagaries of rainfall induced by climate change in the study area. Irrigation is both labour and time demanding, it can potentially contribute significantly to local and regional food security, which in a world of higher food prices and reduced food aid assumes large importance. This work therefore examines the activities of smallholder irrigation farmers in Kaduna state highlighting their roles in household food security.

1.2 Statement of the Problem

Smallholder farmers in the semi-arid areas of Nigeria have not been performing well in terms of their agricultural output because of erratic rainfall patterns in these areas. The majority of the farmers in these semi-arid regions have failed to achieve food security because of unreliable rainfall and other factors contributing to agricultural production in these areas. Smallholder farmers suffer from low incomes and living standards, poor nutrition, poor housing and health (FAO, 1997). This is aggravated by the fact that there is usually very little rainfall, especially in the northern guinea agro-ecological zones. Annual mean rainfall varies between 942mm and 1000mm in this area (KADP, 2011). Under these

climatic conditions, rainfall variability affects the various aspects of plant growth and yields; consequently, alter crop productivity and food security. As observed by Awosika *et al.* (1994), the aggregate impact of drought on the economy of Nigeria in 1992 was between 4% and 6% of the GDP. Thus, those that rely on rainfall in these areas are still impoverished and they are faced with food insecurity. As a result of these erratic rains in such areas, crop productivity on dry land has been low because farmers are limited to low productive crops such as millet, sorghum and short season maize variety (Manzungu, 2003).

In consonance with the growing importance of small scale irrigation activities, an in-depth knowledge about the correlates of the irrigation farmers and their food security status is crucial to reducing household food insecurity in developing economies like Nigeria. The tendency for rural households to engage in irrigation activities is often noticeable, but few attempts have been made to link this scheme in a systematic way to rural poverty reduction and food security policies. Based on the foregoing, the questions of interest in this research are the following:

(i) What are the socio-economic characteristics of smallholder irrigation and non-irrigation farmers in the study area?

(ii) What is the food security status of the smallholder irrigation and non-irrigation farmers in the area?

(iii) What are the factors affecting food security among smallholder irrigation and non-irrigation farmers in the study area?

(iv) What are the constraints faced by smallholder irrigation and non-irrigation farmers in the area?

1.3 Objectives of the Study

The broad objective of this study is to examine household food security among smallholder irrigation and non-irrigation farmers in Kaduna State. The specific objectives are to:

(i) describe the socio-economic characteristics of the smallholder irrigation and non-irrigation farmers in the study area

(ii) determine and compare the food security status of the smallholder irrigation and non-irrigation farmers in the area

(iii) examine the factors affecting food security among smallholder irrigation and non-irrigation farmers in the study area

(iv) identify the constraints faced by smallholder irrigation and non-irrigation farmers in the area

1.4 Justification of the Study

Nigeria is an agrarian economy with 70% of its people dependent on agriculture (NBS, 2007). The Government of Nigeria has been trying to achieve food security at both household and national level through the communal farmer's efforts. Smallholder irrigation has been reported by many studies to have enhanced food security in the semi-arid areas of Nigeria (FAO, 1997) however, there are still areas requiring attention. This study focuses on smallholder irrigation farmers to establish their food security status. Various factors contributing to household food security are discussed so that recommendations can be made for better strategies and measures to assist communal farmers address household food insecurity in the semi-arid areas of Nigeria. This study will help to identify gaps in communal areas and come up with reasons why communal farmers are food insecure.

Several studies such as one done by Babatunde *et al*. (2007) have been carried out to assess household food insecurity in the guinea savanna region of Nigeria. Studies by Mano (2003) and Guveya (1995) have shown that there are many factors that enhance food security such as irrigation, land quality, incomes, size of household, wealth of farmers and land size. Among these factors, water has been highlighted as the most limiting factor to food security in communal areas of Nigeria (FAO, 1997). Backeberg *et al*. (1996) developed a comprehensive policy proposal aimed at assisting the development of the smallholder irrigation sector. This proposal recognized that smallholder irrigation and associated livelihoods are affected directly by three policy domains, namely irrigation policy, agricultural policy and rural development policy. So far it has been shown that smallholder irrigation has a number of benefits which include crop diversification, better incomes, good nutrition and employment opportunities to local people and farmers for achieving household food security (Makombe & Meinzen-Dick, 1993). While these studies are commendable, if effective policies to increasing food security are to be formulated and successfully implemented, an in-depth knowledge about the correlates of the irrigation farmers and their food security status is crucial.

In Nigeria, the percentage of food insecure households was reported to be 18% in 1986 and over 40% in 2005 (Sanusi *et al.,* 2006). Although, figures released by Food and Agricultural Organization in 2005 on the state of food insecurity in the world, indicated that 9% of Nigerian population was chronically undernourished between 2000 and 2002 (FAO, 2005). This was less than the regional average of 33% for Sub-Saharan Africa. However, the 9% or about 11 million undernourished Nigerians translate to about 5.4% of total number of undernourished people in Sub-Saharan African as a whole. On the national level,

per-capita growth of production of major food items in Nigeria has not been sufficient to satisfy the demand of an increasing population. The result is a big gap between national supply and demand for food. Several reports have been published that show a consistent increase in the production of staple food in the country especially between 1999 and 2005, but there is still an observable gap between food demand and food supply (Sanusi *et al.*, 2006; FAO, 2005).

The socio-economic characteristics and resources of individual households have been identified as basic factors influencing the food security status of households (Sanusi *et al.*, 2006). Rural households continue to face poor economic conditions which impact on their living standard and food security situation. The returns to land in terms of output have been on the decrease especially where increased population and non-agricultural uses compete for land use. This further creates gaps in resource availability among the poor households. The impact of this is that the food situation gets worse; farms are being abandoned to the elderly or for off-farm jobs. The income from off-farm activities has not been proven to be adequate to meet households' needs (Akinsanmi and Doppler, 2005). This situation requires that the economic conditions are known for a guided change to take place. The particular factors which affect households differently must also be examined and understood. Thus, this study concentrated on three smallholder irrigation schemes in Kaduna state to examine household food security. It is envisaged that the results of the study will contribute in the design of appropriate food security policies and programmes for rural Nigeria where the majority of the population reside.

1.5 Hypotheses

The hypotheses tested in this study are:

(i) There is no significant difference between the food security status of irrigation and non-irrigation farmers in the study area.

(ii) There is no significant relationship between the socio-economic characteristics of irrigation and non-irrigation farmers and their food security status.

CHAPTER 2

LITERATURE REVIEW

2.1 Role of Smallholder Irrigation on Food Security and Poverty Alleviation

Investing in smallholder irrigation is one the most effective ways to develop smallholder agriculture and, thus, contribute to poverty alleviation. The contribution of irrigation to poverty alleviation has been demonstrated in countries such as Bangladesh where growth in public sector funded canal irrigation and private sector funded tube-well irrigation have played a major role (Shah, 1993). Hussain and Hunjra (2004) noted that although irrigation water is only a single factor in poverty alleviation, it plays a disproportionately powerful role. Sally *et al*. (2003) conclude that smallholder agriculture intensification by improving the management and productivity of land and water in a sustainable manner is a solution for both poverty reduction and agricultural growth in sub-Saharan Africa. Irrigation development benefits the rural poor in various ways including (a) reduced food prices resulting from increased production; and (b) increased on-farm and off-farm employment leading to income generation for the poor. Thus, irrigation contributes to food security. Smallholder irrigation schemes have not performed well in Africa. These schemes have performed poorly in terms of yields and economic returns (Barghouti and Le Moigne, 1990; Underhill, 1990).

2.2 Irrigation Systems in Nigeria

The type of irrigation system used in West Africa is determined by 1) the type of water source (i.e. surface water or groundwater); 2) the specific forms of the water bodies; and 3) length and timing of irrigation practices (Namara, 2009). In much of West Africa, the location and form of available water highly constrains the choice of the irrigation system

adopted. Moreover, the seasonal use of irrigation may reflect the land use/tenure system in the country. For example, dry season irrigation is often practiced by irrigators renting land. In Nigeria, a typical traditional small-scale irrigation system includes dry season irrigation of river flood basin and pumped irrigation. On large flood plains, surface water storage and shallow ground water is exploited using lifting devices (Kay, 2001). The type of irrigation system employed differs across crops/commodities and regions (Namara, 2009). The equipment used for smallholder irrigation has been gradually modernized, but Nigerian farmers still widely use such traditional water-lifting devices as *shadouf* (a long slender pole with a container, usually made from animal skin, attached to its end), calabash, and rope and bucket. Nevertheless, the various types of pumps, from pedal/treadle pump to diesel-fueled motorized pump, have been quickly adopted in certain regions.

2.3 Management and Production Issues in Smallholder Irrigation

Unavailability of water for crop growth and development during a growing season is a major limiting factor in crop production in semi-arid regions of the world. The situation is further worsened by the increasing human population which has resulted in simultaneous increased demand for water for domestic and industrial use. Despite the threat on water resources, irrigation water continues to be an important resource in crop production to date. Irrigated farmland is reported to provide 60 percent of the world's grain production. It is, therefore, critical to develop appropriate water saving techniques in crop production to ensure efficient use of water resources. An important aspect of irrigation water management in crop production is to increase water productivity which is assessed through gain in crop yield per unit of irrigated water applied. A three-fold increase in irrigated rice yields per volume of water applied over the past two decades has been reported (Hong *et*

al., 2000). The authors further reported a 16 percent increase in rice yields and a consequent 19% drop in land area planted to rice during the same period.

2.4 Sustainability of Irrigation Projects

Despite the myriad of problems facing smallholder irrigation schemes, they can become more efficient and sustainable by upgrading smallholder irrigation techniques, putting in place a management structure responsive to water users access to (innovative) credit schemes, good support services (credit, marketing, transport, storage). Government's role in supporting irrigation development is therefore important in terms of the policies and regulations formulated and implemented (Msukwa and Kandoole, 1992). The planning undertaken at the macro and micro level, training and provision of services to support development of the agriculture sector requires support from both government and NGOs so that irrigation schemes can be completely transferred to communal farmers (Bembridge, 2000).

2.5 Constraints facing Irrigation Development

Apart from being associated with household food security, irrigation schemes in the semi-arid areas have some problems associated with their development and management. The problems faced by smallholder irrigation schemes in communal area can be categorized as follows:

2.5.1 Environmental factors

On some irrigation schemes, it has been noted that poor water quality especially as related to sediment concentration has affected the amount of water that can be used for irrigation purposes. This means that farmers experience low crop production and farmers cannot grow crops throughout the whole year (FAO, 1997). Land degradation is also one of the important environmental factors which result from poor operation and management activities leading to siltation of some of these irrigation schemes. This is partly related to inefficient water management resulting in water wastage and water logging as well as land-use regulation (Rukuni, 1993).

2.5.2 Capacity of the farmers

The level of literacy in most circumstances has been a major constraint to communal irrigation schemes. Farmers lack know-how in and access to, the opportunities of irrigation technology (Pazvakawambwa and Van Der Zaag, 2000). The weak economic base of most farmers in communal areas and the relatively high development costs involved in developing irrigation schemes has resulted in some irrigation schemes performing poorly because of not being maintained properly (Makombe & Meinzen- Dick, 1993).

2.5.3 Government policy, institutional and legal support

There has been limited or no priority given to irrigation development during national, local planning and budgeting in sub-Saharan countries. This has led to some irrigation projects failing to sustain themselves. As established in communal areas of Zimbabwe there are poor management structures in place to support farmers and promote irrigation development (Hillel, 1989).

2.5.4 Economic and financial constraints

The availability of financial resources for the development of smallholder irrigation is a constraint in almost all the countries. Development costs for small-scale irrigable schemes are high in sub-Saharan countries. The present costs are extremely high per hectare for irrigation engineering works alone (FAO, 1997). A study carried out in sub-Saharan Africa showed that rehabilitation of irrigation schemes is expensive (FAO, 1997). Government schemes were found not to be functioning as efficiently as before, given the government's failure to fund operation and management costs. The cost of borrowing money from credit institutions is high and this makes it difficult for farmers to borrow and pay back the loans (FAO, 2001).

2.5.5 Marketing

Almost all smallholder irrigation schemes have marketing of its produce as one of the most difficult challenges. As revealed in Zimbabwe, most of the produce from irrigation schemes is sold to locals as irrigation farmers are constrained by transport to carry their produce to profitable markets, lack of information and marketing linkages and lack of collection centres in communal areas (Meinzen-Dick *et al.*, 1993). In many Sub Saharan African countries, local markets are not well organized and the crops produced by smallholders are sold at low prices (Meinzen-Dick *et al.*, 1993).

2.6 Irrigation Development and Food Security

The development of smallholder schemes were followed by a number of socio-economic studies in order to help policy makers in formulating sound policies for future development in the communal areas (Bembridge, 2000). Irrigation development is a determinant of

household food security in that it has both advantages and disadvantages to communal households. Thus, it is important to look at the development of irrigation in relation to food security in communal areas as it has a direct effect on agricultural production in communal areas. Irrigation development is an important part of policy development for sustainable economic growth of any country especially third world countries. The initiative for development of irrigation mostly has been taken up by governments and to some extent development agencies since farmers are unwilling or unable to undertake irrigation development due to the large amounts of money required for the initial development. The rate of expansion and improvement of irrigation is constrained not only by the country's land and water resources limitations, but by its ability to plan, construct and manage irrigation systems (Alibaruho *et al.*, 1990). Irrigation development has contributed immensely to improved food security (Burton *et al.*, 2005). The proportion of global food supplies due to improved irrigation is significant. On the other hand, irrigation enthusiasts should not exaggerate the contribution of irrigation to food security and neglect other important influences on global food growth such as substantial increases in use of fertilizer and crop protection chemicals, and the development of improved, high-yielding varieties supported by agricultural extension services (Carruthers *et al.*, 1996). There is a perception that irrigation promotes food security in rural areas (Crosby *et al.*, 2000).

2.7 Concept of Food Security and Insecurity

The concept of food insecurity includes not only the lack of availability, access, and utilization or use of food (for example, food preparation and intra-household food distribution), but also perceptions (for example, that food is insufficient, inadequate, unacceptable, uncertain, or unsustainable) (Wolfe and Frongillo, 2001). For example, food

insecurity has been defined as the inability to acquire or consume an adequate quality of sufficient quantity of food in socially acceptable ways, or the uncertainty that one will be able to do so (Radimer *et al*., 1992). Food insecurity as experienced in other locations is likely to be somewhat different but will include similar components that go beyond availability and access. Food security affects dietary intake and ultimately, nutritional status and physical well-being.

Although, measures of dietary intake of individuals can assess some aspects of food insecurity, such as caloric insufficiency and nutrient inadequacy, they do not assess the cognitive and affective components of uncertainty (expressed as anxiety), unacceptability, or un-sustainability. For example, current intake may be adequate, but food security may still be experienced because of concern over future intake. Alternatively, intake may be inadequate, but only temporarily to protect supplies and prevent future food insecurity (Wolfe and Frongillo, 2001). Furthermore, growth status is an indirect outcome, since it also depends on factors such as health and child care, in addition to access. Food insecurity is also related to available economic and social resources. Precursors such as income or total expenditure are correlated with caloric sufficiency, but they only capture this component of food insecurity and are quite indirect (Maxwell, 1992).

Food security, on the other hand, refers to the condition in which all people, at all times, have physical, social, and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 1996). Food availability, stability of supplies and food access are related determinants of food security. At the household level, food security implies an adequate access to food over time. This is

possible when there is adequate food availability to the household, and an adequate income capacity for the purchase of the available food. Stability of food implies that the food availability is not affected by any shocks or risks affecting food production at all times. Food access has three components: 1) physical access to food, 2) economic access to food, and 3) sustainable access to food. Physical access implies food availability or food supply to the household, as there might be food available at the national level which, however, may not trickle down to the household level (Oluwatayo, 2009). Food insecurity is the result of a confluence of factors. The raging conflicts in Africa and drought in parts of southern Africa alone need not cause food insecurity. Food security, by definition, is not simply about availability of food, it also entails accessibility, that is, the ability of individuals or a nation to acquire food on a sustainable basis. Food security is also about the reliability and distribution of food. The former relates to utilization and consumption of safe and nutritious food, while the latter relates to the equitable provision of food to points of demand at the right time and place (Richard, 2002).

Food security is a broad concept that is more than food production and food accessibility. In reality, it revolves around four pillars, namely: food availability, food accessibility, nutritional factors and stability of food supply (Babatunde *et al*., 2007). A nation is food secure when food is available and accessible in sufficient quantity and quality for a productive livelihood for every individual (Kidane *et al*., 2005). On the other hand, food insecurity represents the inability to fulfill such conditions; that is people have no access to sufficient, safe and nutritious food needed to maintain a healthy and active life. The most evident sign of food insecurity is the prevalence of hunger.

2.8 Food Security Measures

Food security measures are used to develop and validate quantitative measures of food security status of households. These measures are based largely on researches that involved quantitative, in-depth interviews with low-income, rural women with and without children who had experienced food insecurity (Radimer, 1990). Food insecurity is experienced differently at the household, adult and child levels; adults buffer the effects of food insecurity on children. Food insecurity has four components, two related directly to food (quantity and quality of food) and two are psychological and social in nature (certainty, which is related to worry about food, and acceptability, which is related to how food is acquired) (Wolfe and Frongillo, 2001). A number of methods have been used to gain an understanding of food insecurity and to apply this understanding to the development of measures. These include:

2.8.1 Ethnography

Ethnography involves in-depth interviewing of participants, usually by living in a community for an extended period of time. It can be used to help quantitative measures. For example, Chung *et al.* (1997) used ethnography in south-central India to understand local perceptions, early signs, coping strategies and intra-household decision-making related to food security. From this, unique, locally defined indicators of food insecurity were developed (Chung *et al*., 1997).

2.8.2 Food security ranking

A number of simple tools and techniques for assessing problems and situations at the community level have been developed as part of rapid rural appraisal (RRA) and the

similar but more action-oriented, participatory rural appraisal (PRA). These often involve focus groups and in-depth interviews. Information gathered through RRA can be used to understand the food security situation and to help develop quantitative measures (Wolfe and Frongillo, 2001). Food security ranking involves asking a diversity of key informants to categorize village households according to the level of food security in the current year and in good and bad years. Criteria used for categorizing households, differences between years and causes given can be useful for understanding food security in that community. Food security calendars are useful for understanding the seasonal dimension of household food security in both good and bad years and the months in which the households eat until they are full and the months they suffer from hunger. Then the respondent is "interviewed," asking about consumption patterns and coping strategies for each group during each period of food security, as well as underlying causes of hunger. Activity calendars are similar and involve asking villagers in different food-security categories to distinguish between food-related activities they do in good versus bad years or seasons, including coping and investment strategies and activities that act as buffers against having to resort to coping.

2.8.3 Bean-ranking

Bean-ranking is a pictorial method used for a number of different purposes. It can be used to rank households into food-security groups and then "interview" the piles of beans to understand the coping strategies and other characteristics of each group, to develop household "food charts," and to construct histogram-like seasonal charts for rainfall, harvests of staples, food consumption and illness.

2.8.4 Coping strategies

Maxwell (1996) developed a method for assessing household food security indirectly through food related coping strategies, that is, the actions people take when they do not have enough food or money to buy food. In-depth interviews were used to identify coping strategies, and then their relative severity was rated by target groups. A questionnaire assessing frequency of use of each strategy was developed, from which a food-security score is derived by applying severity weightings.

2.8.5 Food-economy approach

The food-economy approach monitors household food security and early warning of food crises by quantifying household access to food in normal years and the effects of external shocks on this. By using in-depth interviews and various RRA techniques, a "baseline picture" describing how different families in a geographic-specific "food-economy zone" normally obtain food and nonfood income is developed, describing sources and means of food and means of food and cash income and sometimes expenditure patterns. Potential changes in agricultural, economic, or security conditions that affect families' access to food are also quantified. A software program called Risk Map is then used to calculate the extent to which these changes affect different households' access to food and the amount this may be reduced by household-coping strategies. The results include an estimate of the shortfall in food income that people are likely to face, the costs of families and the likely effects of different levels and forms of assistance.

2.9 Determinants of food security among farming households

The socio-economic characteristics and resources of individual households have been identified as basic factors influencing the food security status of households (Sanusi *et al*., 2006). Kidane *et al.* (2005) identified household size, education and farmland size and land quality as determinants of food security status of a household. Educational attainment by the household head could lead to awareness of the possible advantages of modernizing agriculture by means of technological inputs; engage them in diversification of household incomes which, in turn, would enhance households' food supply. Amaza *et al.* (2006) noted that the major determinants of food insecurity are: household size, gender, educational level, farm size and types of household farm enterprise. They concluded that policy measures towards the provision of better family planning should be given adequate attention and priority by the government in addition to improving access to education, credit facilities and agricultural extension services for rural households. Sanusi *et al.* (2006) further reported in his study conducted in some selected Local Government Areas of Oyo and Lagos States that income status and the educational status of the household head influence food security status of the household.

Babatunde *et al.* (2007) noted that household income, household size, education status of the household head and quantity of food obtained from own production determined the food security status of farming households in North Central Nigeria. They concluded that socio-economic variables of the households are important determinants of their food security or insecurity status.

2.10 Review of related literatures on factors of food security

Two objective methods of food security measurement have been widely used in most food security studies (Maxwell, 1996). One is to estimate gross household production and purchases over time, estimate the growth or depletion of food stocks held over that period of time and presume that the food that has come into the households possession and ‘‘disappeared’’ has been consumed. The other method is to undertake food consumption recall for individual members of a household or for the household as a whole and analyze each type of food mentioned for calorie content. Using the logistic regression model adopted by Feleke *et al.* (2005) and Kidane *et al.* (2005) in their studies, explanatory variables measured as continuous and discrete variables which are identified to be major determinants of food security could be collected and examined. These factors are a *priori* and are expected to have a positive or negative impact on food security.

Hofferth (2003) argues that the higher the age of the household head, the more stable the economy of the farm household, because older people have also relatively richer experiences of the social and physical environments as well as greater experience of farming activities. Moreover, older household heads are expected to have better access to land than younger heads, because younger men either have to wait for a land distribution, or have to share land with their families. A similar study by Obamiro *et al.* (2003) arrived at a similar conclusion regarding the relationship between age of a household head and household food security. Educational status of household head could lead to awareness of the possible advantages of modernizing agriculture by means of technological inputs; enable them to read instructions on fertilizer packs and diversification of household income which, in turn, would enhance household food supply (Najafi, 2003). According to Najafi

(2003), it is expected that households with large farms are food secure than those with small farms. A study by Zenda (2002) revealed that married people are able to share household activities such as agricultural production, herding of livestock, harvesting of fruits, fetching firewood and water. While households with single, divorced and widowed heads have to do all the household activities as they do not have all the support unless from children who are old enough to do some household activities.

CHAPTER 3

METHODOLOGY

3.1 Description of the Study Area

Kaduna state lies in the north western part of the country's geopolitical zones, about 200km away from Abuja the Federal Capital. The state lies between latitudes 11°32' and 09°02' N and longitudes 08°50' and 06°15' E (Kaduna state government, 2012). Kaduna state shares boundaries with Katsina and Kano states to the north, Plateau State to the north east, Nasarawa and Abuja to the south, and Niger and Zamfara States to the west (Kaduna state government, 2012). The State occupies an area of approximately 48,473.2 square kilometers and has a projected population of 6.67 million based on annual population growth index of 3.2% (NPC, 2006). The mean annual rainfall shows a marked decrease from South to North (1,524 to 635mm) which favours crop and livestock production (Kaduna state government, 2012).

Farming is the main occupation of the people with emphasis on the cultivation of cereals like maize, sorghum, millet and legumes like cowpea, soya bean and groundnut which are either irrigated or rain-fed. Both irrigation and rain-fed farming are practiced in the state. On the irrigated land, vegetable crops like tomatoes, pepper and cabbage are grown. The cropping systems are dominated by sole and mixed cropping. Some of the farmers are involved in livestock keeping but Fulani herdsmen dominate the rearing of livestock in the area.

3.2 Sampling Procedure

A combination of purposive and random sampling techniques were used for this study. The first stage involved a purposive selection of the three (3) villages where the state's smallholder irrigation schemes are located. These villages include; Likoro, Buruku and Jagindi. The three villages are also located in three different local government areas representing the three senatorial zones of the state. The local government areas covered include; Kudan L.G.A (North), Chikun L.G.A (Central) and Jama'a L.G.A. (South). Non-Irrigation farmers included those registered with KADP and located adjacent the irrigation schemes. Finally, 80% of the sample frames based on 2011 cropping season in each of these areas were randomly selected, giving a total of 260 respondents (Table 1).

Table 1: Distribution of Respondents in the Study Area

Senatorial Zones	**LGA's**	**Villages/ Sites**	**Sample Frame***		**Sample size (80%)**	
			Irrigation	**Non-Irrigation**	**Irrigation**	**Non-Irrigation**
North	Kudan	Likoro	60	70	48	56
Central	Chikun	Buruku	40	55	32	44
South	Jama'a	Jagindi	40	60	32	48
Total			**140**	**180**	**112**	**148**

*Source: Kaduna State Agricultural Development Programme (KADP, 2011)

3.3 Data Collection

Primary data were used for this study. These were collected with the aid of structured questionnaire. Information were collected on: (a) farmers' socio-economic characteristics such as age of household head, educational level of household head, farm size, technology adoption, per capita aggregate income, distance to market, membership of cooperative, household size; (b) constraints faced by the farmers; and (c) farmers' food consumption and expenditure.

3.4 Analytical Techniques

3.4.1 Descriptive Statistics

Descriptive statistics such as frequency counts, means and percentages were used to achieve objectives i and iv of the study.

3.4.2 Food Security Line

Food security line was used to achieve objective ii. This was used to classify farmers into either food secure or food insecure depending on which side of the line they fall. The food security line is the recommended daily per capita calorie intake of 2260 kilo calorie (FAO, 1996). A farmer whose daily per capita calorie intake is up to 2260 kilo calorie intake was regarded as food secure and those whose daily per capita calorie intake is below 2260 kilo calorie were regarded as food insecure. This method has been applied to several studies whose main focus was on food security (Babatunde *et al.*, 2007).

The food security line is given as:

$$Z = Yi / R \text{---------- (1)}$$

Where:

Z_i = food security status of ith farmers.

Y_i = daily per capita calorie intake of ith farmers

R = recommended per capita daily calorie intake (2260kilo calorie)

Z_i = 1 for Y_i greater than or equal to R

Z_i = 0 for Y_i less than R

Additionally, the shortfall/surplus index and the headcount ratio of food security were calculated for the sampled households based on the food security line. The shortfall index

(P) measures the extent to which poor households are food insecure while the headcount ratio (H) measures the percentage of the population of household that are food insecure/secure.

$$\text{Shortfall Index (P)} = \frac{1}{M}\left(\sum_{i=j}^{M} G_i\right) = \frac{1}{M}\left(\sum_{i=j}^{M} \frac{Y_i - R}{R}\right) \ldots\ldots\ldots (2)$$

$$\text{Head Count Ratio (H)} = \frac{M}{N} \ldots\ldots\ldots (3)$$

Where:

M = The number of food insecure households

G_i = Per capita calorie intake deficiency for ith household

N = Number of households in the sample

3.4.3 Logit Regression Model

Logit regression model was used to achieve objective iii. The probability of a farmer being food secure is determined by an underlying response variables that capture the true economic status of a farmer. The underlying response variable y* in the case of binary choice is defined by the multivariate logit regression relation:

$y^* = \Sigma x_i \beta_j + \mu$ …….. (4)

where:

$\beta_j = \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$; and

$X_i = X_{i1}, X_{i2}, X_{i3}, X_{i4}, X_{i5}, X_{i6}, X_{i7}$

The relevant logistic expressions are given as:

Prob (y^* =1) =1-F*($\Sigma xi\beta j$) $= \frac{e^{\Sigma xi\beta j}}{1+e^{\Sigma xi\beta j}}$ …….. (5)

Prob (y* =0) =F*(Σxiβj) $= \frac{e^{-\Sigma xi\beta j}}{1+e^{\Sigma xi\beta j}} = \frac{1}{1+e^{\Sigma xi\beta j}}$ ……..(6)

Where:

F = The cumulative logistic distribution function for $\mu_{i,\ldots}$

Prob ($Y_i = 0/\beta_j X_i$) = F(−Σxiβj) ……(7)

Prob ($Y_i = 1/\beta_j X_i$) = 1-F(−Σxiβj) ……(8)

The likelihood function is given by;

L = Π{F(−Σxiβj)} Π {1-F(−Σxiβj)} ……(9)

$y_i=0$ $y_i=1$

while the log likelihood function for the expression is:

H(β) = log L(β) = $\sum_{i=0}^{n}$ yi log ……..(10)

1-F[(-∑X_i ‘β_i) + (1-y)logF(-∑X_i ‘β_i)] …….. (11)

Where;

Y = Food security status measured as dummy (1 = food secure, 0 = food insecure)

μ_i = a logistic cumulative distribution in F

X_1 = Age of household head (years)

X_2 = Education (years of formal schooling)

X_3 = Membership of cooperative (years)

X_4 = Household per capita monthly income (Naira)

X_5 = Farm size (hectares)

X_6 = Technology adoption (adoption rate)

X_7 = Distance to Market (km)

β_i = The coefficients for the respective variables in the logit function

The probability of a household being poor and the corresponding change in probability due to unit change in a variable X_1 are given as:

prob ($y_i = 1/\beta X_i = \frac{e^{\Phi}}{1+e^{\Phi}}$)

3.4.4 T-test of significance

This was used to test hypothesis (i), that is, the difference between the food security status of irrigation and non-irrigation farmers in the study area. The formula is given by:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \text{ ---------- (12)}$$

Where:

$\overline{X}_1$ = average calorie intake of irrigation farmers

$\overline{X}_2$ = average calorie intake of non-irrigation farmers

σ_1^2 = standard deviation of irrigation farmers calorie intake

σ_1^2 = standard deviation of non-irrigation farmers calorie intake

n_1 = sample size of of irrigation farmers

n_2 = sample size of non-irrigation farmers

3.5 Explanation of Dependent and Independent Variables

Eight explanatory variables measured as continuous and discrete variables which are identified to be major determinants of food security were collected from irrigation and non-irrigation farmers and examined in this study. These variables were included in this model as they have been used in other studies to determine household food security. Feleke *et al.*

(2005) and Kidane *et al.* (2005) adopted the same logistic regression model in their studies. These variables include age of household head, marital status, educational level of household head, farm size, technology adoption, household per capita income, access to market distance, and membership of cooperative. These factors are a *priori* and were expected to have a positive or negative impact on food security.

i. **Age of Household head:** This is the number of years a respondent has lived. The age of household's head is expected to have impact on his labour supply for food production. It is also expected to have impact on ability to seek and obtain off-farm jobs and income, which could increase household income. Young people are stronger and are expected to cultivate larger-size farm than old people. However, the expected effect of age on food security could be positive or negative. Age of household head is a continuous variable. However, the expected effect of age on food security could be positive or negative.

ii. **Education level of household head:** This refers to the acquisition of knowledge through formal means. Educational attainment of a household head is considered to be a qualitative variable. Individual's level of education was measured by the number of years a respondent had spent in formal education. The expected effect on food security is positive.

iii. **Farm size:** This refers to the area of land devoted to irrigation and non irrigation cultivation in the 2011 cropping season. It was measured in hectares. It is expected that households with large farms are food secure than those with small farms. The expected effect on food security is positive because the more land used for farming, the higher the output. Farm size is a continuous variable.

iv. **Household per capita income:** This is the sum total of the earnings of the households resulting from the summation of all income coming from crop sales divided by the household size. Household income will be calculated. The household per capita income is

expected to boost household's food production and also access to more quality food. The expected effect of this variable on food security is positive

v. **Technology adoption:** Technology adoption refers to the use of farm inputs such as improved seeds, agrochemicals, access to irrigation water and chemical fertilizer use with improved agronomic practices. Households that report to have used some package of technology were considered adopters and those that have not used this package were considered non-adopters. This was measured using adoption rate. Adoption is expected to increase food security through its effect of increasing food availability and income.

vi. **Distance to Market:** Distance to Market is measured by the amount of time (hours) required to reach the nearest local market from the irrigation schemes and adjacent non-irrigated farms. The longer it takes to get to the market, the less frequent the farmer visits the market and hence the less likely he/she to get market information. In this study, the distance in km to the nearest market was used since Nigeria is experiencing fuel shortages. Using time would distort results as farmers spend a lot of time searching for fuel. Expected effect on food security is positive.

vii. **Membership of cooperatives:** Cooperatives are vehicle for development in the rural areas for both irrigation and non-irrigation farmers. Access to cooperative loans depends on membership of the society and it is expected that access to credit should increase household's income, food production and food consumption. Membership of a society was measured in years, the expected effect on food security is positive.

viii. **Food security:** In this study, a one month (30 days) recall method was used. The food security line is the recommended daily per capita calorie intake of 2260 kcal (FAO, 1996). The household's calorie intake was obtained through the household's consumption and expenditure data. From the data, the quantity of every food item consumed by the

households in the 30 days period was estimated. The quantities were converted to gram and the calorie content estimated using the nutrient composition table of commonly eaten foods in Nigeria (Oguntona and Akinyele, 1995). Per capita calorie intake was calculated by dividing estimated total household calorie intake by the family size after adjusting for adult equivalent using the consumption factors for age-sex categories. To get the household's daily per capita calorie intake, the household's per capita calorie intake was divided by 30. A household whose daily per capita calorie intake is up to 2260 kcal was regarded as food secure and those below 2260 kcal were regarded as food insecure households. The food security status is bivariate, taking the value 1 for food secured households and 0 for food insecured households.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of the farmers in the Study Area

This section describes the socio-economic characteristics of smallholder irrigation and non-irrigation farmers. These are; gender, age, household size, farm size, educational level, membership of cooperative, access to credit, distance to market and per capita income.

4.1.1 Age of the farmers

The age of the respondents ranged between 18-82 years. The result presented in Table 2 indicates that about 49% of the irrigation farmers and 27% of non-irrigation farmers were within 30-39 years, 4% of irrigation farmers and 42% of non-irrigation farmers were between 40-49 years, while 14% of the irrigation farmers and 5% of the non-irrigation farmers were above 59 years. Only 30% of the irrigators and 19% of the non-irrigation farmers were below 30 years of age. The mean age of the irrigation farmers was 37 years while that of non-irrigation farmers was 42 years, implying that the farmers involved in the irrigation schemes were in their active age group. Age is very important in agricultural production and livelihood activities. It presupposes active period people are expected to be responsive to developmental initiatives and food security programs. According to Romuld and Sandham (1996), young people are more adaptable and willing than older people to try out new innovations since old people believe in their old cultural ways of doing things. However, Hofferth (2003) argued that older people have better experiences in agricultural activities than younger people in that they know the social and physical environments better than younger people. The age of household's head is expected to have impact on its labour supply for food production. It is also expected to have impact on ability to seek and obtain

off-farm jobs and income, which could increase household income. Young people are stronger and are expected to cultivate larger-size farms than old people. Age also has been reported by Amaza *et al.* (2009) in their work on changes in household food security and poverty status in PROSAB area of Southern Borno State to determine how active and productive the farmer would be. They argued that age has a positive and significant influence on the decision making process of farmers with respect to farm production-related decisions.

Table 2: Distribution of the farmers based on their age

	Irrigation		**Non-Irrigation**	
Age (Years)	**Frequency**	**Percentage**	**Frequency**	**Percentage**
20-29	34	30.36	28	18.92
30-39	55	49.11	40	27.03
40-49	4	3.57	62	41.89
50-59	3	2.68	10	6.76
>59	16	14.29	8	5.40
Total	**112**	**100**	**148**	**100**
Minimum = 28			Minimum = 23	
Maximum =82			Maximum =76	
Mean = 37			Mean = 42	

4.1.2 Educational Level of the Farmers

Distribution of the farmers by educational level as shown in Table 3 indicates that 21.4% and 37.84% of the irrigation and non-irrigation farmers had no formal education respectively, 16.1% of the irrigation farmers and 18.92% of the non-irrigation farmers had primary education, 37.5% and 35.14% of the irrigation and non-irrigation farmers had secondary education while 25% of the irrigation farmers and 8.10% of the non-irrigation farmers had tertiary education. This result shows that majority of the respondents (78.6%) involved in the irrigation schemes had one form of formal education or the other. The implication is that education is a social capital and could impact positively on household

ability to take good and well-informed production and nutritional decisions. Some scholars have argued that spouse education could be more important in food security than household's head educational status. Najafi (2003) noted that educational attainment is very important because it could lead to awareness of the possible advantages of modern farming techniques which in turn would enhance household food security.

Table 3: Distribution of the farmers based on their level of education

	Irrigation		Non-Irrigation	
Education	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Non formal Education	24	21.4	56	37.84
Primary	18	16.1	28	18.92
Secondary	42	37.5	52	35.14
Tertiary	28	25	12	8.10
Total	**112**	**100**	**112**	**100**

4.1.3 Household Size

The distribution of the respondents by household size is shown in Table 4. The result shows that, 37% of the respondents in the irrigation schemes and 30% of the non-irrigation farmers had 6-10 members. Those with 1-5 members constituted 40% and 49% for irrigation and non-irrigation farmers respectively while 19% and 14% had household size which ranged between 11-15 members for the irrigation and non-irrigation farmers respectively. 0nly 4% of the irrigation farmers and 6% of the non-irrigation farmers had household size above 15 members. The average household size was about 8 people per household for irrigation farmers and about 9 for non-irrigation households. The significance of household size in agriculture hinges on the fact that the total area cultivated, the amount of farm produce retained for domestic consumption, and the marketable surplus under smallholder irrigation schemes are all determined by the size of the farm household (Amaza *et al.,* 2009). Size of the household may enhance labour availability that can be

used for different activities under these smallholder irrigation schemes. However, the implication of household size for food security is that small-sized households are less prone to food insecurity than large-sized households because larger families put pressure on consumption than the labour they contribute to agricultural production.

Table 4: Distribution of the farmers based on their household size

	Irrigation		Non-Irrigation	
Household size	**Frequency**	**Percentage**	**Frequency**	**Percentage**
1-5	45	40.18	56	37.84
6-10	41	36.61	28	18.92
11-15	21	18.75	52	35.14
>15	5	4.46	12	8.10
Total	**112**	**100**	**148**	**100**
Minimum = 1 Maximum = 24 Mean = 8			Minimum = 1 Maximum =17 Mean = 9	

4.1.4 Cooperative Participation

The results in Table 5 show the distribution of the farmers by their years of membership in cooperatives. It was found that 38% of the irrigation farmers and 35% of the non-irrigation farmers did not belong to any cooperative, 50% of irrigation farmers and 47% of the non-irrigation farmers had between 1-5 years in cooperative, 7% of the irrigation farmers and 10% of the non-irrigation farmers had between 6-10 years while 5% of the irrigation farmers and8% of the non-irrigation farmers had more than 10 years in cooperative. Cooperative participation can enhance the accessibility of farmers to credit facilities and other farm inputs and serve as a medium for exchange of ideas that can improve their household's income, food production and food consumption.

Table 5: Distribution of the farmers based on years of membership in cooperative

Cooperative participation (years)	Irrigation		Non-Irrigation	
	Frequency	**Percentage**	**Frequency**	**Percentage**
No membership	42	37.50	52	35.14
1-5	56	50.00	69	46.62
6-10	8	7.14	15	10.14
>10	6	5.36	12	8.10
Total	**112**	**100**	**148**	**100**
Minimum = 1 Maximum = 20 Mean = 5			Minimum = 1 Maximum = 12 Mean = 3	

4.1.5 Farm Size

The distribution of farmers by their farm size is shown in Table 6. The results reveal that 26.79% of the irrigation farmers and 19.60% of the non-irrigation farmers had farm size between 0.1-0.5 hectares, while 60.71% of the irrigation farmers and 49.31% of the non-irrigation farmers had between 0.6-1.0 hectares. Only 12.5% of the irrigation farmers and 31.09% of the non-irrigation farmers had farm sizes greater than 1.0 hectares. Households under irrigation farming have an average farm size of 0.8 hectares while those farming on non-irrigation farmers have 0.9 hectares. This result is not implausible as most of the farmers in the study area are smallholder farmers. Small farm sizes may affect the size of food production which in turn will affect the food security status of the farmers. According to Najafi (2003), food production can be increased through expansion of area under cultivation. Therefore under smallholder agriculture, farm size is expected to play a significant role in influencing a farm household's food security because size of the land under cultivation will determine the size of food production

Table 6: Distribution of the farmers based on their farm size

	Irrigation		Non-Irrigation	
Farm size (ha)	**Frequency**	**Percentage**	**Frequency**	**Percentage**
0.1-0.5	30	26.79	29	19.60
0.6-1.0	68	60.71	73	49.31
>1.0	14	12.50	46	31.09
Total	**112**	**100**	**148**	**100**
Average	0.8		0.9	

4.1.6 Household per capita Income

The total household income from crop sales was converted into per capita monthly income. The result in Table 7 reveals that 72.32% of the irrigation farmers and 65.54% of the non-irrigation farmers had a per capita monthly income between ₦500-5000, 16.07% of the irrigation farmers and 14.87% of the non-irrigation farmers had between ₦5001-9500, 2.68% of the irrigation farmers and 8.79% of the non-irrigation farmers had between ₦9501-14000, 3.57% of the irrigation farmers while 4.71% of non-irrigation farmers had between ₦14001-18500. Only 5.36% of the irrigation farmers and 6.09% of the non-irrigation farmers had above ₦18500. The average monthly per capita income for irrigation households was ₦4932.61 which is equivalent to about $33*. This translates to an average adult income of $1.1 per day in the area, just about the threshold of the $1 poverty line. Thus, it is plausible to conclude that crop sales from the irrigation schemes contribute to their income and food security. This result negates the findings of Babatunde *et al.* (2007) that indicate an average adult income of farming households in Kwara state to be $0.2 per day, even lower than the $1 poverty line. The mean per capita income for non-irrigation households was ₦3984.52 which is equivalent to about $27 and translates to an average adult income of about $0.9 per day, slightly below the $1 poverty line. The analysis shows that irrigation farmers get higher income from on-farm activities as opposed to dry-land

farmers. This is because most of their income came from vegetables that are grown on the irrigation projects. Vegetable crops had a high income because they are grown twice or more times per year and they mature quickly because of intensive cultivation practiced on the irrigation schemes. The vegetable income percentages for non-irrigation farmers were low because very few farmers grow vegetables around their homesteads. Vegetables produced by non-irrigation farmers are primarily for household consumption, unless the rains are adequate, that is when they sell surplus vegetables to locals around them. It can be inferred that irrigators have more disposable income than non-irrigators because vegetables contribute higher percent of total income realized by the farmers as they are popular source of income for daily household use.

Table 7: Distribution of the farmers based on their household per capita income

	Irrigation		**Non-Irrigation**	
Per capita income (₦)	**Frequency**	**Percentage**	**Frequency**	**Percentage**
500-5,000	81	72.32	97	65.54
5,001-9,500	18	16.07	22	14.87
9,501-14,000	3	2.68	13	8.79
14,001-18,500	4	3.57	7	4.71
>18,500	6	5.36	9	6.09
Total	**112**	**100**	**148**	**100**

* Exchange rate was ₦150 to One US dollar

Minimum = 684.52
Maximum = 23,791.67
Mean = 4,932.61

Minimum = 572.61
Maximum = 21,622.34
Mean = 3,984.52

4.2 Food Security Status of Smallholder Irrigation and Non-Irrigation Farmers

The result of the food security status of the respondents is presented in Table 8. In this study, a one month (30 days) recall method was used. The food security line of daily 2260 kcal by FAO (1996) was adopted in this study. The household's calorie intake was obtained through the household's consumption and expenditure data. From the data, the quantity of

every food item consumed by the households in the 30 days period was estimated. The quantities were converted to gram and the calorie content estimated using the nutrient composition table of commonly eaten foods in Nigeria (Oguntona and Akinyele, 1995). Per capita calorie intake was calculated by dividing estimated total household calorie intake by the family size after adjusting for adult equivalent using the consumption factors for age-sex categories. To get the household's daily per capita calorie intake, the household's per capita calorie intake was divided by 30. A household whose daily per capita calorie intake is up to 2260 kcal was regarded as food secure and those below 2260 kcal were regarded as food insecure households.

Based on the recommended daily calorie intake (R) of 2260 kcal, the headcount ratio shows that 57% of the irrigation households with an average daily per capita household calorie consumption of 3606.30 kcal were food secure and 43% of this group with an average daily per capita calorie consumption of 1673.62 were food insecure. The headcount ratio for non-irrigation households indicates that 42% of the households were food secure with an average daily per capita calorie consumption of 3190.68 kcal and 58% were food insecure with an average daily per capita calorie consumption of 1599.17 kcal. Irrigation households had a surplus index of 0.60 and the least shortfall index of 0.26 indicating that food secure households under irrigation exceed the calorie requirement by 60% while the food insecure households in this group fell short of the recommended calorie intake by 26%. A shortfall index of 0.29 and a surplus index of 0.64 for non-irrigation farmers indicate that food insecure households in this group fell short of the recommended calorie intake by 29% while food secure households exceed the calorie requirement by 64%. This is similar to results obtained by Agbola *et al.* (2008) in their study on the effect of income

diversification strategies on food insecurity status of farming households in Africa. They reported that based on the recommended daily calorie intake of 2260 kcal, 82% of the households were food secure and 18% were food insecure for households that combined crop production with livestock production. Based on the headcount ratio, it is expedient to infer that households under the irrigation schemes were more food secure (P<0.10) than non-irrigation households. This is adjudged so because irrigation farming helps to buffer the impact of drought, offers more stability in farm income, offers more stability in farm employment, stabilizes yield and increases land value.

Table 8: Distribution of the respondents by their food security status

Statistical estimates	**Irrigation**		**Non-Irrigation**	
	Food secure	**Food insecure**	**Food secure**	**Food insecure**
Frequency	64	48	62	86
Average daily calorie intake (kcal)	3606.30	1673.62	3190.68	1599.17
Maximum daily calorie intake (kcal)	19231.90	2248.63	7248.80	2245.83
Minimum daily calorie intake (kcal)	2261.31	926.14	2279.24	726.50
Shortfall/surplus Index (P)	0.60	-0.26	0.64	-0.29
Head count ratio (H)	0.57	0.43	0.42	0.58
Standard deviation	1544.47	391.01	1310.37	382.23

Table 9 shows the result of the hypothesis test comparing the means of the food security status of irrigation and non-irrigation farmers. The result showed a significant difference between the food security status of irrigation and non-irrigation farmers. Since the average calorie intake of irrigation farmers is greater than the average calorie intake of non-irrigation farmers with a significant t- value (P<0.10), the null hypothesis which states that there is no significant difference between the food security status of irrigation and non-irrigation farmers is therefore rejected. This implies that irrigation farmers are more food secured that non-irrigation farmers. The output and income of irrigation farmers are relatively greater as compared to non-irrigation farmers. Investigation from this study shows that vegetables contribute a higher income than other crops. The high income in vegetables is because they can be grown more than once per year and can be harvested several times making it possible to get a continuous flow of income. Access to water for irrigation purposes has shown that it can put disadvantaged farmers to a better position. With the availability of water, irrigation farmers can adopt intensive technologies and produce better yields than non-irrigation farmers. Thus, it can be concluded that irrigation plays an important role in enhancing food security and reduce poverty as against non-irrigation farmers.

Table 9: Test of hypothesis on food security status of irrigation and non-irrigation farmers

Category	**Mean Calorie intake**	**N**	**Standard Deviation**	**Standard Error**	**t-value**	**t-critical**
Irrigation	2778.010	112	1530.228	144.893	1.886*	1.652
Non-irrigation	2484.903	148	1375.723	113.082		

*P<0.10

4.3 Factors affecting Food Security among Smallholder Irrigation and Non-Irrigation Farmers in the Study Area

The results of the parameter estimates of factors affecting food security among irrigation and non-irrigation farmers are presented in Tables 10 and 11. As shown in the Tables, most of the variables significantly affect household food security. The results indicate that of seven variables included in the model, five were found to significantly affect food security of the irrigation farmers while four of the variables were significant in the case of non-irrigation farmers.

Education:

Interestingly, estimated parameter for education was positive and significant at 5% and 10% level for both irrigation and non-irrigation households respectively. This implies that the higher the educational level, the more food secure the farmers and vice versa. This is because education enhances the productivity of the farmers and the respondents tend to be better informed and have better food management techniques that will ensure equitable and all-round supply of food. This result is similar to the findings of Babatunde *et al.* (2007) who found education to be positively related with food security, which implies that households with more education are more food secure.

Membership of Cooperative:

The estimated parameter for cooperative was positive and significant at 10% level of probability for irrigation farmers but insignificant for non-irrigation households. This implies that an increase in the cooperative variable will lead to an increase in the odds in favour of food security. This is because financial assistance from cooperative credit unions is significant despite the fact that cooperative movement in this area is still in its infancy

(KADP, 2011). The implication of this is that membership of cooperative can enhance the accessibility of farmers to credit facility and serve as a medium for exchange of ideas that can improve their farm activities. The mean years spent in the association was 5 and 3 for irrigation and non-irrigation farmers respectively as shown in Table 5. This shows that the irrigation farmers have stayed in the association than their non-irrigation counterparts. It could be that the irrigation farmers are the founders of the association, which accounts for the wide difference in membership duration for the two categories of farmers.

Technology Adoption:

The parameter estimate obtained for technology adoption was positive and significant at 1% level of probability for irrigation households but insignificant for non-irrigation households. This implies that an increase in technology adoption will result in an increase in the odds in favour of the households being food secured. The insignificance of technology adoption for non-irrigation farmers may be due to the fact that these inputs are expensive and not readily available to this category of farmers as opposed to the irrigation farmers that have access to them because of government support. Technology adoption refers to the use of farm inputs such as improved seeds, agro-chemicals and chemical fertilizer. Adoption of these technologies is expected to increase the likelihood of being food secure through its effect on increasing farming systems and eventually increasing food availability and income.

Distance to Market:

The parameter estimate obtained for distance to market was also positive and significant at 1% level of probability for irrigation households but insignificant for non-irrigation

households. This implies that an increase in market access will result in an increase of the odds in favour of the households being food secured. Thus, it can be inferred that the longer it takes to get to the market, the less frequent the farmer visits the market and hence the less likely he/she to get market information. The shortest distance to the market was used in this study to determine how often the farmers went to the market to sell their produce. This study revealed that the shortest distance to the market was 2 km for irrigation farmers and about 5km for non-irrigation farmers. The insignificance of market distance for non-irrigation farmers may be due to the fact that they produce smaller amounts of vegetables and cereals especially maize as opposed to the irrigation farmers. When there is less adequate information about prices, farmers may sell their produce at times when prices are low and buy when prices are high. Lesser output for the non-irrigation farmers as against the irrigators means they would have to sell most times at the farm gate. However, the irrigators could sell at nearby markets given the volume of their output all year round because of double cropping on the irrigation schemes. Irrigators who did not market their crops either produced only enough for household consumption or sold at the farm gate. Feleke *et al.* (2005) used amount of time taken to reach the nearest market to assess if households were food secured or not but, for this study distance was used because of fuel shortages and transportation problems in the rural areas.

Age:

The estimated parameter for age was negative and significant at explaining household food security for non-irrigation farmers. This means that the odds likelihood of a household being food secure decreases with an increase in age of the household head. This result is similar to the findings of Babatunde *et al.* (2007) who found age of household head to be

negatively related with food security. In their study, the estimated parameter for age was negative and insignificant at explaining household food security in the study area. The implication of this is that young people are stronger and are expected to cultivate larger-size farm than old people. This result was expected. The insignificance of the variable for irrigation farmers may be attributed to the fact that they have more younger people than older people who have better experiences in agricultural activities than younger people in that they know the social and physical environments better than younger people.

Per capita Income:

The per capita income of both the irrigation and non-irrigation farmers was found to exert significant and positive influence on food security status of the respondents. This indicates that the higher the respondents per capita income, the higher the probability that the household would be food secure. This is because increased income would increase access to food. Incomes were higher for irrigation farmers as compared to non-irrigation farmers as shown in Table 7. The incomes come mainly from vegetables and grain sales. Vegetable crops had a high income because they are grown twice or more times per year and they mature quickly because of intensive cultivation practiced on the irrigation schemes. Irrigation farmers are unlikely to have vegetable and maize shortages during the course of the year when compared to non-irrigation farmers who grow their crops in the rainy season only.

Farm size:

The parameter estimate obtained for farm size of non-irrigation farmers was found to exert positive and significant influence on food security status of the respondents. This implies that the likelihood of households being food secure increases with an increase in farm size.

The parameter estimate obtained for farm size was negative and insignificant for irrigation farmers. The negative coefficient was contrary to expectation, and this could be due to reasons such as inefficiency in the use of land resources. The insignificance of land size could also be due to irrigation farmers who operate on smaller plots and use intensive methods of farming.

Table 10: Factors affecting food security among smallholder irrigation farmers in the area

Variable	Reg. Coefficient	Standard Error	T-value
Age (X_1)	-0.10064E-01	0.35848E-01	-0.28074
Education (X_2)	0.15409	0.69183E-01	2.2273**
Cooperative (X_3)	0.28757	0.16863	1.7054*
Per capita income (X_4)	0.1923	0.0520	3.695***
Farm size (X_5)	-0.15300E-01	0.14870	-0.10289
Technology adoption (X_6)	0.69544	0.77561	4.0523***
Distance to Market (X_7)	0.69544	0.20783	3.3462***

*** = significant at 1% ** = significant at 5% * = significant at 10%

Table 11: Factors affecting food security among non-irrigation farmers in the area

Variable	Reg. Coefficient	Standard Error	T-value
Age (X_1)	-0.41660	0.0971	-4.2910***
Education (X_2)	0.00582	0.00338	1.7242*
Cooperative (X_3)	0.10752	0.07468	1.4796
Per capita income (X_4)	0.45849	0.18624	2.4618***
Farm size (X_5)	1.77650	0.81325	2.1844**
Technology adoption (X_6)	0.33849	0.22153	1.5269
Distance to Market (X_7)	0.10650	0.9450	0.1130

*** = significant at 1% ** = significant at 5% * = significant at 10%

4.4 Constraints faced by Smallholder Irrigation and Non-Irrigation Farmers

Table 12 and 13 shows the distribution of farmers based on constraints faced in irrigation and non-irrigation farming and are discussed according to their ranking. These problems were affecting the profits they could realize.

4.4.1 Market Challenges

Both categories of farmers ranked market obstacles as their 1st constraint. About 91.07% of the irrigators identified this as a problem while 79.73% of the non-irrigators had this challenge. However, it cannot be unconnected to the unorganised nature of our rural markets. Market information flow as regards good prices is also another market challenge in this aspect. Markets are located in far areas which induce the irrigation farmers to sell at give away prices.

4.4.2 Inadequate Storage Facilities

The sampled irrigation and non-irrigation farmers identified inadequate storage facilities as a constraint; hence, it was ranked the 2nd constraint by the irrigation farmers (83.93%) and 3rd by the non-irrigation farmers. Generally, most of the crops produced under irrigation are vegetables which require specialized storage facilities like cold rooms etc. Therefore, during the peak season, when prices of farm products are usually low as a result of glut, farmers are forced to sell at even unwilling prices to avoid spoilage. Some of the non-irrigation farmers also grow vegetables around their homesteads. Those that grow vegetables either have boreholes that constantly supply them with water to irrigate their vegetables.

4.4.3 High Cost of Transportation

Harvested farm produce are transported with great difficulties from the farms to market or points of processing. The farm products are mostly transported to the market for sale. Therefore, irrigation farmers ranked high cost of transportation 3rd (80.36%) constraint among the constraints encountered by them while for non-irrigation farmers, it was 2nd

(70.27%). This cannot be unconnected to the bad roads in the area which makes some roads inaccessible by vehicles rather they use motorcycle, hence, charges are high. Erratic fuel prices and its scarcity is also a factor in this case. The difficulty in getting transport to market their produce leads to these farmers being exploited by hawkers and people with their own private transport, thereby causing a decline in returns.

4.4.4 Problem of Sourcing Inputs

Ranked 4th constraint by both groups of farmers was problem of sourcing inputs. It was highlighted by about 79.46% of the irrigation farmers and 62.16% of the non-irrigation farmers. The farmers said they experienced problems (high cost of purchase) of sourcing inputs such as hybrid seeds and fertilizers.

4.4.5 Inadequate Farm Land

About 75.89% of irrigation farmers and 58.11% of non-irrigation reported they failed to secure adequate farm land for their farming purposes. It was ranked 5th among the constraints for irrigation farmers but least (6th) for the non-irrigation farmers. This could be attributed to the nature and design of the irrigation schemes. Population problem and urbanization could also be a factor is this regard.

4.4.6 Inadequate Government Support

Some of the irrigation farmers (70.54%) and non-irrigation farmers (60.14%) stated that inadequate government support in terms of expansion of irrigated farm land and provision of farm inputs is hindering their maximum productivity. It ranked least (6th) among the identified constraints for irrigation farmers and 5th for non-irrigation farmers. If investment

encouraging ground is set by the government, private investors would be motivated to enter into the enterprise, thereby improving the development of the area.

Table 12: Constraints encountered by irrigation farmers

Constraints	Frequency	Percentage	Rank
Marketing problems	102	91.07	1
Storage facilities	94	83.93	2
Transport	90	80.36	3
Sourcing inputs	89	79.46	4
Farm land	85	75.89	5
Government support	79	70.54	6

*Total frequency is more than 112 due to multiple responses

Table 13: Constraints encountered by non-irrigation farmers

Constraints	Frequency	Percentage	Rank
Marketing problems	118	79.73	1
Transport	104	70.27	2
Storage facilities	95	64.19	3
Sourcing inputs	92	62.16	4
Government support	89	60.14	5
Farm land	86	58.11	6

*Total frequency is more than 148 due to multiple responses

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The broad objective of this study is to examine household food security among smallholder irrigation and non-irrigation farmers in Kaduna State. The specific objectives were to describe the socio-economic characteristics of the smallholder irrigation and non-irrigation farmers in the study area, determine and compare the food security status of the smallholder irrigation and non-irrigation farmers in the area, examine the factors affecting food security among smallholder irrigation and non-irrigation farmers in the study area, identify the constraints faced by smallholder irrigation and non-irrigation farmers in the area

Primary data were used for this study. These were collected with the aid of structured questionnaire. A combination of purposive and random sampling techniques was used for this study. The first stage involved a purposive selection of the three (3) sites where the state's smallholder irrigation schemes are located. The three sites are also located in three different Local Government Areas representing the three Senatorial Zones of the State. The sites covered include; Likoro site in Kudan L.G.A (North), Buruku site in Chikun L.G.A (Central) and Jagindi site in Jama'a L.G.A. (South). Non-Irrigation farmers included those registered with KADP and located adjacent the irrigation schemes. Finally, 80% of the sample frames based on 2011 cropping season in each of these areas were randomly selected, giving a total of 260 respondents. The results revealed that out of the 260 respondents interviewed, about 49% of the irrigation farmers and 27% of non-irrigation farmers were within 30-39 years, 4% of irrigation farmers and 42% of non-irrigation farmers were between 40-49 years, while 14% of the irrigation farmers and 5% of the non-

irrigation farmers were above 59 years. Only 30% of the irrigators and 19% of the non-irrigation farmers were below 30 years of age. The mean age of the irrigation farmers was 37 years while that of non-irrigation farmers was 42 years. Only 21% and 38% of the irrigation and non-irrigation farmers had no formal education respectively while 79% and 62% of both categories respectively had one form of formal education or the other. About 40% and 49% of the irrigation and non-irrigation farmers respectively had 1-5 members in their household and the average household size was about 8 people per household for irrigation farmers and about 9 for non-irrigation households. It was found that 38% of the irrigation farmers and 35% of the non-irrigation farmers did not belong to any cooperative did not belong to any cooperative while 62% of the irrigation farmers and 65% of the non-irrigation farmers belong to one cooperative or the other. Average farm size was estimated to be 0.8 hectares for irrigation farmers and 0.9 hectares for non-irrigation farmers. Average monthly per capita income for irrigation households was ₦4932.61 which is equivalent to about $33. This translates to an average adult income of $1.1 per day in the area, just about the threshold of the $1 poverty line. However, the mean per capita income for non-irrigation households was found to be ₦3984.52 which is equivalent to about $27 and translates to an average adult income of about $0.9 per day, slightly below the $1 poverty line.

Based on the recommended daily calorie intake of 2260 kcal, 57% of the irrigation households with an average daily per capita calorie consumption of 3606.30 kcal were food secure and 43% of this group with an average daily per capita calorie consumption of 1673.62 were food insecure. Only 42% of the non-irrigation households were food secure with an average daily per capita calorie consumption of 3190.68 kcal and 58% were food

insecure with an average daily per capita calorie consumption of 1599.17 kcal. The factors affecting food security among irrigation farmers in the study area were education, cooperative, per capita income, technology adoption and distance to market. Education, age, per capita income and farm size were also found to significantly affect food security among non-irrigation farmers. Most important constraints encountered by irrigation farmers include marketing challenge ranking 1st. others include; inadequate storage facilities, transport, inputs problem, inadequate farm land and inadequate government support.

5.2 Conclusion

Form the empirical evidences of this research work, it can be safely inferred that irrigation farming in the area contributed to the aspiration of food security of the irrigation farmers. Specifically, food security situation of irrigation farmers is determined by education, cooperative membership, per capita income, technology adoption and distance to market. The same is true for non-irrigation farmers except that distance to market, cooperative participation and technology adoption remain unimportant factors. Age was however an important factor for non-irrigation farmers. The challenges facing food security situation of households rally around input sourcing, inadequate farm land, inadequate government support, marketing challenges, high transportation cost and inadequate storage facilities.

5.3 Recommendations

Based on the findings of this study, the following recommendations are made:

1. The study indicated that education contributed to the food security status of the farmers in the study area. Thus, reduction in food insecurity should involve an integrated approach that promotes formal education as regard farm production activities among farm households.

2. Technology adoption (use of improved seeds, agrochemicals and chemical fertilizers) was significant and positively related to food security status of the farmers. Thus, increasing the productivity of crops through the use of improved farm technologies and providing an enabling environment for the private sector to provide such services at affordable prices would help to address food insecurity.

3. Distance to market access is one other important factor that contributes to household food security as the farmers sell at better prices the nearer the market to their farms. Market access could also be improved by provision of good rural transportation system that would assist farmers to convey their farm produce to the market at cheaper cost.

4. With the role of irrigation as a dependable strategy of improving food security status of farmers, it is expedient for government and other stakeholders to provide support through the establishment of more irrigation projects and other income generating projects that can assist farmers to produce their own food and be food secured.

5. It would be extremely difficult to enhance the sustainability of the schemes without community based organizations being functional. A functional umbrella organization is

required to handle issues of capacity building for farmers, linkage with output dealers, provision of inputs, credits and extension messages.

5.4 Contribution to Knowledge

1. The empirical evidence of this research work revealed that irrigation farmers are more food secured than non-irrigation farmers. This is buttressed by the fact that 57% were food secured and 43% were food insecured for irrigation farmers while 42% were food secured and 58% food insecured for non-irrigation farmers.
2. Food security situation of farmers is determined by age, education, cooperative membership, per capita income, market distance and technology adoption. The same is true for non-irrigation farmers except that distance to market and technology adoption remain insignificant.
3. The challenges facing food security situation of households include input sourcing, inadequate farm land, inadequate government support, marketing challenges, high transportation cost and inadequate storage facilities.

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APPENDIX 1

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY,

AHMADU BELLO UNIVERSITY, ZAIRA.

FARMERS QUESTIONNAIRE

TOPIC: ANALYSIS OF HOUSEHOLD FOOD SECURITY UNDER SMALLHOLDER IRRIGATION SCHEMES IN KADUNA STATE, NIGERIA

Dear Respondent,

This questionnaire will be used for M. Sc. research in the above- named department. Please, provide the necessary information required in the questionnaire. All information will be treated with utmost confidentiality and will strictly be used for accademic purposes.

Thanks for your cooperation.

(A) General information

(i) Name.....
(ii) LGA.....
(iii) Village.....
(iv) Date of interview.....

(B) Socio-economic characteristics

(1) Age ……..... (Years)

(2) Gender.....

(3) Marital status.....

(4) Educational qualification

(i) No formal education ( )

(ii) Primary ( )

(iii)J.S.S ( )

(iii) S.S.S ( )

(iv) Tertiary ( )

(v) Others (specify).....

(5) How many of your household members fall in the following age group

Age group (in years)	Number of males	Number of female
< 1		
1-4.9		
5-9.9		
10-14.9		
15-59.9		
>59		

(6) Do you belong to farmers' association or cooperative society (a) Yes ( ) (b) No ( )

(6b) If yes how long have you been in the association or cooperative.....

(7) How much does your household earn from the following sources of income?

SN	Income Source	Amount in Naira
1	Food crops/ Vegetables	
(i)	Maize	
(ii)	Sorghum	
(iii)	Rice	
(iv)	Cassava	
(v)	Yam	
(vi)	Cocoyam	
(vii)	Groundnut	
(viii)	Soybean	
(ix)	Cowpea	
(x)	Okra	
(xi)	Tomato	
(xii)	Onion	
(xiii)	Pepper	
(xiv)	Egg plant	
(xv)	Carrot	
(xvi)	Water melon	
(xvii)	Green leaves	
(xviii)	Guava	
(xix)	Citrus	
(xx)	Mango	
(xxi)	Sugar cane	
	Others (specify)	
(xxii)		
(xxiii)		
(xxiv)		

(C) Respondents' calorie intake

(8) Kindly provide information on the following crops

	Item purchased last season for household		Amount produced last cropping season (Quantity/units)	Amount consumed from food purchased (quantity/units)	Amount consumed from production (quantity/units)	Value of Foods eaten outside the household last one month (₦)
	Quantity or units	Price paid/unit				
Maize						
Grain						
Flour						
Sorghum						
Grain						
Flour						
Rice						
Imported						
Local						
Cassava						
Tubers						
Gari						
Cassava chips						
Yam						
Tubers						
Yam flour						
Cocoyam						
Corms						
Groundnut						
Shelled						
Unshelled						
Soybean						
Grain						
Flour						
Cowpea						
Okra						
Tomato						
Onion						
Pepper						
Egg plant						
Carrot						
Pumpkin						
Green leaves						
Guava						
Citrus						
Mango						
Others specify:						

1						
2						
3						

Units refers to local measures (e.g., Mudu, Tiya, baskets, etc) and Kilogramme (kg)

(9) Indicate the amount purchased of the following items for household consumption

Item	**Quantity purchased**	**Purchase value (₦)**	**Quantity consumed**
Salt/Potash/Maggi			
Groundnut oil			
Palm oil			
Other oils, specify:			
1.			
2.			
3.			
Fish (Fresh/dried/smoked)			
Meat (beef/mutton etc)			
Sugar			
Bread			
Drinks, specify:			
1.			
2.			
3.			

(10) Kindly indicate how many livestock you own and also provide other related information.

(D) Farm size and inputs used

(11) Kindly give a rough estimate of the total farm size cultivated.....

(11b) Please specify area of land allocated to the following crops

SN	Food crops/ Vegetables	Unit
(i)	Maize	
(ii)	Sorghum	
(iii)	Rice	
(iv)	Cassava	
(v)	Yam	
(vi)	Cocoyam	
(vii)	Groundnut	
(viii)	Soybean	
(ix)	Cowpea	
(x)	Okra	
(xi)	Tomato	
(xii)	Onion	

(xiii)	Pepper	
(xiv)	Egg plant	
(xv)	Carrot	
(xvi)	Water melon	
(xvii)	Green leaves	
(xviii)	Guava	
(xix)	Citrus	
(xx)	Mango	
(xxi)	Sugar cane	
	Others (specify)	
(xxii)		
(xxiii)		
(xxiv)		

(12) Did you apply fertilizer to your crops Yes ( ) No ( )

(12b)Which of the fertilizers did you apply? (i) Organic ( ) (ii) Inorganic ( )

(12b) If yes, specify unit (i)..... Number of unit.....

(ii)..... Number of unit.....

(13) Did you employ any improved technology on your farm Yes ( ) No ( )

(13b) If yes, kindly indicate below

(i) Agrochemicals( ) (ii) Improved seeds( ) (iii) Inorganic Fertilizers( ) (iv) Others specify.....

(14) How far is the nearest market to your farm.....

(D) Constraints facing Irrigation Farming

Please tick as appropriate

(i) Market problems ( )
(ii) Problem of sourcing inputs ( )
(iii) Inadequate storage facilities ( )
(iv) Transport problems ( )
(v) Inadequate government support ( )
(vi) Inadequate farm land ( )
(vii) Others (specify) a)……
b)…….
c)……

Appendix 2: Calorie content of some commonly eaten foods in Nigeria

Food items	Kcal/kg	Food items	Kcal/kg
Staple foods		Mango	590
Cassava Tube	1500	Pawpaw	300
Cassava flour	3800	Pineapple	320
Cassava chips	3000	Apple	570
Garri	3840	Coconut	580
Yam Tuber	1100	Guava	730
Yam flour	3810	Sugar cane	360
Yam chips	3000	***Meat and animal products***	
Sweet potato Tuber	1100	Cow meat	2370
Sweet potato chips	900	Goat meat	2370
Irish potato	1200	Sheep meat	2370
Cocoyam Tuber	3830	Pork	2370
Maize green	3100	Bush meat	2370
Maize grain	4120	Chicken	2380
Maize flour	4120	Turkey	2380
Sorghum grain	3500	Fish	2230
Sorghum flour	3500	Snail	2245
millet grain	3500	Shrimps	2230
Millet flour	3500	Crayfish	2200
Rice	1230	Crabs	2200
Wheat grain	3400	Eggs	1400
Wheat flour	3300	***Dairy products***	
Cowpea (beans)	5920	Milk	4900
Groundnut	5950	Cheese	4000
Soybeans	4050	Yoghurt	4100
Soybeans flour	2600	Ice cream	4100
Melon (shelled)	5670	Beverages	
Plantain	770	Cocoa	1200
Banana	960	Tea (leaves)	1200
Vegetables		Tea (liquid)	1200
Okra	4550	Coffee (powder)	1340
Tomato	880	Coffee (liquid)	1340
Pepper	3930	***Drinks***	
Onion	440	Soft drinks	620
Carrot	400	Orange juice	400
Egg plant	440	Apple juice	550
Cucumber	270	Pineapple juice	560
Chochorus/ewedu	500	Local beer	740
Spinach	220	Bottled beer	460
Bitter leaf	220	Wine	330
Water leaf	180	***Condiments and spices***	
Cabbage	230	Magi	220
Pumpkin	440	Salt	180

Source: Oguntona and Akinyele, (1995)

Appendix 3: Adult equivalent scale for adjusting household size

Age category (years)	Male	Female
< 1	0.00	0.00
1-4.9	0.25	0.20
5-9.9	0.60	0.50
10-14.9	0.75	0.75
15-59.9	1.00	0,90
>59.9	0.80	0.65

Source: Stefan and Pramila, (1985)