

**SUSTAINABLE IRRIGATION AGRICULTURE FOR FOOD SECURITY AND POVERTY
REDUCTION AMONG SMALLHOLDER FARMERS IN NORTHERN NIGERIA**

BY

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**PHD THESIS SUBMITTED TO THE
INSTITUTE FOR SOCIAL DEVELOPMENT (ISD),
FACULTY OF ECONOMIC AND MANAGEMENT SCIENCES,
UNIVERSITY OF THE WESTERN CAPE (UWC)**

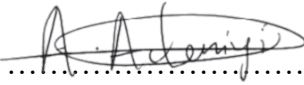
**IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DOCTOR OF
PHILOSOPHY (PHD) DEGREE IN DEVELOPMENT STUDIES**

SUPERVISOR: PROFESSOR MULUGETA F. DINBABO

MARCH 2019

DECLARATION

I hereby declare that this PhD thesis entitled *Sustainable Irrigation Agriculture for Food Security and Poverty Reduction among Smallholder Farmers in Northern Nigeria* is my own work and that I have not previously submitted it at any university for a degree or examination. All sources that I have quoted have been indicated and duly acknowledged by means of referencing.

Signature:

Daniel Adeoluwa Seun Adeniyi

March, 2019.



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ACKNOWLEDGMENT

A doctoral thesis does not only relate to the person whose name adorns the title page of the thesis, but also speaks to the many individuals whose ideas, friendship, support and encouragement behind the scenes have culminated in the completion of such work. My appreciation goes to my supervisor, Professor Mulugeta F. Dinbabo who was instrumental towards the successful completion of thesis. His constructive criticisms, insights, support and commitment in supervising the thesis are deeply acknowledged. Indeed, his relationship with me transcends only academic supervision. He was a coach and mentor to me and deeply cared during the trying times of writing this thesis.

My appreciation also goes to the staff of the Sokoto Rima River Basin Development Authority and farmers under the Middle Rima Valley Irrigation Project who made themselves available and contributed immensely to the conduct of this research. The thesis would have been impossible without the involvement of the participants who accepted to participate in the research process. I wish to thank also Adeola Adegoke for her immense assistance during my research stay at Sokoto State.

I appreciate the National Institute for Humanities and Social Sciences (NIHSS) and the Council for the Development of Social Science Research in Africa (CODESRIA) for the financial support through the African Pathways Scholarship Programme.

Having spent many years at the Institute for Social Development (ISD), UWC, I must appreciate some of my colleagues for their support and the several enlightening discussions on the developmental challenges of the African state: Clement Mensah, Kwesi Aloysius Agwani, Michael Belebema, Fru Awah Wanka, Adeyemi Badewa, Rejoice Mabhena, Tsega Tefera, Jonas Nzabamwita, Kenny Chiwarawara, Shamiso Mandioma, Freda Philander, Grace Nkomo among others. Special thanks goes to the entire staff of ISD, particularly Ms. Priscilla Kippie for her administrative efficiency.

I also express my gratitude to members of the R.C.C.G., Household of God Parish, Cape Town who contributed in no little way in making my stay in Cape Town a comfortable and memorable

one. I thank Pastor and Mrs. Lanre Fatoba, Pastor and Mrs. Oluwatimilehin, and Pastor and Mrs. Tolu Balogun for being true shepherds and for their prayers and support. Also Dr. and Mrs Sola Adeniyi, the Abegundes, the Bode-Alukos, the Akinrinmades, the Adewumis, the Omoruyis, Adaze Enogeru, the Egunlusi, Temitope Kuti and my fellow choir members, for their love and care.

I sincerely appreciate my friends here in Cape Town, Olumide Olaoye (my friend from First Republic), Funmibi Marcus Olatunji, Dipo David, Dada Temilola, Ife Omodanisi, Bukola Solanke, Toyin Alabi, Comfort Tamanda Mtoha, Moyin Precious John, Onyinye Akunne, Chris Demola Bode-Aluko, Tephney Gladness Mahomaddy, Roland Missengue, Cecilia Ojemaye and Lela Mukaruzima. I cannot forget the sacrifice of Emmanuel Alechine Ameh, my wonderful friend, which he rendered those days when I could barely do anything for myself. You are an epitome of friendship, a friend indeed, a friend who sticks closer than a brother. Thanks for all your love and care.

I am indebted to some of my friends in Nigeria and diaspora who have supported and encouraged me; Olasunkami Okunola, Oluwale Ojewale, Temitope Laniran and Oluwatobiloba (Tobi) Moody. Thank you, Temitope Laniran and Saheed Bello for the review of one of my chapters. I also appreciate the support and encouragement of the Moodys and the Sangoyomis.

To my family, you have been very supportive all the way. My Parents, Rev. Dr. and Mrs Samuel Adeniyi put their dreams on hold for me to achieve mine. You have sacrificed immensely to provide me the type of education I desire and I am forever grateful. To my siblings, Fisayo and Lamide Adeniyi, Wale and Fisola Bamisile, Morayo Adeniyi and Fiyin Adeniyi, I am grateful for the support, understanding and prayers especially during the trying times of this study when the light at the end of the tunnel seemed far away.

Finally, I appreciate the Almighty God for the gift of life, for grace, strength and empowerment to complete this thesis. Indeed, He has been my light and salvation. He has filled my mouth with songs of thanksgiving. I will forever sing of your mercy that has brought me from valleys of sorrow to rivers of joy.

DEDICATION

To the smallholders the world over for their tenacity. You will win!

To my family for their immense and unwavering support. You rock!

To Almighty God for His love, mercy, grace and salvation. You are my rock!



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ABSTRACT

Nigeria, like many African countries is caught up in the uncertainty of the effectiveness of agricultural intervention in achieving food security, poverty reduction and improved quality of life. This ambiguity is more pronounced especially in rural areas where majority of the poor and those involved in agriculture reside. Indeed, issues relating to resource utilization and productivity in the agricultural sector and how they affect livelihoods and food security of smallholder households remain underexplored. The study examines the contribution of small-scale irrigation agriculture towards ensuring food security and poverty alleviation among smallholder households. It assesses the productivity, food security and livelihoods status of smallholder households in the Middle Rima Valley Irrigation Project, North West Nigeria, the relationship that exist between the phenomena, as well as factors influencing them. It also explores smallholder households' differentials on the basis of their efficiency, food security and income status, and what other factors determine the smallholder typologies.

The research was situated within three bodies of theoretical work; political ecology, political economy of food and agriculture, and sustainable livelihoods. This was done with a view to providing a nuanced understanding of both the micro and macro processes and factors influencing agricultural production, food security and livelihoods of smallholder households. A concurrent triangulation mixed methods research design was adopted for the study. This involves the use of both quantitative and qualitative methods of research to drive the research agenda. Systematic random sampling technique was used to collect data for the quantitative aspect and purposive sampling was used to select participants for semi-structured interviews for the qualitative research. A total of 370 questionnaires were administered but 306 questionnaires were successfully completed and returned, representing an 83% response rate. Also eight respondents were interviewed for the study. While thematic content analysis was used to analyse the qualitative data, quantitative data was analysed using both descriptive and inferential statistics.

Findings revealed that the technical efficiency levels of farmers ranged from 42.1% to 97% with mean efficiency levels of 85.9%. Efficiency differences were significantly explained by years of experience, financial capital and the generation of off-farm income. Using the Household Dietary Diversity Score (HDDS) and Food Consumption Score (FCS) to assess household food security

level, results indicated that at least 45% of the households were food insecure. Multivariate regression used to examine factors associated with food security showed that the phenomenon is influenced by farm size, household income, education, training, farming experience, and livestock ownership.

The study provided evidence of beneficial land management practices among smallholders. It established that livelihoods capitals statistically significantly predicted livelihoods improvement of the smallholder households. However, physical, social, human and natural capitals were capitals that added statistically significantly to the prediction. Evidence also revealed diversified livelihoods strategy among the households, although the importance of migration as a livelihoods diversification strategy was minimal. The study established a significant positive association between efficiency, income and food security status of households. It identified distinct homogenous smallholder groups that exhibit significant differences based on the clustering variables. Furthermore, household characteristics differentials determined variation in the efficiency, food security and income status of smallholder households.

Qualitative findings indicate farm size, input and financial capital as constraints to agricultural productivity and accumulation. Further constraining accumulation are issues relating to the flooding of farms as well as the continuing conflict between cattle herders and farmers and the concomitant crop damage. Evidently, capitalism and the mechanism of the corporate food regime system has left smallholders powerless in the obtainability of essential inputs needed for production and accumulation, while specialization which is prevalent among them has rendered them over-dependent and susceptible to the vagaries of the market. The dialectical relationship between human and nature within the irrigation scheme was far from being symbiotic, with humans exploiting nature in manners that are unsustainable.

Increased focus on improving human, physical and financial capital, market access, agroecology, sustainable intensification as well as the promotion of grazing routes and ranching system are some of the recommendations emanating from the study. The study argues that a re-conceptualisation of the state's role in smallholder agriculture which would include more deliberate and purposeful intervention is needed to alleviate the flaws of the prevailing relations of production and to improve

smallholders' capabilities. It also advocates for a renewed politicization of smallholder agriculture as well as the acknowledgement and adoption of the plurality of approaches to solving the multifarious challenges irrigation smallholders are confronted with, as opposed to a one-size-fits-all approach. Intrinsic to these approaches must be the promotion of equitable, productive and sustainable solutions to the plethora of issues confronting smallholder irrigation agriculture.



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KEYWORDS

Agriculture

Capitalism

Efficiency

Food Security

Irrigation

Livelihoods

Nigeria

Poverty

Productivity

Smallholder



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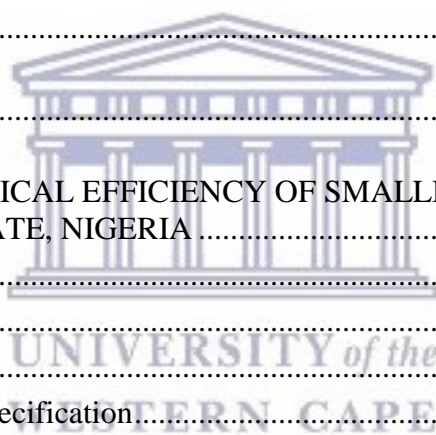


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LIST OF ABBREVIATIONS

ABP	Anchor Borrowers' Programme
ACCOMEX	Agricultural Commodity Exchange Market
ACGSF	Agricultural Credit Guarantee Scheme Fund
ADER	Average Dietary Energy Requirement
ADESA	Average Dietary Energy Supply Adequacy
ADP	Agricultural Development Programmes
AfDB	African Development Bank
AGRA	The Alliance for a Green Revolution in Africa
ATA	Agricultural Transformation Agenda
ATAP	Agricultural Transformation Action Plan
CADP	Commercial Agricultural Development Programme
CAPPA	Community Action Programme for Poverty Alleviation
CBN	Central Bank of Nigeria
CCA	Canonical Correlation Analysis
CFS	Committee on World Food Security
CFSVA	Comprehensive Food Security and Vulnerability Analyses
DAPRS	Developing Agricultural Policy and Regulatory System
DEA	Data Envelopment Analysis
DfID	Department for International Development
DFRRI	Directorate for Food, Roads and Rural Infrastructure
EIA	U.S. Energy Information Administration
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization of the United Nations
FCS	Food Consumption Score
FCS	Food Consumption Score
FMARD	Federal Ministry of Agriculture and Rural Development, Nigeria
FMWR	Federal Ministry of Water Resources, Nigeria
FMWR	Federal Ministry of Water Resources
FPPP	Food Purchasing Power Parity
FSP	Family Support Programme

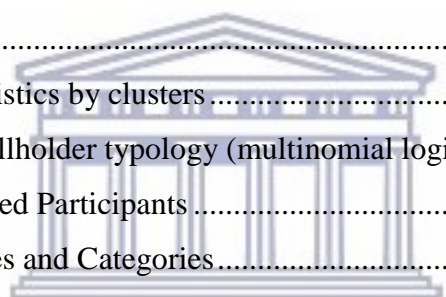
GDP	Gross Domestic Product
GES	Growth Enhancement Support
GHI	Global Hunger Index
HDDS	Household Dietary Diversity Score
HDSS	Household Dietary Diversity Score
HDI	Human Development Index
IAASTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
ICESCR	International Covenant on Economic, Social and Cultural Rights
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IFRC	International Federation of Red Cross and Red Crescent Societies
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ITD	Intertropical Discontinuity
LSU	Total Livestock Units
MARKETS	Maximizing Agricultural Revenue in Key Enterprises
MDGs	Millennium Development Goals
MLE	Maximum Likelihood Estimates
MNCs	Multinational Corporations
MPI	Multidimensional Poverty Index
NACB	Nigerian Agricultural and Co-operative Bank
NAFPP	National Accelerated Food Production Programme
NBS	National Bureau of Statistics, Nigeria
NEEDS	National Economic Empowerment Development Strategy
NFDP	National Fadama Development Project
NGO	Non-Governmental Organisation
NPFS	National Programme for Food Security
OECD	Organisation for Economic Co-operation and Development
OFN	Operation Feed the Nation
PCA	Principal Component Analysis

PIOC	Presidential Initiative on Cassava
PIOR	Presidential Initiative on Rice
PoU	Prevalence of Undernourishment
RAISE	Raising Agricultural Income with Sustainable Environment
RBDA	River Basin Development Authority
SAP	Structural Adjustment Programme
SDGs	Sustainable Development Goals
SDSN	Sustainable Development Solutions Network
SGRSP	Strategic Grain Storage Reserve Programme
SLA	Sustainable Livelihoods Approach
SPF	Stochastic Production Frontier
SPSS	Statistical Package for the Social Sciences
SRRBDA	Sokoto Rima River Basin Development Authority
TE	Technical Efficiency
TRIMING	Transforming Irrigation Management in Nigeria
UNCTAD	United Nations Conference on Trade and Development
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
USAID	United States Agency for International Development
WAERM	Water, Aquaculture and Environment Resource and Management
WBCSD	World Business Council for Sustainable Development
WFP	World Food Programme
WFS	World Food Summit
WUA	Water Users Association

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CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1 Introduction

Agricultural development and its role in socio-economic transformation has been a topic of much debate. The chapter introduces an original research work which focuses on the productivity, poverty and food security status of smallholders involved in an irrigation project in North West Nigeria. The chapter provides a relevant background to the study, thus contextualizing the research. The research problem, research questions, aims and objectives are explicitly set out. Also presented in the chapter are the rationale for the study, the description of the study area, study limitations and the general outline of the thesis

1.2 Background to the Study

Over the years, debates regarding methods or means of resolving the several challenges posed by poverty and food insecurity have constantly taken into account agriculture's role considering its significance to livelihoods and developing nations' economies (Garrity *et al.*, 2010; Agarwal, 2012). Indeed, the mechanism through which agriculture contributes to livelihoods, food security and poverty reduction especially at the macro level has been subject of consistent discourse in literature (see for example, World Bank, 2007; Byerlee, de Janvry and Sadoulet, 2009; Christiaensen, Demery and Kuhl, 2011; Dethier and Effenberger, 2012; FAO, 2012; Thorbecke, 2013). It is posited that agriculture can stimulate economic growth, and in instances where agricultural sector is the main driver of economic growth compared to other sectors, such growth is more effective in reducing poverty especially in developing nations where majority earn their livelihoods from agriculture (Christiaensen, Demery and Kuhl, 2011; Deininger and Byerlee, 2012; FAO, 2012). At the micro level however, studies that have focused on agricultural productivity and its influence on livelihoods and food security are few and far between.

Globally, food security is still receiving attention owing to the number of people that are still food insecure. According to FAO estimates, about 821 million people are undernourished, and one in every nine people in the world has insufficient food needed for well-being as at 2017 (FAO *et al.*,

2018:2). New evidence points to a reversal of trends and milestones achieved over the years as the levels of hunger and food insecurity are on the increase after years of sustained decline (FAO *et al.*, 2017, 2018).

There is also great unevenness in food security trends across regions. For instance, undernourishment and severe food insecurity has been on the increase in all sub-regions of Africa as well as in South America (FAO *et al.*, 2018). The situation in Africa and sub-Saharan Africa however looks direr as 20.4% and 23.2% respectively of the total population are undernourished compared to 10.9 % global estimation (FAO *et al.*, 2018:4). In Nigeria, food insecurity remains a major challenge as the nation still ranks high on the Global Hunger Index with an index score of 25.5, being ranked 84th out of 119 countries and a hunger challenge categorized as serious (IFPRI, Welthungerhilfe and Concern Worldwide, 2017). Further, 11.5% are currently undernourished compared with 6.5% in 2006 (FAO *et al.*, 2018:119).

Poverty and food security are however inextricably linked as both serve as causal factors of the other. While poverty indisputably causes hunger, lack of adequate and proper nutrition has been identified as an underlying cause of poverty (FAO, 2008). In Nigeria, food insecurity's relationship with poverty is made bare in Kuku-Shittu *et al.*'s (2013) analysis which noted that 29% of households in the poorest wealth quintiles in Nigeria have unacceptable diets compared with 15% in the wealthiest. Although the millennium development goals (MDG) target 1c of halving the proportion as percentage of the total population, of undernourished people by 2015 was met, the World Food Summit (WFS) target of halving the number of undernourished people by 2015 was not achieved (FAO, IFAD and WFP, 2013:43).

Agriculture plays a highly significant role in reducing poverty and ensuring food security in nations and regions. As aptly noted by FAO (2013a), investment in agriculture contributes significantly to increased food security, which consequently helps in the promotion of economics of diversification and growth. Indeed, the role agriculture plays in Nigeria's economy cannot be overemphasised. Although most of the foreign exchange earnings for Nigeria come from oil export, agriculture plays a prominent role in Nigeria as reflected in the number of people who earn their living from it. Agriculture remains the most dominant source of employment in Nigeria,

although the rate is gradually declining. The sector employs about 41% of Nigeria's total labour force; a decrease from 51% recorded in 2000 (Ajakaiye *et al.*, 2016:4), provides 75 per cent of non-oil earnings, and contributed 23 per cent of GDP in 2015 (Michael, Tashikalma and Maurice, 2018). Nigeria occupies a total area of 92.4 million hectare, consisting of 91.1 million hectare of land and 1.3 million hectare of water bodies (Adetunji, 2006). The World Bank (2008) estimated that about 75 per cent (68 million hectare) of the total land area has potential for agricultural activities with about 33 million hectares under cultivation. Similarly, of the estimated 3.14 million hectares of irrigable land area, only about 293,000 hectare (9 per cent) is utilised (FAO, 2017a). From the foregoing, it could be said that agriculture in Nigeria has the inherent potential of generating more employment, foreign exchange earnings, and income, thereby reducing poverty in Nigeria. As a result, the Nigerian government has prioritised the development of agriculture in an overall attempt to reduce poverty and hunger (Sanyal and Babu, 2010; Awotide *et al.*, 2012a). The key elements of Nigeria's agricultural policies include commercial agriculture, land reform, irrigation development, market stabilisation and institutional support (Ugwu and Kanu, 2012).

However, the potential of Nigeria's agriculture is yet to be transformed into reality as the nation does not produce enough food to feed its population. The challenge of food insecurity is therefore exemplified by the continued expansion of the food supply-demand gap. Food production growth rate is put at 3.7%, which lags behind food demand growth rate of 6.5% (Kuku-Shittu *et al.*, 2013:4). The resultant effect of this is increased food importation owing to shortages in food supply to meet the nation's demand for food. The foregoing is indicative of the fact that food productivity in Nigeria is problematic. Indeed, Nigeria has become one of the largest food importers in sub-Saharan Africa (Idachaba, 2009), and this portends crisis as any system where food demand is not sufficiently matched by supply is not sustainable.

Owing to irregular rainfall patterns in some parts of Nigeria, investment in irrigation schemes is important in order to boost agricultural production which is critical to the nation's overall attempt to achieve food security and poverty reduction. In Northern Nigeria where a significant proportion of the vulnerable and food insecure are found (Kuku-Shittu *et al.*, 2013), a major constraint to increased agricultural production is inadequacy of rainfall which has resulted in large areas of land being left uncultivated. The foregoing is not unconnected with the impact of climate change on

food production as the declining food production in some parts of Africa has been linked to the effect of climate change. It is commonly agreed that countries in tropical and subtropical regions will suffer agricultural losses through climate change while the reverse will be the case in countries in temperate and polar regions (Devereux and Edwards, 2004). Many areas of the country are vulnerable to disaster either from drought, most frequently experienced in the North, or from flooding experienced along the major rivers and in the delta region (Kuku-Shittu *et al.*, 2013). Consequently, irrigation facilities are rapidly expanding in Northern Nigeria in a bid to bring more land under cultivation (Jamala, Shehu and Garba, 2011).

Smallholders however constitute majority of beneficiaries of the several irrigation schemes in the nation and their productivity and contributions towards food security remain contested. The study aims at undertaking an analysis of the productivity and sustainability of irrigation agriculture among smallholder farmers in Middle Rima Valley Irrigation Project, Sokoto State, North West Nigeria, with a view to ascertaining its contribution to food security and poverty reduction.

1.3 Research Problem

Problems relating to food insecurity, malnutrition and poverty are development challenges that continue to confront decision makers (Broca, 2002; UNDESA, 2009; Pauw and Thurlow, 2011; Otsuka, 2013). Tackling these issues through the formulation of effective policies undoubtedly require a thorough analysis based on sound data (Babu, Gajanan and Sanyal, 2014). Although the analysis of food security and interventions against food insecurity has gained much ground over the years, Clover (2003) asserts that actions to deal with food security issues have failed to make the desired impact owing to faulty analysis and consequently, faulty actions. Lang and Barling (2012) argue that there is presently a lack of a thorough grasp of what needed to change before food systems are sustainable.

Further to this, arguments about the efficiency and superiority of small scale farming over large scale farming still persist in literature. Although the achievements of smallholder farmers in the Asian green revolution and some other instances indicate that smallholders can be critical to poverty reduction and food security, certain scholars (such as Collier and Dercon, 2014) have argued against the adoption of small scale farming, viewing it as unable to significantly boost agricultural production and instead advocated for a renewed focus on large scale farming. The

empirical record of performance of small and large farms in Africa, according to Wiggins (2009), has been uneven, incomplete and nebulous such that there is no consensus over which farming scale is better. Wiggins (2009) further posits that variations in the performance of smallholder agriculture in Africa persist not only across regions but also within countries.

Despite the foregoing shortcomings, the interplay between smallholders, irrigation agriculture and food security has been studied at different levels in Nigeria. There is also presently no clarity of argument on the role of smallholders in food security and poverty reduction (see for instance, Yahaya, 2002; Ojo and Adebayo, 2012; Oyelade and Anwanane, 2013; Isma'il *et al.*, 2014). Kuku-Shittu *et al.* (2013) conducted a detailed food security and vulnerability assessment in Nigeria and established that the poorest livelihoods are found in agriculture, and that most households in all regions and at all levels purchase food, but rural and poorer households also rely heavily on own food production. Highlighting the important role agriculture plays in combating poverty and food security, Oyelade and Anwanane (2013) noted that the low level of agricultural mechanization, especially among smallholder farmers, has contributed immensely to food insecurity in Nigeria.

In his analysis of the role water can play in delivering significant increases in agricultural production which is needed to ensure food security in sub-Saharan Africa, Gowing (2003) points out that the integrated analysis of land-use and water resources issues is imperative for achieving food security. Isma'il *et al.* (2014) considered the impact of Galma Irrigation Scheme on the farming community in Dakaci, Zaria Area of Nigeria and found that the irrigation scheme significantly boosted crop yields and agricultural production in the area, thus improving the socio-economic status of the smallholder farmers in the area. Yahaya (2002) examined the Bakolori Irrigation Project in Sokoto State, Nigeria and its impact on the intended beneficiaries of the project. He found that the project impacted positively on the lives of the beneficiaries, although there were still challenges relating to project planning and implementation. Ojo and Adebayo (2012) in their assessment of food security in Nigeria, however observed that the nation's agriculture is still predominantly rain-fed and the country has not taken full advantage of its irrigation potential.

The foregoing literature serves as an indication that there is no consensus on the performance of smallholder agriculture in Nigeria. Furthermore, there is presently a dearth of research focusing on irrigation agriculture productivity and its intersections with food security, livelihoods and sustainability in Nigeria. As noted by Carruthers, Rosegrant and Seckler (1997), research to improve the understanding of the links between water scarcity, food production, food security and environmental sustainability is imperative as irrigation and water development strategies have been hampered by a lack of understanding of the aforementioned.

Furthermore, despite studies on food security at the household level in Nigeria, Akerele *et al.* (2013) advocated for more in-depth assessment of household food security to inform policy and programme decisions. However, this would seem rather incomplete without due consideration of the income and/or poverty status as well as economic activities of households. It is indeed expedient to lay emphasis on a holistic approach that enhances the productive and economic capacities of smallholders; towards ways of collectively improving their productivity, income and food security status. The foregoing would thus require an examination of the interplay between agricultural production, food security and poverty which seems presently lacking in literature.

It is these gaps in research that this study intends to fill by critically analysing irrigation agriculture productivity and sustainability to achieve food security and poverty reduction among smallholder farmers in North West Nigeria. The research seeks to clarify the relationship between smallholder irrigation agriculture, poverty and food security. The main focus is on the question of whether irrigation agriculture reduces food insecurity and poverty among smallholder farmers and what structures and/or factors enable or constrain smallholders' agricultural productivity in the Middle Rima Valley Irrigation Project, Sokoto State, North West Nigeria.

1.4 Research Questions, Aim and Objectives

In the context of the research problem identified above, the main purpose of the research would be to provide an answer to the following general research question:

- What is the role of irrigation agriculture in ensuring food security and the reduction of poverty among smallholders in North West Nigeria?

The specific questions relating to this case study include:

- To what extent are smallholders efficient in agricultural production?
- What factors and livelihood strategies enable or constrain smallholder irrigation agriculture productivity?
- To what extent are smallholders in the irrigation project food secured?
- How does nature shape, and is shaped by smallholder irrigation agriculture?
- What forces and/or processes (both micro and macro) shape local production, accumulation and livelihoods strategies of smallholders in the irrigation project?
- What relationship exists between smallholder productivity, food security and poverty in North West Nigeria, and are smallholders differentiated based on their efficiency, income and food security status?

The questions were critically addressed and answers to them sought using the mixed-methods design. In other words, both quantitative and qualitative research methodology were employed in providing answers to the questions.

1.5 Aim of the Research

The aim of the research is to ascertain the productivity, food security and livelihoods status of smallholder households in North West Nigeria, the relationship that exist between the phenomena, as well as factors influencing them, with a view to providing policy implications for sustainable irrigation strategies to reduce food insecurity and poverty.

1.6 Objectives of the Research

The objectives of the study are:

1. To estimate the efficiency and productivity of smallholders in irrigation agriculture and examine factors influencing them in the study area.
2. To assess the food security status of smallholders and its determinants in the irrigation project.
3. To examine the livelihoods profiles and strategies of smallholder households in the irrigation project.

4. To assess the relationship between efficiency, food security and income in the study area.
5. To examine smallholder households' differentials on the basis of their efficiency, food security and income status.
6. To examine the constraints and enablers of agricultural production and accumulation among irrigation smallholders.
7. To contribute in developing a more sustainable irrigation agricultural system for food security and poverty reduction.

1.7 Justification for the Study

It cannot be overstated that we live in a highly unequal world in terms of wealth and food security. There is a great disparity in terms of food security across regions and nations owing to a number of factors such as availability of resources, climate, policies to mention but a few. In Nigeria, there is a huge gap between urban and rural households in terms of access to resources, living standards, and food security status which can be largely attributed to the fact that most households in rural areas are smallholder agricultural households, with low productivity (Kuku-Shittu *et al.*, 2013). This is further compounded by the dearth of infrastructures including irrigation facilities to boost agricultural productivity. However, there exist great potentials for smallholder farmers in Africa as IAASTD (2008) observes that small-scale farming is important for landcare and smallholder productivity can be high given the right environment and incentives.

In their assessment of the impact of climate change on global food supplies, Devereux and Edwards (2004) asked whether national governments are making the necessary investments in irrigation and pro-poor agricultural technologies. It is thus apposite to also clarify the results of the irrigation projects and policies governments are implementing, and most importantly the sustainability of such irrigation projects. As Lang and Barling (2012) put it, the food system that is sustainable is that which is secure, and the path to food security lies in addressing sustainability. It is thus imperative to analyze the productivity of smallholders, their contribution to food security and poverty reduction as well as the sustainability of the Middle Rima Valley Irrigation Project in North West Nigeria in the hope that information from the study will be helpful for policy designers and analysts, agricultural project and programme managers as well as governments in understanding the potentials and challenges of irrigation agriculture in Nigeria.

1.8 The Study Area

The Middle Rima Valley Irrigation Project is operated by the Sokoto Rima River Basin Development Authority (SRRBDA), and was established to provide irrigation facilities for all year round farming activities on an area covering about 5,360 hectares. Located between latitudes 13°25'N - 13°33'N and longitudes 5°39'E - 5°50'E, the project falls within Goronyo and Gada Local Government Areas of Sokoto State. The project area is on the banks of River Rima between the towns of Keta and Goronyo on the left bank and Gidan Alwali and Tuluske on the right bank.

The Goronyo Dam, which is built across River Rima, is the key structure for the water resources and agricultural development of the Middle Rima Valley. The dam is situated near Keta Village, about 25km East of Goronyo Town and 90km North East of Sokoto City. The dam is a multi-purpose storage dam and has 942 million cubic metres water storage capacity for irrigation and development of downstream areas from Goronyo to Argungu. The project comprises three earth fill dams (main, secondary and saddle dyke) of total length of 12km, a concrete intake and outlet structure including spillway of 1,540 cubic metre capacity as well as other infrastructures. The work for the development of the irrigation area however started in 1999 and was divided into phases. The first phase was completed in 2006 and the contract for the second phase was awarded in 2007. Presently, out of the proposed irrigation development area of about 5,000 hectares, 2,726 hectares have been completed with farmers cultivating the irrigated areas.

Sokoto State is located within the Sahel Savannah characterised by short grasses. The state's climate is categorised into dry and wet seasons. The wet season starts between April and June and last till October while the dry season lasts from November to April. Extreme heat is normally experienced between February and April, with temperature often exceeding 45°C. The annual average temperature is about 28°C but maximum daily temperature could reach 40°C. Precipitation is usually erratic, unreliable and often accompanied by periodic drought (Yahaya, 2002; Eniolorunda, Mashi and Nsofor, 2017).

As farming is the major preoccupation of the people in the study area, irrigation activities becomes necessary owing to the climatic condition of Sokoto State. Smallholders constitute majority of farmers in the study area and they are organised in farmer families with access to irrigated land.

Some farmers are leasers of government land, while most are land owners. Crops cultivated in commercial quantities within the scheme include millet, rice, sorghum, maize. Others include onions, beans, groundnut, potatoes and leafy vegetables.

1.9 Limitations of the Thesis

The thesis is able to offer some explanations to some of the dynamics of production in smallholder agriculture, as well as the underlying factors and processes affecting food security and livelihoods of smallholder households. Nevertheless, there are some limitations to the research.

The use of a case study limited the research, particularly the qualitative aspects, to a defined geographical area. Also the thesis did not critically and holistically examine the structure and dynamics of the Nigerian food and agriculture market. As the data is not a time series data, it thus precludes the examination of how changes in the rural production process over the years has affected livelihoods of farmers. Further, the subjective measure of well-being based on smallholders' perception is adapted as the thesis is unable to objectively measure poverty. The thesis is also not able to interrogate critically the gendered dimensions of irrigation agriculture, that is, why irrigation agriculture was predominantly male gendered in the study area.

1.10 Structure of Thesis

The thesis is organised into eleven chapters (see figure 1.1 for thesis structure showing the sequential relationship between chapters). **Chapter One**, which is the introductory chapter, presents the research problem, rationale for the research, research question as well as the aim and objectives of the study.

Chapter Two provides a comprehensive review of literature on food security and related concepts. It explores the dimensions of and current thinking on food security as well as food security measurement. The chapter also critically explores the debate between small and large scale farms, while it also considers irrigation technology development and its importance. **Chapter Three** contextualises the study. It traces the history and trend of agricultural intervention in Nigeria from 1960 till date, and examines the role of agriculture in Nigeria's economy, particularly poverty reduction and food security. The chapter also examines irrigation agriculture development in Nigeria.

Chapter Four presents the theoretical frameworks used for the research. The research was situated within three theoretical notions. These are the political economy of food and agriculture, political ecology as well as sustainable livelihoods. The chapter provides the diverse perspectives of the theories which helps to understand, analyse and interpret the research findings.

Chapter Five provides the discussion of the research philosophy, research design and methodology. It presents a detailed elucidation of the research process, methods and assumptions used for the study. It also provides an ethics statement necessary for the conduct of the research.

Chapters Six, Seven and Eight and Nine focuses on the empirical research, with the presentation and discussion of findings emanating from the quantitative methods. These chapter explain the findings in relation to the theoretical and conceptual frameworks adopted for the study.

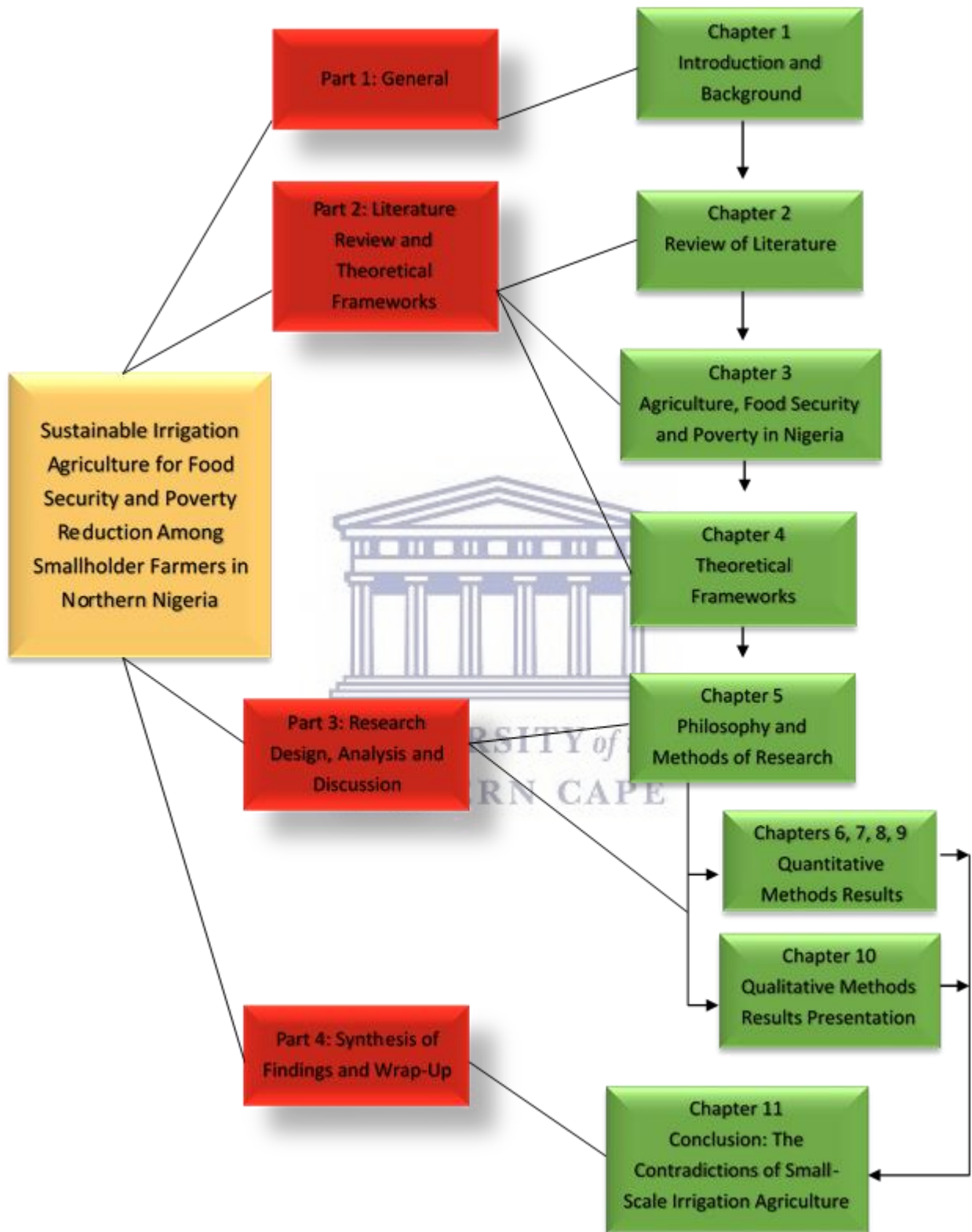
Chapter Ten presents the findings emanating from the qualitative research methods. It provides a detailed analysis of the enablers of, and constraints to agricultural productivity as experienced by the smallholders. It presents the analysis and discussion of the structured interviews conducted with smallholders and staff of the irrigation agency saddled with the project.

Chapter Eleven presents a detailed discussion of findings and explores the re-thinking of the sustainability of irrigation agriculture with a view to achieving increased productivity, food security and poverty reduction. It also provides research and policy implications relevant for the study, as well as an appropriate conclusion for the thesis.

1.11 Chapter Summary

The chapter has provided an overview of what the research seeks to accomplish. It introduces and contextualises the research by providing relevant background to the research. The research problem, research questions, aims and objectives were also explicitly clarified. Furthermore, rationale and limitations for the study were expounded and the study area adequately described. The chapter was concluded with an outline and description of the subsequent chapters of the thesis.

Figure 1.1: Thesis structure showing sequential relationship between the chapters.



Source: Own compilation

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides an exploratory discussion of the diverse relevant concepts utilized in the research. The chapter conceptualizes food security, poverty, smallholder and agricultural production. It provides an explanation of the relationship between agricultural production, food and livelihood security. The chapter examines the potential of agriculture for economic growth and development. The ongoing debate as to which farm scale between large scale and small scale farms should be the preferred scale to achieve poverty reduction and food security was also examined. The chapter also looks at the significance of irrigation technology in agriculture.

2.2 The Concept of Food Security

The term food security is constantly evolving and this has influenced the several attempts at refining and modifying its definition and conceptualization. This is a reflection of efforts by scholars, policy makers and practitioners to engage better with, and deepen the understanding of the complexities of concept. Presently, what constitutes food security and how it can be improved remain contested and diversified. This owed so much to the interdisciplinary, multidisciplinary and multi-sectoral nature of the concept, with many institutions and academic disciplines taking part in the conversation and contributing to the debate (Pottier, 1999; Jones *et al.*, 2013; Candel, 2014). As a result, food security has over the years become a slippery concept, without an all-encompassing view of what it constitutes to lay hold of in literature.

In many instances, there have been a construction and reconstruction of the meanings of food security as people become more aware of the intricacies of the concept. These understandings have helped to put food security at the front burner of national and international policy discourse and intervention (Clay, 2002; Godfray *et al.*, 2010; Hinrichs, 2013). Indeed, achieving global food security and eliminating hunger is a critical and persisting challenge the world faces today (McMichael and Schneider, 2011; Agarwal, 2012; Akerele *et al.*, 2013; Cistulli *et al.*, 2014). Notwithstanding substantial progress in recent years, eradicating global food insecurity has

become a Gordian knot which has defied solutions. In 2015, about 795 million people, representing one in nine, were undernourished in the world (FAO, IFAD and WFP, 2015). The report further indicates that 98% of the total number of undernourished live in developing countries, with uneven progress recorded across regions and countries. In 2017, this has increased to a staggering 821 million people, indicative that one of every nine people in the world is food insecure (FAO *et al.*, 2018).

By 2050, the world population is projected to reach 9 billion, which would lead to a consequent increase in food demand by more than 50% (Godfray *et al.*, 2010; Tomlinson, 2013; Cistulli *et al.*, 2014). This increased demand is expected to come largely from developing countries where majority of the poor and food insecure live and where population increase will be more significantly pronounced. The adverse effect of food insecurity to human and economic development particularly in developing countries is also reflected in the way it affects the nutrition and health status of undernourished people, thus impacting negatively on their productive capabilities. Further complicating the problem are the interconnected processes of economic, social and environmental change (Hinrichs, 2013; Candel, 2014), evident in the competing demand for food crops between food and biofuels, climate change and its predicted impact on food production, inadequate investment in agriculture as well as continuous increase in food prices (Agarwal, 2012; Hinrichs, 2013). The most recent global food crisis, for instance, is not unconnected with the rise in food prices and in food price volatility that started in 2008 (Kavallari, Fellmann and Gay, 2014; Godfray and Robinson, 2015).

Issues such as the foregoing have led to the continuous shift in thinking about food security. Since the 1970s however, three major shifts have been conspicuous. First is the shift in the unit of analysis from the global/national to the local/household level and finally to the individual level. Second, there has been a shift from a sole focus on food to a broader context which incorporates the dynamics and sustainability of household livelihoods. Third is the integration of subjective perceptions to food security analysis to complement the often adopted objective measures (Mechlem, 2004; Baro and Deubel, 2006).

One of the earliest conceptualisations of food security dates back to the 1943 founding conference of the FAO, where the term was framed as freedom from want of food (Carolan, 2012a), and basically correlates it with the achievement of food self-sufficiency, particularly at the national and international level. This interpretation prevailed up until the 1970s, and even included the equation of the concept with safeguarding world food supply, thus serving as a response to the increasing threat of global food scarcity. The rationale was that hunger is the direct consequence of food shortage which could be tackled through productivity gains in agriculture and better distribution (DfID, 2004; Carolan, 2012a; Hendriks, 2015). Food security was defined at the 1974 World Food Conference as, “availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices” (United Nations, 1975).

Evidently, the focus in the 1970s was on increased availability and stability in the volumes of world food supplies to get to the bottom of the 1974 world food crisis and offset growing demand. The escalating demand, as Mechlem (2004) points out, was sparked by population growth and the intensity of drought that affected crop yields especially grains in many countries, thus leading to huge demands on international grain markets and an upsurge in global food prices. From this period it seems the scrimmage between food and prices which would later play a massive role in rekindling interest in food security issues was cast in stone. Despite improvements in global and national food supplies through increased investment in agriculture, better distribution and food aid shipment interventions to food distressed countries, the problem of food insecurity persisted (Hendriks, 2015).

Amartya Sen’s seminal work on hunger and entitlements in the early 1980s however heralded a new way of thinking about food security, embracing the demand side of food. A pivotal argument in his thesis is that the prevailing notion of food availability is not sufficient to guarantee access to food. People are food insecure not mainly because of inadequate food supply, but primarily because they suffer from access constraint. Given periods of excess food supply with a concomitant reduction in wage labour demand and rising food prices, the poor whose primary asset is their labour and who spend a significant proportion of their income on food may find their access to food encumbered (Jones *et al.*, 2013). A key determinant of access is thus food affordability

which is greatly contingent on prices of food and disposable income that can be expended on food (Capone *et al.*, 2014).

For Maxwell (1996), a major contribution of Sen to food security can be summed up in his extrapolation of the access question to mean food entitlements, highlighting its relevance in his analysis of famine conditions. Sen laid emphasis on the entitlements of individuals and households in what was referred to as the ‘failures of entitlements’, a term which relates to the inability of individuals to access basic needs as a result of poverty. Consequently, demand failure rather than supply failure became accentuated, with an attendant focus on poverty and famine (Pottier, 1999).

The notion of entitlement systems is described as “beliefs, created in political practice, about who ought to get what under what circumstances, and the embodiment of those beliefs in legal and economic processes, e.g land tenure rules, notions of family obligations, wage rates, rules of market transactions, etc” (Richards 1983:46, quoted in Pottier, 1999:143). Entitlements are an array of commodity bundles that individuals can command in society utilizing the sum of the rights and opportunities they possess (Sen, 1981). Food entitlements thus refer to the totality of the possible methods through which food access is facilitated (Mkwambisi, Fraser and Dougill, 2011).

Food entitlements can be categorized into four types. First, there is direct or production-based entitlement which takes place when households consume the food they directly produce from their farm plot. Second is labour-based entitlement which occurs when wages earned from labour is spent on household food consumption. Third is trade-based entitlement which is obtainable through sale or exchange of assets for food. Finally, there is transfer-based entitlement which can be obtained through transfers including food aid (Devereux, 2007; Mkwambisi, Fraser and Dougill, 2011). Invariably, people become food insecure when the totality of the food that is acquired through production, labour, trade and transfers is insufficient to meet their minimum requirements for healthy living (Devereux, 2015).

The definition of food security was thus refined to reflect the notion of entitlements. Food security was taken to mean a situation where “all people at all times have both physical and economic access to the basic food that they need” (FAO, 1983). This definition begs an interrogation of need

for what. Indeed food needs vary across regions and culture and are often influenced by knowledge. The silence about what constitutes basic food needs and what the needs are meant for is a major flaw of the definition. The World Bank in 1986 however, defined food security as “access by all people at all times to enough food for an active, healthy life” (World Bank, 1986:1). Intrinsic in the definition is the emphasis on individual access and what the food need is meant to achieve; not merely survival but a healthy and active life (Maxwell, 1996).

By mid-1990s, there was an increasing demand for a positional shift in the way food security was conceptualised given persistent inequality in global food security, particularly typified in the discrepancies evident in national and household distribution and access to food. This is despite the numerous policy and programme interventions that followed the major definitions of food security in the 1980s. During this period, focus had shifted from household access to individual access, as well as from caloric adequacy to overall diet quality reflecting the renewed focus on micronutrient deficiencies (Jones *et al.*, 2013). The consensus was that than hitherto acknowledged, complexities exist in terms of the relationship between food access and nutrition. Additionally, previous definitions failed to consider issues relating to dietary (im)balance and food preferences. It is indeed possible for individuals to have access to food at all times and the food being consumed would fail to provide sufficient nutrition for healthy living.

Consequently, a new definition was agreed upon at the World Food Summit in 1996, which was further ratified by the Committee on World Food Security (CFS) and presently remains the most widely used and accepted definition of food security. Food security is defined as a situation “when 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, 1996:3). The definition does not only address food safety and dietary balance but also acknowledges the importance of social and cultural factors in determining people’s food choices (Clay, 2002; Mechlem, 2004; Pinstруп-Andersen, 2009; Jones *et al.*, 2013). The consideration of food preferences suggests that local perspectives and realities as well as the understandings of the food insecure must be respected and taken into cognizance (Pottier, 1999). Further, food security as presently construed is not necessarily a goal in itself but a medium through which active and healthy living is ensured (Clay, 2002; Mechlem, 2004). It provides a useful tool for the design,

implementation and evaluation of development programmes and policies (Pinstrup-Andersen, 2009; Hendriks, 2015).

The relevance and application of the nutrition dimension to food insecurity has likewise grown over the years such that the term nutrition security and food security are often used interchangeably. Undernutrition and undernourishment are terms often used in nutrition parlance. While the latter refers to a state where the caloric intake is constantly insufficient to meet the minimum dietary energy requirements, the former is the resultant effect of undernourishment, poor absorption and/or poor biological use of nutrients consumed (FAO, IFAD and WFP., 2015:53).

Focus in nutrition discourse over time had shifted from protein deficiencies to calorific intake, and thereafter to micronutrient deficiencies (DfID, 2004). Nutritionists have emphasised that food intake and nutritional well-being are contributory factors of each other; hence malnutrition provokes vulnerability to disease while disease also gives rise to worsening nutritional status (Mechlem, 2004). Consequently, nutrition-based interventions have focused on food-based programmes and boosting of micronutrients availability through fortification, biofortification and supplementation (Hendriks, 2015).

2.2.1 Food Security and Livelihoods

Food security has not only been associated with livelihood security, but has been averred to be better understood as components of the latter (Maxwell, 1996; Pottier, 1999; Stevens, Devereux and Kennan, 2003; DfID, 2004). Being food insecure reflects a deeper and broader issue of livelihood security, thus advancing the need for a comprehensive focus on the long-term productivity and viability of households (Maxwell, 1996). Food security is enhanced through income generation which depends on the livelihood capitals that individuals possess. As Baro and Deubel (2006) point out, household's level of vulnerability to income shortage and food insecurity is determined by its risk to livelihood failure. The vulnerability of individuals and households, their resilience and coping strategies, all components of livelihood security, are thus important in determining food security status.

2.2.2 Food Security and Poverty

Poverty and food security are inextricably linked and each serve as causal factors of the other. On the one hand, lack of adequate and proper nutrition inevitably perpetuates poverty as people's ability to work and lead prosperous lives is negatively altered. Poverty, on the other hand, largely results in food insecurity as households lack the income, assets and entitlements required to purchase the food they need for healthy living. Food insecurity is not just an issue of inadequate food supplies but more related to poverty which plays a critical role in determining access to available food (Tschardt *et al.*, 2012; FAO, IFAD and WFP, 2013; Cistulli *et al.*, 2014). Essentially, lack of food represents a severe form of absolute poverty when poverty is construed as the absence of basic human needs (Ojo and Adebayo, 2012).

Globally, FAO, IFAD and WFP (2013) observe a strong relationship between high poverty levels and high prevalence of undernourishment, as well as between high levels of extreme poverty and low food utilization levels in some countries. The association between poverty and food insecurity, according to Devereux (2015), is however more pronounced in farming households and communities in rural areas where there is higher likelihood of a strong correlation between income and crop production. Further complicating this, especially for smallholders, is the rising costs of modern agriculture, lack of asset and limited integration into market (Pottier, 1999).

Food availability at the national or household level does not inevitably guarantee individual access to food. For instance, intra-household allocation of food may not be directly proportional to the needs of individual members which may render food secure and food insecure members of the same household to exist simultaneously (Pinstrup-Andersen, 2009). Individual food access within a household is often connected to control over household resources and income, with women and children on the receiving end of the inequitable distribution (Mechlem, 2004). The notion advanced by Pinstrup-Andersen (2009) that household food security may not translate to food security for all its members as ability to purchase enough food may not be converted into actual food acquisition may be undisputed after all because such households should not be considered food secured in the first place. If the ability or wherewithal to purchase food is high, but not matched with a desire or willingness to purchase food, such household is food insecure as the food needed for active and healthy living is basically not acquired. It is however plausible, as Pinstrup-

Andersen (2009) points out, that household may prioritize the acquisition of other goods and services, over the acquisition of required food. This is indicative that in some climes, household behavior and not necessarily lack of income and poverty may be a major determinant of food insecurity.

There is a dimension of time to food insecurity as it could either be transitory or chronic in nature. While the former is transient, emanating from temporary loss of the ability to purchase food or momentary shortfall on food supply, the latter is more permanent, incessant and nearly intractable. Jones *et al.* (2013) argue that both conditions are interconnected and may be experienced by a household at different times. Household responds to continuous exposure to temporary, less severe shocks by engaging in coping strategies such as sale of assets or seeking unstable employment. A failure of these coping strategies or depletion of them may then result in a condition of chronic food insecurity (Jones *et al.*, 2013).

2.2.3 Food Security and Market

Indeed, the role market plays in food security discourse cannot be overstated. There has been an enduring view of market as the mechanism through which efficient allocation of resources is ensured. Given that food is also a resource, the interplay among the functionings of these markets and the forces that shape them, their effects on food security as well as how humans respond to them have long been under scrutiny. Generally, two types of market exists; international markets which encompasses imports and exports between and among nations and local markets, characterized by the exchange of goods and services within the geographical boundaries of a nation.

Local power structures which are products of the negotiation and relationship between and among producers (farmers) and marketers (traders) shape terms of trade and trade channels (Pottier, 1999). Because of the changing nature of the negotiations and relationships, Pottier (1999) concludes that it would be imprecise firstly to refer to the market as a single, unified exchange environment, and secondly to assume that farmers have free access to resources and market. Local markets especially prices for local produce are affected by seasonal variations, thus having an effect on poor households who are often left with no option than to market their crops at the lowest price in order

to meet other pressing needs (Stevens, Devereux and Kennan, 2003; DfID, 2004). Compounding this further is the perishable nature of some goods and lack of storage facilities which go a long way in forcing the hands of these households to lower their prices.

In what Carolan (2012a:178) referred to as the “neo-liberalization of food security”, emphasis have been placed, since the 1970s, on integrating agricultural commodities into international markets, thus alluding to the rationale that countries should exploit their comparative advantage (McMichael and Schneider, 2011; Carolan, 2012a). Following this logic, the idea was not for a nation to become self-sufficient in food production as it were, but to be productive in what such nation is good at and to trade. As such, attention was diverted to policies to promote the latter at the expense of the former, with export being given priority (McMichael and Schneider, 2011; Carolan, 2012a).

The foregoing has had overarching implications for food security. Many developing countries became the dumping sites of cheap food imports from developed nations who extensively subsidize their agricultural sectors. As a result of exposure to this unfair competition, there have been loss of jobs, income and entitlements for people involved in agriculture in developing nations especially smallholders (Carolan, 2012a). As many nations who hitherto were food sufficient became food dependent, food insecurity worsened for numerous households because of the inability to access available food supplies.

Furthermore, reliance on international markets consistently renders nations susceptible to international price volatility, and this has played out over the years, with dire consequences observed for nations that rely heavily on food imports. As Minot (2014) notes, food price instability is a major source of risk in developing countries, especially for poor African households. In another vein, the growing competition between direct consumers of food crops and indirect consumers such as those that use food crops for feeds and biofuels have added another dimension to market's role in food security (McMichael and Schneider, 2011). Since market is believed to be the efficient allocator of resources, then the winner among the competitors is the one that can bid the highest in the midst of rising prices. In such circumstances, the poor and vulnerable is usually at the losing end, thus rendering them more food insecure. It is for these reasons that many have

argued that trade liberalization may be a nostrum after all, as the main beneficiaries are often the large-scale commercial producers and traders at the expense of smallholders who are confronted with access to inputs and markets constraints (Stevens, Devereux and Kennan, 2003). The corollary of this is that hunger and food scarcity has become an obvious outcome of market processes.

2.3 Multidimensionality of Food Security

Food security is multidimensional as issues involved in its understandings, operationalization and analysis are multifarious. The intricately interconnected technical, social, economic, political and environmental dimensions of the issue lend credence to the multidimensionality of the concept and these are increasingly being given attention. Food security is also inextricably linked with other global development issues such as poverty, energy, environment, climate change among others (Candel, 2014). Owing to the multi-disciplinary and multi-sectoral nature of food security, numerous terms have been used in the explanation of, and reflections on the concept. The plurality of understandings of food security is a manifestation of the diverse backgrounds and orientations of those engaging with the phenomenon (Hendriks, 2015).

The consequence of this multidimensionality is that food security has become an intrinsically ambivalent concept. The multiplicity has become both a blessing and a curse, and as Hendriks (2015) aptly notes, the outcome is a nuanced comprehension of the concept but which has also muddled the waters. The merit lies in the fact that there no longer exist any “meta-narratives”, any all-encompassing notion or model appropriate for all situations for food security, and there is of course, several beneficial ideas to borrow from diverse fields (Maxwell, 1996). On the other hand, diverse and contested views often detracts from the problem, thus stalling responses and efforts to address the issue (Hendriks, 2015).

Following FAO's (1996) definition of food security, four dimensions of the concept have emerged and are widely alluded to in literature. The consensus view is that food security encompasses four dimensions; availability, access, utilization and stability. Food availability does not only relate to the quantity, but also the quality and diversity of food (FAO, IFAD and WFP, 2014). While it addresses the supply side of food security either through local production or import, it is generally held that food availability at the national or international level does not automatically translate to

household level food security. Food access thus deals with individual access to adequate resources needed to guarantee appropriate foods for a nutritious diet. It is the ability of individuals and households to procure food in the market place or from other sources (Kuku-Shittu *et al.*, 2013). There are two dimensions to food access; economic and physical dimensions. Whereas economic access represents the ability to pay for food and determined by factors such as disposable income, the prices of food as well as access to social support, physical access refers to the quality and availability of infrastructure which is needed to make food accessible (FAO, IFAD and WFP, 2013).

Hendriks (2015) asserts that it would be thoroughly inadequate to examine food insecurity only from the viewpoint of availability or access to food without taking into consideration how food is used. Food utilization thus addresses the nutrient requirements needed for well-being, which FAO (2008) puts succinctly as the way the body makes the most of various nutrients in the food. In other words, it refers to the appropriate usage of food and includes processing, storage, consumption and digestion (Kuku-Shittu *et al.*, 2013). Food utilization is also captured in two dimensions. The first represents a variety of input indicators which determines how available food is being effectively utilized and these include among others, food quality and preparations as well as health and hygiene conditions, while the other is captured by a number of outcome indicators of food utilization, also referred to as the anthropometric indicators used in measuring undernutrition, which comprises wasting, stunting and underweight (FAO, IFAD and WFP, 2013). Food utilization further stresses the importance of non-food inputs in food security including clean water, sanitation and health (Carletto, Zezza and Banerjee, 2013; Reddy *et al.*, 2016).

Food stability deals with the stability of the other three dimensions at all times, as against the temporal or seasonal access to, as well as availability and utilization of food. It is, in essence, the ability to regularly obtain food over time (Qureshi, Dixon and Wood, 2015). There exist several drivers of each of the first three dimensions of food security. Whereas food availability is determined by production, distribution and exchange, accessibility is driven by affordability, allocation and preferences, while nutritional value, social value and food safety are all drivers of food utilization (Capone *et al.*, 2014). Furthermore, a hierarchical structure is clearly established across the dimensions; availability is crucial but insufficient to guarantee access, access is

necessary but not sufficient for appropriate food utilization, while stability of all these three dimensions ultimately dictates the attainment of food security (Carletto, Zezza and Banerjee, 2013; Hendriks, 2015).

Progress in terms of food availability and productivity at the global level has steadily been on the increase, albeit uneven across nations and regions. For instance, it is estimated that overtime, gains in labour productivity as well as average value added per worker in agriculture is at its lowest in sub-Saharan Africa with the latter amounting to \$1,199 in 2013 as against \$15,300 and \$6,000 obtained for Eastern Asia and Latin America respectively (FAO, WFP and IFAD, 2015:31-32). Food availability per person has also been on the increase owing to increased food supplies which is growing at a much faster rate than population growth in developing countries. Evidence suggests that the prevalence rates for stunting and underweight in children under five years of age have declined in all developing regions since 1990, and this is a resultant effect of enhanced access and availability of food (FAO, IFAD and WFP, 2013).

Long term progress in terms of food stability may be hindered by exposure to short-term risks. According to the FAO, IFAD and WFP (2013), the suites of indicators available to measure the extent and exposure to risk generally consider issues such as the area equipped for irrigation which offers an idea of how efficacious the response to climatic shocks would be, and the share of food imports in total merchandise exports. Other indicators capture risks or shocks which directly affect food security and this include fluctuations in food and input prices, production and supply as well as political instability. Price is central in ensuring stability and the recent fluctuations in global input and output prices had an adverse effect on smallholders who had low capacity to react positively to the oscillation, thus making them more risk-averse and eventually reducing their overall productivity (FAO, IFAD and WFP, 2013). The world has indeed witnessed variations in food supplies since the 1990 and this is markedly pronounced in Africa, Latin America and Caribbean as these regions experienced the widest variability in food production per capita (FAO, IFAD and WFP, 2013).

2.4 Food Security and Right to Food

There has been a paradigm shift in thinking on food security in literature with emphasis being laid on food security as a fundamental human right. Indeed, international human rights law has reiterated in a variety of human right instruments, the right to adequate food and freedom from hunger. Right to food was initially entrenched as a fundamental human right by the Universal Declaration of Human Rights of the United Nations (Article 25), noting that everyone has a right to standard of living adequate for healthy living including right to food. As Eide (1999) and Mechlem (2004) observed, food as a human right is explicitly set out in other instruments such as the 1989 Convention on the Rights of the Child (Article 24 and 27), the World Declaration on Nutrition adopted at the 1992 International Conference on Nutrition, the 1994 International Conference on Population and Development, the 1995 Copenhagen Declaration on Social Development.

The most exhaustive instrument dealing with rights to food is the International Covenant on Economic, Social and Cultural Rights (ICESCR) (Article 11), which besides acknowledging the rights of everyone to an adequate standard of living including adequate food, also recognizes the basic right of everyone to be free from hunger. The instrument outlines “the basic premises, normative content of the right, states’ obligations, violations, and implementation at the national level, as well as international obligations” (Mechlem, 2004:638). As all human rights, the right to food involves three types of state obligations; the obligations to respect, protect and fulfill the right to adequate food. Whereas the obligation to respect suggests that States must forbear from direct or indirect interference in such a way that limit or deny access to food, obligation to protect indicates that States must put measures in place to control the activities of third parties which may seek to interfere with the enjoyment of the right, and obligation to fulfill implies that States must ensure the facilitation and provision of this right which may connote the development of a mechanism which assures that individuals can meet their own food needs (Mechlem, 2004).

It is obvious from the foregoing that contrary to what Clay (2002) in his critique of the right to food approach noted that the onus regarding who has to do what, for whom and when was fairly fuzzy, the ICESCR explicitly laid out the obligation of the States in ensuring this right. It is the means that is however not clearly defined and this is, in a way, contingent on adequate synthesis

of household and national food issues, as well as national planning and priorities. In another vein, Mechlem (2004) asserts that right to food should not suffer from a reductionist standpoint of attempting to align or describe it as a means to achieve food security, but must be seen as an objective in itself. McCarthy and Obidzinski (2015) also see the right to food as an alternative approach to addressing food poverty issues within a legalistic frame where rules and standards are defined and adhered to. Adopting this approach, it is posited that food security will be “complemented by dimensions of dignity, rights acknowledgment, transparency, accountability, and empowerment” (Mechlem, 2004:648).

2.5 Food Security and Food Sovereignty

Although food security and food sovereignty are both focused on ensuring that individuals have sufficient food needed for healthy living, this is where their relationship ends as they differ in the explanation of the causes, consequences and responses to hunger and malnutrition. For food sovereignty advocates, food security is a rhetoric that is deeply entrenched in neoliberalism discourses with an emphasis on international trade and fixation with feeding the masses by any means necessary, thus often working to the advantage of developed economies and big agricultural corporations (Jarosz, 2014; Reddy *et al.*, 2016).

Since the mid-1990s, the peasant movement known as La Via Campesina has been at the forefront of the demand for food sovereignty. The movement in their position statement defined food sovereignty as “the right of each nation to maintain and develop its own capacity to produce its basic foods respecting cultural and productive diversity. We have the right to produce our own food in our own territory. Food sovereignty is a precondition to genuine food security” (La Via Campesina, 1996:1). As such, food sovereignty in its initial conception was preoccupied with issues of national sovereignty and food systems diversity (Agarwal, 2014). In 2002, the scope of the movement expanded and this was reflected in the definition of food sovereignty which was broadened to mean “the rights of people to define their own food and agriculture; to protect and regulate domestic agricultural production and trade in order to achieve sustainable development objectives; to determine the extent to which they want to be self-reliant’ (cited in Patel, 2009). The reference to ‘peoples’ here embraces the local (community) as well as the household, thus recognizing the importance of individual food self-sufficiency. Self-reliance serves to promote the

rights of ‘peoples’ to determine their priorities and courses of action on food and agriculture without coercion. Furthermore, the emphasis on regulation is striking as it highlights the need to protect local production and guard against susceptibility to inequitable workings as well as fluctuations of international market.

The most comprehensive definition was an outcome of the Nyeleni declaration of the forum for food sovereignty held in Nyeleni, Mali by La Via Campesina in 2007. Food sovereignty was defined as:

“the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems. It puts those who produce, distribute and consume food at the heart of food systems and policies rather than the demands of markets and corporations. It defends the interests and inclusion of the next generation. It offers a strategy to resist and dismantle the current corporate trade and food regime, and directions for food, farming, pastoral and fisheries systems determined by local producers. Food sovereignty prioritises local and national economies and markets and empowers peasant and family farmer-driven agriculture, artisanal fishing, pastoralist-led grazing, and food production, distribution and consumption based on environmental, social and economic sustainability. Food sovereignty promotes transparent trade that guarantees just income to all peoples and the rights of consumers to control their food and nutrition. It ensures that the rights to use and manage our lands, territories, waters, seeds, livestock and biodiversity are in the hands of those of us who produce food. Food sovereignty implies new social relations free of oppression and inequality between men and women, peoples, racial groups, social classes and generations” (La Via Campesina, 2007:9).

The latest definition stresses peasant empowerment, household farming, elimination of gender inequality, while it also incorporates different rights such as right to manage land (Agarwal, 2014). More importantly, it encompasses everyone involved in the food chain; from farm to plate. However operationalizing the definition, as Agarwal (2014) notes, may prove to be a tall order because farming families’ choices may be contradictory to the vision of the concept as these are

determined by their priorities and constraints they contend with. Limiting their choices, she argues, may undermine the democratic principles of self-determination the declaration advances. The message of the food sovereignty movement is however exigent. Frowning against the business as usual approach which prioritises trade, food sovereignty is not merely about economics of food production but also a social and environmental imperative and a *sine qua non* for food security (McMichael and Schneider, 2011; Lang and Barling, 2012). It prioritizes the analysis of power relations and effects of trade liberalization on agricultural development, poverty, hunger and environment (Jarosz, 2014). It privileges the ‘commons’, arguing for the recognition of their rights to access and have control over productive resources (McCarthy and Obidzinski, 2015).

2.6 State of World Food Insecurity

Compelling evidence of world food insecurity inherently threatens global development. Undoubtedly, the nature of the food security challenges is complicated and protracted. Although noticeable progress has been made in relation to the challenges, this appears uneven and masks the dire situation poor people are confronted with relating to food insecurity. Despite prevailing proof that the world produces sufficient food to feed everyone daily, about 1 billion people go hungry every day and approximately 2 billion people are undernourished (Tschardtke *et al.*, 2012; Cistulli *et al.*, 2014).

Globally, recent estimates indicated that about 795 million people are undernourished, a 27.2% decrease in absolute numbers from the 1990-92 estimates (FAO, IFAD and WFP., 2015). About 10% of the world’s population was unable to meet their dietary energy requirements in 2014-16, down from 18.6% reported in 1990-92. With regards to the two globally renowned targets for food security; the MDG goal of reducing the proportion of people who suffer hunger by half by 2015 was assumed to have been met, but the WFS target of halving the number of people who suffer hunger by 2015 was missed by a large margin (FAO, IFAD and WFP, 2015). The absolute numbers of undernourished people has however risen to 821 million people in 2017 (FAO *et al.*, 2018). Nevertheless, these estimates may fall short of global reality if global food insecurity is measured using other dimensions or elements. As Pinstrup-Andersen (2009) points out, if the interpretation of FAO’s definition of being food secure encompasses meeting the nutritional needs of each individual, then the FAO estimate of undernourished people (795 million in 2015, and 821 million

in 2017) may be grossly underestimated. For instance, micronutrient deficiencies remain pervasive, affecting about 2 billion people (Wheeler and Braun, 2013; IFPRI, 2014).

By 2050, global population is forecasted to reach 9 billion people and this will require particular attention being paid to global food demands. Furthermore, a steady increase in per capita income in several developing countries is envisaged with an attendant increase in the demands for some kinds of food. To meet the food demands of the 2050 projections therefore, food production must be increased by at least 70% (Tomlinson, 2013; Grote, 2014). In another vein, the impact of global food pricing on food security cannot be underplayed. Indeed, global food prices have had a checkered history and this has taken its toll on global food security. Patterns of food prices over the past century, have shown a general decrease in gross food prices, but this has been markedly sandwiched by periods of price spikes in 1970s, 2008 and 2011 (Godfray *et al.*, 2010). The 2008 food price spikes particularly saw prices of some commodities tripled from their early 2005 levels, thus leading to increased costs for consumers globally and civil unrests in some climes (Beddington, 2010). Presently however, it is posited that the world has entered a period of sustained volatility in global food prices which is mainly driven by rising demands from developing countries and increased demand for resources by competing users such as biofuels (Godfray *et al.*, 2010).

More importantly however, regional disparities remain a dominant feature of the global food security situation. Majority of the world's food insecure are found in developing regions despite a 44.5% decrease in the prevalence of undernourishment in this region since 1992 (FAO, IFAD and WFP., 2015). As at 2017, about 280 million of the food insecure people are in South Asia; 139 million in East Asia; and 231 million in Sub-Saharan Africa (FAO *et al.*, 2018:127-139). Africa's hunger challenge is indeed perturbing. About 75% of the world's ultra-poor (who earn less than half a dollar per day) are found in the region (Garrity *et al.*, 2010) and about 26% of the total population is severely food insecure (FAO *et al.*, 2018:116). Africa is currently experiencing faster population growth rate than any other region and this undoubtedly is expected to have implications for food security. The region's population is envisaged to grow from about 796 million in 2005 to about 1.8 billion by 2050. The dire situation is more markedly pronounced in Sub-Saharan Africa, which has the highest prevalence of undernourishment in the world despite significant

decline over the years. Additionally, threats of famine constantly reinforce chronic food insecurity in the region. For instance, the increasing incidence and severity of climate shocks in the Sahel is having an adverse effect on the coping capacity of vulnerable households as this is incessantly eroded (IFPRI, 2014). A significant indicator of, or contributor to food insecurity in Sub-Saharan Africa is the rising food deficits the region is contending with. Growth in food production currently lags behind rising population growth, thus resulting in widening food gaps in the region as food imports take precedence in order to deal with the deficit in production (Baro and Deubel, 2006).

2.7 Drivers of World Food Insecurity

The fact that there are millions of undernourished people in the world is undisputable. Many factors have combined to serve as drivers of world food insecurity, thus drawing attention to these underlying reasons some of which are interrelated. Several of these impact either directly or indirectly on agricultural productivity with a resultant enduring effect on food security. They include:

2.7.1 Climate Change

Climate change is a reality with lasting global implications on the environment and earth's resources. As aptly stated by IPCC (2014), astounding changes have been noted in global climate system as evident in the warming of the atmosphere and ocean, the diminishing amounts of snow and ice, fluctuations in rainfall, rise in sea levels, as well as extreme weather events. The changes, generally referred to as warming, are unrivalled in the last 70 years as humans have impacted on the system through the incessant anthropogenic emissions of green-house gases alluded to have reached an all-time high in recent years (IPCC, 2014). These emissions are driven largely by man's activities ably exemplified via/in industrialization, urbanisation and population growth. The consequences of climate change have indeed been overwhelming.

There are pronounced differences on how climate change impacts upon the earth and its resources across regions and continents and this is further contingent on each region's resource endowments, the extent of man's intervention on its environment in these regions, as well as livelihoods and resilience strategies peculiar to each region (Devereux and Edwards, 2004). In tropical regions, climate change may lead to more intense rainfall sandwiched between protracted periods of

dryness, as well as diminishing water resources for irrigation (Rosegrant and Cline, 2003). Globally, it is predicted that if nothing is done to address climate change, there would be an upsurge in the rate of recurrence of extreme weather events such as droughts and floods (Godfray and Robinson, 2015).

The implications of climate change for food security is far reaching and not straight forward. However, food security is affected by climate change chiefly through its impact on agricultural productivity. It is also fundamental to note that climate change impacts on agriculture and vice versa. Climate change affects agriculture by reducing harvest especially through the incidence of droughts and flooding. Godfray and Garnett (2014) however argue that climate change may also be beneficial to agriculture in some instances where land hitherto unsuitable for agriculture especially in high latitudes become suitable as a result of increase in temperature. As much as climate change affects agriculture and food productivity, agriculture is also a significant contributor to climate change, accountable for about 10 to 12 percent of emissions via the use of fertilizers without even taking into cognizance its impact through deforestation (Beddington, 2010; Cistulli *et al.*, 2014). Despite several contentions, it is generally held that the net results of the impact of climate change on agriculture emerging would be diminishing productivity (Godfray and Garnett, 2014).

Although issues around food access are more pronounced worldwide, ensuring food availability is still important especially in areas that suffer most from the impact of climate change through the incidence of drought, flooding among others. Against the backdrop of global warming and its consequent effect on water, land and ecosystems all of which food systems depend upon, the imperativeness of matching food demand with supply cannot be overlooked. This calls for stringent measures aimed at reducing the impact of climate change as well as greenhouse gas emissions which Beddington (2010) noted must be reduced by at least 50 to 60 percent by 2050.

2.7.2 Population Growth

Continuing population increase is steadfastly intensifying demand for agricultural produce, thus putting strain on supply that is far from infinite, with an attendant pressure on global food security. According to UNDESA (2015), world population rose to 7.3 billion in 2015, an addition of

approximately one billion people to the earth within the last five years. World population is projected to increase to 8.5 billion by 2030 and 9.7 billion by 2050, with Africa expected to contribute more than half of the global population increase rising from 1.2 billion in 2015 to 2.5 billion by 2050 (UNDESA, 2015).

The projected growth in population is expected to bring about a growing increase in food demand as well as increased competition for earth's resources such as land and water which food production relies on. Food demand is anticipated to rise by more than 50% within the next 20 years (Cistulli *et al.*, 2014), and this is occurring against the backdrop of diminishing agricultural yields especially in Africa where majority of the food insecure are found. Meeting future food demand is thus contingent on increasing agricultural productivity which must be achieved within the limit of available resources that are arguably in great demand.

2.7.3 Urbanisation

The quest for better opportunities is often at the heart of the permanent or semi-permanent movement of people from one area to another. Urbanisation, referred to as the increase in the number of people living in urban areas resulting from population shift to these areas from rural areas (Mcgranahan and Satterthwaite, 2014), has tremendous implications for food security. Globally, more people live in cities than in rural areas and the proportion of people who reside in urban areas is projected to rise to 66% by 2050 from 54% in 2014 (UNDESA, 2014). Evidence indicates that Asia and Africa are urbanizing faster than other regions. The percentage of people residing in urban areas in Asia and Africa was 48% and 40% respectively in 2014 but this is anticipated to increase to 64% and 56% by 2050 (UNDESA, 2014).

As people move from rural areas to urban areas, agriculture suffers as labour force working in the sector is lost to increasingly expanding cities which are often serviced with food produced in rural areas. Rapid urbanization is accelerating demand for higher valued food products such as vegetables, fruits, meats and dairy products (Rosegrant and Cline, 2003). The resultant effect of this is shortage of agricultural commodities which may often need to be offset through importation. In Africa, for instance, about 70% of farmers are smallholders living in rural areas but these numbers are slowly shrinking as a result of urbanization. Farming in Nigeria is being left in the

hands of the ageing population as young and energetic people troop to the cities in search of better opportunities (Akerle *et al.*, 2013). The corollary of the foregoing is that continued urbanization is taking its toll on production and consequently on food security; food demand is increasing with a concomitant constrain on supply resulting from reduced agricultural labour force. Furthermore, urbanization of many countries that were hitherto largely rural is associated with the rising expansion of supermarkets and global food retail chain outlets, further driving up demand for higher valued food products (Gregory, Ingram and Brklacich, 2005).

2.7.4 Economic Prosperity

It is a given that as nations and individuals become more prosperous, consumption grows fueled by the desire for better goods and services as well as improved living standards. Income prosperity is expected to be accompanied by increased food demand, especially demand for higher valued food products. Economic growth in developing countries is anticipated to elevate the status of many, lifting millions out of poverty. This development will no doubt come with some attendant outcomes some of which are presently manifesting. Higher economic growth has contributed to hunger reduction in many countries (FAO, IFAD and WFP, 2013). This is more evident in countries where growth has led to better opportunities and reduction in poverty levels.

Income prosperity, if not managed properly, can be a curse rather than a blessing as it may lead to constraint on global food security. An outcome of increasing prosperity will be growth in per capita consumption and shifts in the consumption patterns from diets high in starch to one richer in protein as well as from local to Western foods (Baldos and Hertel, 2014). Rising incomes in developing countries is expected to be accompanied by growth in the consumption of dairy and meat products, thus resulting in an increase in the demand for agricultural commodities needed to feed livestock (Beddington, 2010). Projections to year 2050 have indeed shown that 93% of cereal demand growth and 85% of meat demand growth respectively will come from developing countries (Rosegrant and Cline, 2003). There is also a growing middle class in emerging economies with sophisticated tastes, further increasing the demand for higher valued commodities including agricultural products.

In another vein, increasing prosperity has the potential to lead to more investment in agriculture which can be delivered through infrastructure development, research, new technologies, innovations to improve seed varieties, breeding for crops and livestock among others. The foregoing will no doubt improve global food security but is contingent on the choices and will of stakeholders to prioritise the development of agricultural sector amidst growing prosperity.

2.7.5 Water

It is evidently clear that water and its management will have indelible implications for agricultural productivity and food security. Agriculture is presently the dominant user of water accounting for up to 70% of the water usage, but this is anticipated to drop to 60% by 2050 (Beddington, 2010). This is not unconnected to the diversification of national and global economies manifesting in the reduced contribution of agriculture to gross domestic product, as well as increased competition for water use among other various sectors (Beddington, 2010).

Availability of water when and where it is needed is a major issue around water resource management and this is also true for agriculture. Fewer than 10 countries have about 60% of the earth's available fresh water supply (WBCSD, 2005). Globally, fresh water withdrawal has been increasing by 1% annually since the 1980s, groundwater abstraction has been increasing by 1% to 2% every year and these are all associated with increasing demand from developing countries (WWAP, 2016). In Nigeria, total water withdrawal increase between 1995 and 2005 is about 2%, a percentage significantly lower than the global increase but which is projected to increase significantly as a result of economic and population growth (Amarasinghe and Smakhtin, 2014). Water issues in agriculture are further compounded by climate and seasonal variations, droughts and floods all of which work out to reduce water availability.

Irrigation has remained an essential component of agricultural production accounting for 90% of water withdrawal from available sources in many developing countries (WBCSD, 2005) Globally however, 15 to 35 percent of irrigation withdrawals have been deemed to be unsustainable (WBCSD, 2005; Godfray and Garnett, 2014). Added to this is the demand for water from rivers, aquifers and lakes for domestic and industrial use in the wake of growing population and economies. Consequently, per capita decrease in irrigation water use in all regions of the world

that is being experienced over the past few years is anticipated to continue (Hanjra and Qureshi, 2010; Godfray and Robinson, 2015).

2.7.6 Land

The management of land resources plays a critical role in agriculture and this is expected to continue into the future. More than 30% of global land area is currently utilized in agriculture, with cropland covering one third of agriculture land use (UNEP, 2014; FAO, 2018). By 2050, food demand is projected to rise by 60% (Alexandratos and Bruinsma, 2012) and this will no doubt have to be met by increased agricultural production. Growth in food production is increasingly dependent on arable land expansion, an enduring phenomenon which World Resources Institute (2013) and UNEP (2014) note is accompanied with forest resources depletion especially in tropical regions.

Evidence suggests that while about 90% of projected increase in global crop production (80% in developing economies) is anticipated to come from increased yields and higher cropping intensities, the remainder would come from land expansion (Bruinsma, 2009a, 2009b). Arable land expansion would thus play a crucial role in crop production growth especially in developing countries. Projections into 2050 indicates that arable land would expand by less than 5%, with the expansion being more particularly pronounced in sub-Saharan Africa and Latin America where expansion will assist in offsetting the anticipated decline in developed countries (Bruinsma, 2009a).

Achieving local and national food security will also unarguably depend on the choices made within countries regarding firstly land ownership, and secondly the strengthening of local and national agriculture and protection of local farmers. Tscharrntke *et al.* (2012) alluded to the phenomenon of “land grabbing” and how this affects local food security. Land grabbing refers to “the widespread, rapid increase of commercial land transactions that involve the acquisition or long-term lease of large areas of land by investors” (Golay and Biglino, 2013:1630). Relations concerning land which leads to land grabbing may take different forms depending on the actors involved, the dynamics of transactions as well as the mechanisms guiding and girding the transactions (Golay and Biglino, 2013). Although there exist variations in the conceptualization of land grabbing, a recurring notion

is that common property regimes and community lands are expropriated for the creation of agricultural farms that are privately held (Serwajja, 2014).

Categorising land grabbing into two; direct and indirect, Tschardtke *et al.* (2012) assert that the concept can be exploitative in nature, resulting in agricultural export but inadvertently undermining local food security. Indirect land grabbing occurs when particular agricultural commodities are increasingly imported from a producing country by another country, the former prioritizing export at the expense of local food security. In a way, the producing country could be deemed to have “sold” out their land to be used to satisfy the needs of the importing country at the expense of meeting its local food demand. Direct land grabbing refers to the obvious and unequivocal purchase or lease of farmland from developing countries by international investors. The foregoing raises critical vulnerability concerns for smallholders and portends serious threat to local and national food security.

Available global arable land is constrained by a number of factors. Some of these lands are suitable for the growth of some particular crops, many of which are not in high demand, while some suffer from chemical deficiencies and infrastructural deficits needed to efficiently utilize them. All of these culminate to render such lands unviable for cultivation. Furthermore, rising competition for land for urbanisation and industrialisation is increasingly pushing up land prices, thus pushing some arable lands beyond the reach of agricultural investors especially smallholders. Suffice to note however that although some countries have (nearly) reached the limits of available arable land, available global land resources are adequate to cater for world’s population food demand for the foreseeable future, albeit this will be contingent upon making the necessary investments in agriculture (Bruinsma, 2009a).

2.7.7 Energy

Energy and food systems are increasingly becoming intertwined. There is no gainsaying that the global food system is extremely dependent on energy, thus contributing to energy demand. Based on EIA's (2016) reference case, energy demand is projected to increase by 48% between 2012 and 2040. A major determinant of growth in energy demand is economic growth. Thus most of the projected increase in energy demand will come from non-OECD countries where relatively strong long term economic growth is driving energy demand (EIA, 2016).

Food system's dependence on energy manifests itself in the utilization of fossil fuels as inputs for agriculture especially chemical fertilizers and machinery, as well as its use for transportation and manufacturing across food value chains (Sage, 2013). Heavy reliance on machinery and fertilizers makes agriculture susceptible to oil price shocks, with major outcomes for food security. Sage (2013) asserts that rise in energy prices results in increased fertilizer prices which consequently affects domestic food production capacity, with overall ramifications for food and nutrition security status of the populace. Furthermore, high energy prices lead to rise in the cost of shipping and transporting, leading to increase in prices of food.

In another vein, there is a growing development of energy sources from renewable fuels. Biofuels, which represent a type of renewable fuels and rely heavily on agricultural crops, is increasingly in demand thus contributing significantly to energy systems. To meet the rising demand for energy, there would be a greater reliance on biofuels for transport and industry as well as biomass for heat and electricity, thus engendering increased competition for land and crops (Beddington, 2010; Hanjra and Qureshi, 2010; Baldos and Hertel, 2014). Crops such as grains, soybeans and sugarcane are increasingly being used to produce biofuels. Up until 2020, it is anticipated that 15% of the world's cereal and plant oil production as well as 30% of global sugarcane production will go into biofuel (OECD-FAO 2011, cited in Tschamntke *et al.*, 2012).

This development is more significant in the wake of the growing calls for cleaner energy, particularly the reduction in the use of fossil fuels which are responsible for a significant proportion of greenhouse gas emissions. However, the desire for clean energy is not the only driver of biofuels production as rising energy prices drives demand for crops for biofuels at the expense of food. Consequently, food crises may be the fallout of sustained increases in energy prices thus creating new markets for agricultural crops which have the prospect of earning more in biofuel than in food markets (Lyne, Hendriks and Ngidi, 2009; Hanjra and Qureshi, 2010). For instance, Sage (2013) notes that more than 75% of the 140% increase in food price index from 2002 to 2008 was as a result of biofuels and its associated effects. The implication of the foregoing is unambiguous – barring any significant intervention, household food security will be further constrained by the diversion of agricultural crops and lands to biofuels to meet energy demand.

2.7.8 Other Factors

Other factors driving food security are noteworthy. Devereux and Edwards (2004) observe that failures of national policies have contributed significantly to food insecurity. Policy directions and investment priorities of governments and other stakeholders are important drivers of food security. These relates to how far and how well policy and investments in water resources, rural infrastructure, agriculture value chains and agricultural research are effective. Improved communication in some climes has helped in promoting market integration and increased public investment has raised agricultural productivity, leading to a reduction in hunger prevalence (FAO, IFAD and WFP, 2013). Agricultural innovation is highly vital and there could be significant improvement in food security if farming practices that employ new technologies, breeding programmes and better use of fertilizers are encouraged. Governments' commitment to ensure the success of national policies is also paramount.

Beddington (2010) highlighted other environmental factors that influence food security. According to him, there are constraints on soil quality and biodiversity conservation owing to agricultural practices. Soil degradation is a global threat especially in Africa where eight million tonnes of soil nutrients are lost per year and West Africa where annual loses of soil organic carbon are markedly pronounced (Beddington, 2010). Ensuring political stability is also important to achieving food security. There are countless evidence of nations and regions where conflicts and wars have resulted in the outbreaks of famine. Also, there is a valid connection between political instability and food price volatility in North Africa and the Middle East (Sage, 2013).

Food wastage referred to as the loss, damage or discarding of edible food products intended for the purpose of human consumption, is also a critical factor that impacts greatly on food security. The fact that there is currently low efficiency of food usage is undisputable as 1.3 billion tonnes of food, representing a third of harvested food is thrown away annually (Tschardtke *et al.*, 2012; Bond *et al.*, 2013; Lipinski *et al.*, 2013). These losses occur both at the developed and the developing countries. While 40% of the losses in the former occur at the retail and consumer levels, 40% of losses in the latter were found in the post-harvest and processing stages. As foods are being thrown away, many go to bed hungry with nothing to eat. The need to cut these losses cannot be overemphasized and efforts must therefore be geared towards ensuring better storage facilities and

efficient distribution and transportation of foods from where they are produced to where they are needed.

2.8 Agricultural Production in the World

The role of agriculture in economic development especially in Africa remains widely contested. While many are of the view that the sector is indeed fundamental to driving growth and poverty reduction in Africa, others have criticized the relevance of the sector, contending that its impact on growth and poverty reduction is limited. A study on agriculture's role in Africa's development by Diao et al. (2010) succinctly summarized the arguments from both sides. The skeptics, according to them, assert that the sector is characterised by weak performance and increasingly deteriorating agro-ecological conditions. It is also presumed that since a declining role of agriculture is envisaged for development, a persisting large size of the agricultural sector may be a pointer as to why the region has failed to develop. Non-agricultural sectors, it was claimed, generates more income and employment (Murphy, 2010). On the other hand, advocates of agriculture's role in development have alluded both to the scale and growth-linkages advantages as a propeller of economic development, as well as the underperformance of other alternative sectors in many African countries (Diao, Hazell and Thurlow, 2010). Furthermore, the question that relates to what type of growth is beneficial to all, is pro-poor and shared, reinforces agriculture's position as a sector that can deliver such growth as it presently accounts for one-third of sub-Saharan Africa's GDP and a significant proportion of its total labour force (Diao, Hazell and Thurlow, 2010).

There is no gainsaying however, that increasing agricultural production will always be a critical part of the global attempt to achieve food security and poverty reduction. Through its dual role of feeding consumers and providing income along value chains, agriculture's potential for poverty reduction, human development and food security is undisputable. The foregoing has ensured that the interest and focus of stakeholders have continually been on (increasing) agricultural production. The implications for increasing agricultural production for food security and poverty reduction are numerous. Firstly, increased agricultural production will resolve the food availability issue by eliminating shortages and lowering the prices of food thus improving affordability for the poor. Secondly, by improving economic opportunities and increasing income as a result of the rise

in food production (especially if the rate of productivity increase is higher than that of price decrease), economic accessibility to food is enhanced (DfID, 2004). Thirdly and an offshoot of the aforementioned is that dietary diversity and food quality of households are bound to improve owing to increased agricultural production (Lyne, Hendriks and Ngidi, 2009). Achieving individual food security will enhance healthy living, consequently leading to poverty reduction as people are healthy enough to work and secure their livelihoods.

There is evidence in profusion relating to the positive relationship between increased agricultural productivity and reduction of poverty (Diao, Hazell and Thurlow, 2010; IFAD and UNEP, 2013; Gollin, 2014). For instance Christiaensen et al. (2010) cited in (Murphy, 2010) found in their empirical review of the effect of agricultural development on poverty reduction that agriculture is more powerful relative to non-agricultural sectors in reducing poverty among the poorest in as much as inequality is not too high.

On a global scale, increased agricultural productivity has been recorded over the last five decades, with a consequent improvement in food availability (Baldos and Hertel, 2014). This has had to be achieved through reliance on the cultivation of more lands and technological advancement. Nevertheless, although the world produces enough food to feed its entire population, shortages are increasingly rampant as national and regional food production has showed a great deal of unevenness. Africa's food production growth rate, for instance, lags behind its population growth rate and one-third of the continent's food grain are imported despite having 75% of its labour force employed in agriculture.

Globally however, there has been a decrease in crop yield growth in recent years owing to dwindling investments in agricultural research, infrastructure, irrigation and water resource management (Rosegrant and Cline, 2003). Increased competition for resources has also contributed to the reduction in crop yield growth which is further compounded by the threats of climate change that adversely affects agricultural production in some parts of the world especially tropical regions where protracted periods of heavy rainfall which may result in flooding is sandwiched by periods of prolonged dryness. In Africa, agricultural productivity is affected by poor weather, deficient infrastructure, corruption, policy vacillation and conflicts (Cistulli *et al.*, 2014).

Production of agricultural commodities is also constrained by access to finance (Pinstrup-Andersen, 2000) and markets (Pottier, 1999; Pinstrup-Andersen, 2000; Stevens, Devereux and Kennan, 2003; Lyne, Hendriks and Ngidi, 2009; Qureshi, Dixon and Wood, 2015). Access to institutional credits especially for rural farmers, majority of who are smallholders is problematic and the performance of the publicly provided credit schemes has been underwhelming (Pinstrup-Andersen, 2000). In terms of markets, the notion that all farmers have free access to resources and market is arguably a misleading one. As Pottier (1999) rightly points out, local power structures which are products of the negotiation and relationship between and among producers (farmers) and marketers (traders) shape terms of trade and trade channels. Due to the changing nature of the negotiation and relationships, it would therefore be imprecise to refer to the market as a “single, unified exchange environment (Pottier, 1999:100). For the most parts, markets have favoured large-scale commercial producers at the expense of smallholders who have limited access to input and output markets (Stevens, Devereux and Kennan, 2003). Moreover, smallholders are forced to sell at harvest because they are in dire need of cash (Qureshi, Dixon and Wood, 2015) and also owing to lack of storage facilities.

As a result of the foregoing, there are presently ongoing attempts to increase food production especially in regions where scarcity is prevalent. This is further justified in light of the anticipated increase in world population with an attendant rise in food demand. To feed the anticipated global population of 9 billion in 2050, there has been a renewed call for doubling food production (Sage, 2013; Tomlinson, 2013). To meet future projections of food demand, remarkably high agricultural growth rates are required (Gowing, 2003). This must be achieved under competing land and water resources as well as mutable climate conditions (Lal, 2013).

Seeing that most of the world’s food production has had to rely on irrigated and fertile rain fed lands with the consequent neglect of less fertile lands, increasing productivity into the future is dependent on optimum utilization of existing agricultural lands and expanding cropped area by making the less fertile lands more appropriate for use (Pinstrup-Andersen, 2000; Pinstrup-Andersen, Pandya-Lorch and Rosegrant, 2001; Gowing, 2003; Garrity *et al.*, 2010; Godfray and Garnett, 2014). For instance, 25% of Sub-Sahara Africa’s food production increase into 2030 is

anticipated to come through expansion, while the remaining 75% will come from increasing the intensity of crop yields on already cultivated agricultural lands (Gowing, 2003).

Increasing global agricultural productivity will also require among others, heavy investment in agricultural research, infrastructure, technology, as well as effective combinations of modern and traditional farming practices that stresses sustainability. Indeed, sustainability is germane in re-thinking agricultural production. In what Godfray and Garnett (2014) referred to as the sustainable intensification of production, increased productivity must be achieved with minimal impact on the environment and without compromising the ability of future generations to meet their food need.

It is also imperative to allude to value chain agriculture as there are ongoing efforts globally to increase agricultural productivity by incorporating smallholders into agriculture value chains. Indeed, value chain agriculture has become the “in-thing” presently, bringing together production for domestic consumption and export, while it also fosters inclusive participation of all stakeholders. A suitable strategy to increase agricultural production, McMichael and Schneider (2011) assert, is through commercialization which embraces the integration of smallholder farmers into the broader food trade and production system. Access to markets and finance should also be enhanced especially for smallholders as this will engender their participation in agricultural trade. Increase in rural household incomes is realizable when hindrances to the gainful production and marketing of agricultural commodities are removed (Lyne, Hendriks and Ngidi, 2009).

The foregoing require government intervention in ensuring a right balance between market mechanisms and regulations (Pinstrup-Andersen, 2000). Increasing agricultural production is also contingent on the development and execution of coherent and effective policies. Progress towards food security is achievable even amidst poverty prevalence when policies geared towards boosting agricultural productivity and food availability are given primacy, with ample attention devoted to smallholders. The effectiveness of such policies are further strengthened when linked with social protection programmes and other measures that seek to raise incomes of the poor and make them take advantage of economic opportunities (FAO, IFAD and WFP, 2013).

Furthermore, the need for a deep assessment of production and distribution priorities especially at the local level cannot be overemphasized. A major issue to consider revolves around the fact that export may be prioritized at the expense of production for local markets, which can eventually render the market susceptible to price volatility and cause disparities in food accessibility in favour of urban populace with higher purchasing power (McMichael and Schneider, 2011). To forestall this, McMichael and Schneider (2011) advanced for a multifunctional approach, echoing the sentiments contained in IAASTD's (2008) report on agriculture. Given the wide array of issues related to agriculture and food security, the multifunctionality approach critiques the glorification of industrial agriculture and an absolute market-driven approach to agriculture, arguing rather for a reinforcement of agriculture's multifarious potential for social change and development. The approach emphasizes among others, "strengthening local and regional food systems, democratising food policy, and prioritising the needs of small farmers by securing access to productive resources (seeds, land, water), credit, information, market infrastructures and fair trade systems" (McMichael and Schneider, 2011:113).

2.9 Conceptualising Smallholders

The term 'smallholder farming' or 'smallholder farmers', has been variedly defined using diverse characteristics such that there is no conceptual unanimity as to what it entails. Major criteria for identifying smallholders include the intention or focus of the production, size of holding, labour utilization, and source of capital (Cousins, 2008; Salami, Kamara and Brixiova, 2010). Even among smallholders, wide variations exist relating to farm size, inputs, outputs, operations, as well as resource allocation and distribution (Cousins, 2008, 2013; Wiggins, 2009; IFAD and UNEP, 2013; Gollin, 2014; Siddik *et al.*, 2015). This has made the concept a slippery one as there is no consensus definition to lay hold of in literature. For instance, there is a tendency in some literature to conflate smallholding with subsistence farming which contributes partially to total household income and some have used smallholders as an umbrella and homogenous term for the rural poor (Cousins, 2008, 2013).

Different smallholder definitions are however applicable to distinct production systems as it would be inappropriate to define, for instance, a poultry farm based on the size of the land area used in production as high outputs may be derived from little land (Gollin, 2014). What is important to

note, as Lowder et al. (2016) point out, is that small as a concept is relative, contingent upon agro-ecological and socio-economic factors.

In terms of the size of the farms however, the range falls between less than one hectare to up to 10 hectares depending on the density of the area or region (Salami et al., 2010; FAO, 2012), and the median size of a crop farm ranges from one and two hectares in most countries (Gollin, 2014). Globally, there are more than 570 million farms with about 475 million farms smaller than 2 hectares (Lowder, Scoet and Raney, 2016), and farm sizes getting smaller in several countries (Fan et al., 2013). More precisely, 72% of world's farms are less than one hectare in size, 12% are between 1 and 2 hectares, 10% are within the range of 2 and 5 hectares, and a mere 6% are larger hectares (Lowder et al., 2016:23). In Africa, Collier and Dercon (2014) notes that the majority of farms are smaller than two hectares, with a median size of one hectare. The determinants of farm size are “the quality of land, the profit-maximizing choice of output and technology, and the prices of inputs and outputs” (Gollin, 2014:9). The extent of capital and labour that will go into production will depend on the relative costs of these inputs, thus consequently determining the extent of land put into production. Where there is paucity of capital in poor countries, there is a higher dependence on labour to offset for the lack of capital and appropriate technologies which further constrains farm size (Gollin, 2014).

Relating to the extent or capacity of production, smallholders range from those who supplement their farm earnings with other sources of income to meet household needs, to those who sell the surplus produced after meeting household consumption needs, and to those who produce majorly for the market often referred to as small-scale commercial farmers (Cousins, 2008). They produce agricultural commodities on a small scale with limited external inputs (IFAD and UNEP, 2013). Smallholder agriculture is the major source of food especially for majority of the smallholder families. Among smallholder families in Africa, there are high rates of household consumption of agricultural produce (Gollin, 2014).

Most smallholders own their own farms, are self-employed and very few hire employees. Majority of smallholding agriculture is organized around the family unit as the centre of decision-making and is dependent on family labour for the operation of such farms (Salami, Kamara and Brixiova,

2010). With the exception of large plantations in Africa, majority of the continent's agricultural workforce are self-employed, making up a substantial proportion of the total labour force in the region (Gollin, 2014). Moreover, a lot of smallholders engage in non-farm activities to support their livelihoods. The reasons for this are not far-fetched. Many smallholder households found the incomes emanating from their farming activities barely able to support them all through the year. Livelihoods diversification thus becomes a strategy for survival. As Gollin (2014) puts it, rural non-farm employment helps individuals and households to cope with risks, to better manage seasonal fluctuations in agricultural outputs and labour demand while it also supplements income from farming.

In describing smallholders, Cousins (2008) posits that attention has been inequitably focused on mutual characteristics of smallholders at the expense of the disparities that may exist within them in some socio-economic characteristics such as income, assets, and class identity. Indeed, significant variations exist among smallholders with regards to livelihood assets and strategies (Murphy, 2010; Fan *et al.*, 2013; IFAD and UNEP, 2013). Furthermore, the analysis of the subtleties and underlying forces at work in the ability or otherwise of smallholders to commercialize is lacking (Cousins, 2008). Despite the variations that may exist among smallholders, they generally suffer from marginalization with regards to “accessibility, resources, information, technology, capital and assets” (IFAD & UNEP, 2013:10). Another commonality is that majority of smallholding agriculture takes place in rural areas where they produce the bulk of agricultural produce in developing countries (IFAD & UNEP, 2013; Fan *et al.*, 2013). Furthermore, a greater proportion of people living in absolute poverty and half of the world's undernourished are found on small farms (Fan *et al.*, 2013). Smallholders in the developing world make up a large proportion of the poor, since about 70% of the 1.4 billion extremely poor people in the developing nations live in the rural areas and most are involved in smallholder agriculture (UNCTAD, 2015).

As Cousins (2008) rightly points out, smallholder agriculture can only make a meaningful impact on poverty reduction when smallholders are able to engage in ‘accumulation from below’, that is when they are able to produce a marketable surplus and successfully reinvest part of the profit emanating from the surplus for future expansion of production. Siddik *et al.* (2015) observes that

smallholders' contribution to poverty reduction and economic growth in Sierra Leone was not mainly through export but was evident in the local sales of food items which was beneficial to the economy. In Zambia, smallholders seek to secure household consumption amidst uncertainty rather than target profit maximization (Umar, 2013).

2.10 Small Scale Agriculture versus Large Scale Agriculture

Over the years, there have been lingering arguments and wide contestations about the preferable scale of farms to drive economic growth and prosperity. The continual debate is about whether or not smallholder agriculture is more productive, delivers economic growth and ensures rapid poverty reduction relative to large scale farming. Indeed, evidence is indeed not scanty to support both sides of the debate.

Collier and Dercon (2014) query the continual commitment to smallholder agriculture as the key to agriculture growth in the face of unending urbanization and globalization, and the argument that historically, lasting growth in labor productivity in agriculture has been strongly correlated with labour decline on agricultural land. For them, too much emphasis on smallholder agriculture can constrain large scale poverty reduction. Because agriculture is not the leading sector propelling economic growth, Dercon (2013) posits that the next focus in development should be on creating jobs in urban areas rather than a narrow and often myopic focus on smallholder.

Indeed it is not a given that investment in smallholder agriculture will make the desired impact on growth and poverty reduction. Rather, the extent of the impact would most definitely depend on the effectiveness and feasibility of such programmes targeted at smallholders (Gollin, 2014). For instance, Vershelde *et al.* (2013) observes that different-sized farms have distinct production strategies, and therefore dissimilar production relationships.

Although continually disputed, there have been ample allusions in literature to the inverse relationship between land productivity and farm size, suggesting that farm size should not be a hindrance to productivity. The contestation however borders on the economic notion that barring significant market imperfections, marginal factor productivity should be the same across farms or between the plots of a single family unit (Vershelde *et al.*, 2013).

In another vein, the contribution of small scale farming to global economy cannot be understated. Smallholder agriculture generates employment opportunities and incomes for a significant proportion of the world's population, thus contributing immensely to food security and poverty reduction. Over 500 million smallholder farms support around 2 billion people globally (Wegner and Zwart, 2011). The significance of smallholder agriculture is more markedly pronounced in Sub-Saharan Africa and Asia where a significant percentage of the labour force are smallholders. They manage up to 80% of the small farms and are responsible for over 80% of the food supply in these regions (FAO, 2012; IFAD & UNEP, 2013), while they also produce the bulk of agricultural exports of countries in the regions (UNCTAD, 2015).

Ensuring agricultural growth, food security and poverty reduction thus hinges on tapping the potentials of smallholder agriculture owing to the prominence of this sector (Garrity *et al.*, 2010; Tschardtke *et al.*, 2012; Agarwal, 2012; Wiggins and Keats, 2013; Gollin, 2014; Herrero *et al.*, 2014). There seems to be evidence that growth in agriculture has a relatively large poverty effect because majority of the poor earn their livelihood through agriculture (Diao, Hazell and Thurlow, 2010; Dercon, 2013), and that programmes geared towards improving the productivity of smallholders have high social returns (Gollin, 2014). Tschardtke *et al.* (2012) notes that increases in food production in areas where the hungry and poor live, which is predominantly in developing nations will depend on more efficient and sustainable production by smallholder farmers. It must be stressed, however, that there are some pre-conditions for agricultural growth to have the necessary effect on poverty. For instance, inequality should not be high as it is possible amidst high inequality for agricultural growth to have little or no effect on poverty reduction and such growth may even result in increased poverty and marginalization (Dawson, Martin and Sikor, 2016).

2.10.1 Arguments for Smallholder Agriculture

Wiggins (2009) asserts that a smallholder dominated agricultural sector is not a barrier to economic growth as there are evidence of impressive performance of small farms globally and instances where nations dominated by small farms have outperformed nations that predominantly have large scale farms in terms of agricultural growth. In contrast, earlier economic theorists had stressed that

for economic growth to take place, factors of production must move from an agricultural sector beset with low-productivity to a modern industrialised sector with higher productivity and returns (Diao, Hazell and Thurlow, 2010).

The Green Revolution that took place in some parts of the developing world particularly in Asia in the 1960s and 1970s remains perhaps the most credible and persisting evidence of the efficiency and productivity of agriculture, and of course smallholders in literature, thus confounding earlier belief. The period witnessed a 57% increase in global grain production between 1960 and 2000 as well as significant poverty reduction, both of which were abetted by progress in high-yielding seed varieties, management techniques, extension services, technology and irrigation especially among smallholders (IFAD and UNEP, 2013), as well as better access to land and input subsidies (Fan *et al.*, 2013). Productivity gains impacted positively on farmers income and trickled down to nonfarm sectors of rural communities (Larson *et al.*, 2014). This helped showed the world that smallholders can be productive and that a genuine focus on smallholder agriculture can contribute immensely to poverty reduction.

According to DFID (2004), the Green Revolution example in South and East Asia indicates that progress in income and employment generation, poverty reduction, food security, has been greatest in areas where agricultural development has been prioritized on small farms with labour intensive techniques (DfID, 2004). Targeting smallholder farming development can potentially lead to a rise in the income of rural farmers and reduction in food expenditure, thus resulting in increased rate of poverty alleviation and inequality reduction (Salami, Kamara and Brixiova, 2010). Smallholder development can also play a catalytic role in business and economic development of rural areas through the employment of extra labour especially during peak farming periods as well as through bolstering of consumption and expenditure on non-farm goods and services (IFAD and UNEP, 2013).

In what is generally referred to as the inverse farm size-productivity relationship (or broadly paradox of the scale), empirical evidence abounds on the notion that small and diversified farms exhibit greater productivity per area relative to large specialized farms (Tscharntke *et al.*, 2012; Fan *et al.*, 2013; Collier and Dercon, 2014; Gollin, 2014; UNCTAD, 2015). Diverse reasons have

been adduced to explain the inverse relationship including imperfect factor markets. These may be noted in land, capital, insurance or labour availability (Verschelde *et al.*, 2013). In a similar vein, there are assertions that smallholders benefit from reduced transaction costs per unit because of their operation in rural areas characterized by surplus labour and capital scarcity (UNCTAD, 2015). However the foregoing remains largely disputed, with claims that the evidence may be methodologically flawed as they may not have taken into consideration some tangibles such as land or soil quality, measurement errors and selection issues (Verschelde *et al.*, 2013; Collier and Dercon, 2014). Gollin (2014) adds that small farms' yield productivity advantage is often as a result of the failure of labour and land markets which make smallholders likely to use unusual levels of labour on a small land area; leading to an upshot of small farms' yield advantage compared to the normally lower output per unit of labour. Nevertheless, FAO (2012) reports on a study that assessed smallholder agriculture spanning 286 projects and over 37 million hectares in 57 developing countries, and found a 79% increase in average crop yield when sustainable agriculture was implemented.

Smallholder agriculture helps to control out-migration to cities characterized by unemployment and insecure livelihoods, making use of their own existing knowledge and skills base, and rely more on labour than capital (Murphy, 2010). A cogent reason for the enduring perspective that small scale farms have higher productivity is that smallholders cultivate lands more intensively than large scale farmers, thus leading to higher levels of productivity per land unit (Fan *et al.*, 2013; Gollin, 2014). Furthermore, the dependence on family labour by many smallholders resolves the incentive concerns that plague agricultural labour markets. Unlike the latter, family labour is intrinsically flexible and can be deployed easily when needed most, is inexpensive in terms of monitoring and needs little motivation to be committed (Gollin, 2014). It is however imperative to note that family labour is not an exclusive preserve of smallholders as quite a number of heavily commercialized farms even in developed countries are family farms and rely on family labour as the main source of farm work (Gollin, 2014; Graeb *et al.*, 2015).

Smallholders can be greatly productive and get sufficient earnings where access to fertile soils, irrigation water and markets are guaranteed (Cousins, 2013). The productivity of smallholders and their contributions to food security and poverty reduction is also contingent on the interplay of

activities and forces between smallholders and the ecosystem. For as in other cases and as generally applicable, smallholders' activity affect the ecosystem and vice-versa, and poverty and food insecurity affecting smallholder households for instance, can exert pressure on the ecosystem through overexploitation of resources and habitat modification (IFAD and UNEP, 2013).

2.10.2 Arguments Against Smallholder Agriculture

McMichael and Schneider (2011) argue that contrary to popular notion, smallholder gains from price increases are marginal. To them, increasing food prices do not offer enough commercial motivation for smallholders as they are disadvantaged from seeking such returns owing to factors such as the tendency for self-consumption of harvests, prior binding agreements to sell outputs at fixed rate, as well as rising energy and fertilizer prices. According to DFID (2004), the notion that yields improvement in smallholder agriculture will result in poverty reduction is also not straightforward. This is understandable as smallholders face market, transport, and storage constraints and may be unable to meet the value chain requirements of some commodities.

Like other poverty affected households, poor smallholders are extremely vulnerable to food markets volatility, spending a significant percentage of their earnings on staple foods. To deal with this, smallholders' response could either involve returning to the former approach of mainly producing for household consumption (low-input, low output production) or targeting production for higher value commodities (McMichael and Schneider, 2011; FAO, 2012). The upshot of the foregoing is that production for domestic market suffers as smallholders evolve strategies to manage their vulnerability (McMichael and Schneider, 2011). Furthermore, Fan *et al.* (2013) allude to contrasting evidence in literature of the effects of food price shocks on smallholders. While food price increase resulted in adverse welfare effects for smallholders in Ghana, Malawi and Bangladesh, food price crisis in Indonesia led to increased investments by both small and large scale farmers, and consequently higher incomes for them (Fan *et al.*, 2013).

Smallholders are characterized by low yields, as well as limited productivity growth and commercialization, thus slowing down the overall rate of agricultural growth and constraining socio-economic transformation especially in Africa (Collier and Dercon, 2014). Dercon (2013) questions the narrow focus on agriculture, arguing that a solitary view of agriculture as the

determinant of change in some climes will lead to an insufficient understanding of the processes of economic transformation. The often cited example of the transformation of agriculture in South Asia and the role of smallholders in the transformation, according to him, underrates the other economic processes at work in such transformation. It is little wonder that the transfer of similar strategies that worked well in South Asia to Africa has had minimal effect. The achievement of the desired impact was further constrained by the use of locally unsuitable seed varieties as well as deficient human and institutional capacity (Dawson, Martin and Sikor, 2016).

Investment in smallholders, Dercon (2013) argues, does not constitute a custom-built approach to increasing agricultural growth in all cases. As Collier and Dercon (2014) asserts, a wide range of interventions has been attempted in smallholder agriculture including those that advance market development and up-scaling of technology application, but there have been weak evidence of their success (Collier and Dercon, 2014).

Another limitation of smallholder agriculture relates to potential economies of scale challenges. This constraint is not necessarily a case of farm sizes but rather an issue revolving around organizational metamorphosis from “informal and personalized, to formal and institutionalized” (Collier and Dercon, 2014:94). The foregoing drives commercialization and vice versa, and as Collier and Dercon (2014) assert, large farms are more likely to possess these organizational characteristics and embrace institutional arrangements, and are thus suitably placed to be at the cutting edge of logistics, capital and technological innovation.

There is no gainsaying that for the acquisition of new knowledge, smallholders have had to depend on agricultural extension services which are often inadequately provided. Given that education have been strongly correlated with innovation in agriculture and smallholders’ knowledge base is limited to those acquired through extension and/or social learning, smallholders may possess deficient knowledge of elementary science as well as inadequate managerial and numeracy skills, all of which may preclude them from the effective adaptation to new technologies (Collier and Dercon, 2014).

Access to input and output markets which is critical to the transformation from subsistence to commercial production is lacking for many smallholders (Salami et al., 2010; Murphy, 2010; Fan, *et al.*, 2013; Gollin, 2014). In Africa for example, there is a persisting weak interface between smallholders and the final product market (Collier and Dercon, 2014). Compliance with standards and quality is problematic for smallholders, and this in addition to high transaction costs faced by retailers when dealing with small farms hinder many smallholders from taking advantage of potential market opportunities (Gollin, 2014). Transaction costs are further driven up by the lack of adequate access to infrastructure such as transportation and market facilities (Fan *et al.*, 2013).

Furthermore, the storage, marketing and distribution constraints faced by many smallholder is partly due to the fact that these necessary features of commercial agriculture rely on technologies which involve scale economies that smallholders might not possess (Collier and Dercon, 2014). Furthermore, issues relating to land tenure and more broadly access to land are fundamental challenges confronted by smallholders especially in Africa. For instance, Salami *et al.* (2010) noted a great unevenness in land access in East and Southern Africa as households in the highest per capita land quartile control as many as 5 to 15 times more land than those in the lowest quartile.

Smallholders have insufficient access to credit due to high interest rates and their lack of collateral which render them unable to secure credit from micro-credit institutions and commercial banks, thus producing an inequitable system where large scale farmers are able to secure loans due to their credit worthiness (Salami, Kamara and Brixiova, 2010). The credit issue has denied smallholders the ability to take up appropriate technologies and opportunities the market offers (Gollin, 2014).

2.10.3 Arguments for Large Scale Agriculture

According to Collier and Dercon (2014), large scale farms are relatively better with regards to the process of technology adoption owing majorly to knowledge diffusion and ability to manage adoption risks. There is a positive association between technology adoption and farmer's education and wealth (Dethier and Effenberger, 2012), which large scale farmers are relatively likely to possess. Because of the profusion of resources and skills at their disposal, large scale farming entities are able to learn and grasp new technologies faster and are not disincentivised from risk

taking and experimentation which smallholders may show an aversion for (Dethier & Effenberger, 2012; Collier & Dercon, 2014).

Large scale agriculture has an advantage in the promotion of commercialization (Wegner and Zwart, 2011). Furthermore, the ability to generate additional sources of returns along marketing, logistics and value chains is also greater for large scale farms. This is more a result of the characteristic of such farms as commercial enterprises (Collier and Dercon, 2014), which therefore necessitates the exploration of all possible options for profit maximization within the organizational ambits of the farms.

It is also argued that large farms have enhanced access to capital and finance. As noted by Collier and Dercon (2014), large farms have better access to collateral to secure necessary capital while a lot of smallholders face several constraints. In Nigeria, for instance, processing of land titles which could be used to secure loan is problematic and costly which renders it a tall order for smallholders to get credit facilities. Large scale farmers on the other hand are better placed to secure land rights and are thus able to obtain necessary capital through collateral.

Another hallmark of large scale farms which works significantly to their benefit is the organization of finance and administration which make them institutionalized entities and also sets them apart from small farms. In what Collier and Dercon (2014:95) refer to as “accumulation of reputation”, a large commercialized farm is set up in such a way that documentation of evidence to show the strengths, opportunities and weaknesses of such enterprise is properly done. Economies of scale can potentially deliver cost reduction and this is more pronounced for large scale farming than for smallholders. Cost reduction can be achieved in large agricultural enterprises through coordination or vertical integration which are often non-existent in smallholder agriculture (Collier and Dercon, 2014).

Because of the foregoing advantages of large farms, many studies have contested the presumed efficiency advantage of small farms, arguing that the advantage dissipates above a particular farm size or after taken into consideration such factors as land quality (Fan *et al.*, 2013).

2.10.4 Arguments Against Large Scale Agriculture

In instances where large scale farming was prioritized as a strategy for agricultural development using capital intensive techniques and less labour, progress in hunger and poverty reduction had been underwhelming as the consequent marginalization of smallholders was also accompanied by the tendency of large scale farmers to produce for export and spend their extra income on sophisticated commodities produced outside the region (DfID, 2004).

Labour and farm productivity are found to be lower in large scale farms as they rely on hired labour who are presumed to be less motivated and efficient, in contrast to small farms that depend on family labour (Verschelde *et al.*, 2013; Collier and Dercon, 2014). Other reasonable arguments in literature which may cause this borders on market imperfections (Collier and Dercon, 2014). Contrariwise, Collier and Dercon (2014) argue that a focus on smallholder agriculture cannot effectively drive labour productivity growth in Africa as this requires migration out of agriculture and rural areas, and that smallholder agriculture are also not invulnerable to market imperfections. Poulton, Kydd and Dorward (2006), for instance, suggest that supply chain failures, high transaction costs and risks are widespread in smallholder agriculture. The foregoing, they further note, is mostly as as a result of poor telecommunications and roads, poor dissemination of information (on prices, new technologies and potential business partners, as well as problems around contracts enforcement (Poulton, Kydd and Dorward, 2006:245).

Wiggins (2009) outlined instances where large scale farming experiment has failed in Africa as investment was made without due regard to the technicalities and peculiarities of African agriculture. Dethier and Effenberger (2012:183) note, for instance, that Africa unlike Asia “is heterogeneous in terms of agro-ecological conditions, farming systems, and types of crops planted.” The failure of some large scale farming projects was engendered by reliance on inappropriate technologies (Dethier and Effenberger, 2012) and heavy machineries causing attendant effects such as destruction of soils, operation and maintenance complexities, demand for scarce highly skilled labour to operate the machineries all of which led to increased operating costs and yield reductions (Wiggins, 2009).

Institutional and regulation issues pose certain challenges to large farms as their outlook as formal entities often gets in their way of efficiency. Large farms may not be able to get away with certain

things or issues small farms can circumvent because of their size which renders them foci of attention. For instance, Wiggins (2009) notes that large farms are often obliged or compelled to provide certain additional services or benefits to hired workers and can be targets for inducement payments to overzealous or corrupt officials. In essence, large farms can be expensive to operate incurring costs that small farms do not necessarily have to deal with (Wiggins, 2009).

Despite the failures of some large farm investments in Africa, there are quite a number of large farm experiments that have proven to be successful (Wiggins, 2009). What is however crucial to point out is that big is not always better and success is not about scale; as Wiggins (2009) argues, large scale farming is not necessarily the most viable option in all climes. Where large scale farming have thrived in Africa outside of Southern Africa are areas that huge capital investments were utilised or the physical productivity of commodities were better achieved through large scale farming compared to small scale farming (Wiggins, 2009).

2.10.5 Conclusions on Farm Scale

Although it may be easier to raise productivity on small farms in some instances, in other cases, however, it may be easier to raise productivity on large farms or non-agricultural firms. Prioritising provision of off-farm jobs in some climes would make relatively more profound impact on poverty reduction than focusing on smallholders (Fan et al., 2013; Gollin, 2014). It has also been noted that to achieve growth and poverty reduction, the argument or position in a way should be a discrete (case by case), contextualised and holistic analysis of the economic situation and identification of sectors that can drive growth and poverty reduction, which may not necessarily be agriculture and/or a focus on smallholder farming. Where opportunities lie outside agriculture, it may involve a change of jobs for many smallholders (Dercon, 2013).

On the contrary, Naylor (2011) contends that it would be out of place to back out from smallholder agriculture altogether, as the alternative being proposed may be akin to privileging the elite who can increase land acquisitions for large-scale agriculture, and this consequently may lead to higher rates of poverty and inequality, as well as ethnic and political unrest. Diao *et al.* (2010) also posit that although sectors such as the industrial sector have linkages, these are weaker and create fewer job opportunities for poor workers. However, an agricultural driven growth is more pro-poor

mainly because it enables greater participation of the poor in the process of growth. Furthermore, in the face of the sheer number of smallholders involved in Africa agriculture and the failure of some large scale experiments in Sudan and Tanzania, it is problematic to envisage a structural transformation of the sector that seeks to modulate the role of smallholders (Larson *et al.*, 2014).

Indeed there are diverse claims that smallholders are not fully productive despite the focus and attention they receive. A valid position, however, is that there have been policy shifts in recent years emphasizing diversification both to large scale agriculture and out of agriculture altogether. This is more evident in Africa that have suffered from and is still feeling the effect of a “prescribed and extemporized” structural adjustment programmes (SAPs) of the 1980s and 1990s. The resultant effect of SAP is the reduction of the role of the State, and an overemphasis or oversimplification of the importance of market in allocating resources. Consequently, marketing boards were dismantled, supplies of agricultural inputs such as fertilisers and seed varieties by government agencies to smallholders were reduced, extension services decreased, thus leading to a decline in the productivity of smallholders as a result of constraints in accessing essential factors of production (UNCTAD, 2015). Furthermore, as a result of globalization and market liberalization, smallholders are exposed to international price markets volatility as well as skewed competition in favour of developed countries’ farmers some of which are subsidized.

Summing up the debate, a better and more robust position relating to farm size efficiency, would be that small farms gain an advantage with regards to labour supervision and local knowledge, but the advantage is lost to larger farms when the economy moves toward an agriculture that is capital-intensive, technologically sophisticated and market-driven (Poulton, Dorward and Kydd, 2010). In a similar vein, Wegner and Zwart (2011) argue that there is no need to esteem and prioritise one farming scale as better than the other. Given the heterogeneity of agricultural, socio-economic and infrastructural characteristics, a generic recommendation of a farming scale at the expense of another will be out of place, but a fusion of both scales may be more appropriate in some climes (Wegner and Zwart, 2011).

2.11 Poverty and its Measurement

The concept of poverty is increasingly becoming slippery as there is no general unanimity as to what it actually means. Indeed, it seems an elusive task to lay hold of a consensus definition of poverty in literature and this has impacted on attempts to empirically measure it (Laderchi, Ruhi and Stewart, 2003; Oshewolo, 2010; Dinbabo, 2011). Conceptual definitions of poverty is presently messy (Laderchi, Ruhi and Stewart, 2003), and as Maxwell (1999) rightly posits, the complexity of poverty measurement is a direct reflection of the complexity of its definition. How poverty is conceptualised is however of great importance as it does not only affect its measurement, but also has profound implication on poverty reduction strategies. As noted by Laderchi, Ruhi and Stewart (2003), the ability to devise policies that can effectively reduce poverty is contingent on clarifying what poverty entails.

Central to the debate on poverty and its definition is the question of whether poverty is about material needs or whether it entails an expansive set of needs that permit well-being (Hulme and Mosley, 1996). While on the one hand, some authors have defined poverty primarily in financial terms, there are those who have on the other hand considered poverty to be more than financial resources which they view to be merely a means to an end. The former approach takes income as its point of departure and measures poverty in terms of a shortfall in consumption from some poverty line (Laderchi, Ruhi and Stewart, 2003; Oshewolo, 2010). This approach, which is often referred to as the monetary approach, relies on the use of revenue and expenditure data to assess and cost individual consumption (Dinbabo, 2011). The monetary approach to poverty measurement has been sub-divided into two; the absolute poverty measurement approach and the relative poverty measurement approach (Dinbabo, 2011). As posited by Noble, Wright and Cluver (2007), the absolute measurement of poverty considers poverty in terms of impoverishment which is generally defined without any specific reference to any group, while relative poverty associates poverty to a reference group by conceptualizing poverty in relation to the national distribution of income and or expenditure.

The income approach to poverty measurement has however been criticized because of its failure to take into consideration the many possible dimensions of poverty apart from income (Bourguignon and Chakravarty, 2003; Noble, Wright and Cluver, 2007; Thorbecke, 2007;

Dinbabo, 2011; Ravallion, 2011; May and Diga, 2015). Bourguignon and Chakravarty (2003) argue that people's well-being and ill-being (the latter particularly relating to poverty) are dependent on both monetary and non-monetary variables such as housing, literacy, life expectancy among others. Ravallion (2011) suggests that income and or expenditure is not the "be all and end all" in people's well-being, and that other factors should be considered in poverty measurement and policy considerations for poverty reduction. The foregoing arguments have thus led to another school of thought; that poverty assessment must be multidimensional, and must take cognizance of not only income, but also the deprivation of capitals and capabilities linked to education, health and participation in societal activities (Sindzingre, 2007; May and Diga, 2015). The Human Development Index (HDI), for instance, is an attempt to combine many social indicators to develop a single index indicator to compare human development progress across countries and groups (May and Diga, 2015).

Livelihood analysis has also been recognized as one of the ways by which poverty can be measured. The livelihoods strategy acknowledges the limits of the income-centric approach to poverty measurement (Carter and May, 1999; Prowse, 2008), and offers a logical framework for defining poverty (Erenstein, 2011). The approach identifies the importance of people's entitlements as well as the capabilities and assets they possess. It moves beyond the conventional poverty measure to the appreciation of the plethora of constraints which impinge upon people (Carter and May, 1999), and within which they construct their livelihoods (Olsson *et al.*, 2014).

2.12 Irrigation Development

Irrigation is defined as "the application of water to the soil for the purpose of supplying moisture essential for plant growth... (and) undertaken to provide an insurance against droughts, for cooling the soil and atmosphere" (Yahaya, 2002:412). Indeed, irrigation is necessary in many parts of the world owing to shortage of rainfall. Irrigation can majorly be categorized into two viz.; the traditional and modern irrigation techniques. Modern day irrigation agriculture is reliant on damming river courses, controlling the flow of water and storing same to be delivered to agricultural sites based on need (Yahaya, 2002). Modern day irrigation can further be sub-divided on the basis of the method of water transfer into agricultural farms. As such there is drip irrigation, sprinkler irrigation and surface water irrigation which also has several types. The latter involves the distribution of water by gravity, over and across land.

An important consideration in the development of irrigation infrastructure is the choice of the irrigation technology that is most fitting for the fulfillment of the rationale behind the initiative. The choice should thus be based on the characteristics of users particularly relating to the ease of application of the proposed technology, expected returns after a thorough cost-benefit analysis (Yahaya, 2002), protection of the ecosystem, local and national priorities (Molden, 2007) as well as the avoidance of transnational water conflicts.

The significance of irrigation has been extensively referenced in literature. Irrigation promotes agricultural intensification, resulting in maximum yield per hectare (Yahaya, 2002; Gowing, 2003; Stevens, Devereux and Kennan, 2003; Molden, 2007; Hanjra and Qureshi, 2010; Armah *et al.*, 2011; Jamala, Shehu and Garba, 2011). Also, irrigation assists in efficient plant nutrition and enhances the values of soil amendment activities such as the application of fertilizer (Armah *et al.*, 2011). Irrigation agriculture improves agricultural productivity as more food (with greater diversity) is produced due to the fact that farmers can cultivate all year round. The resultant effect of increased production is improvement of food security as food availability and accessibility become enhanced.

Due the fact that irrigation agriculture is the major user of water, constituting approximately 80% of global water use (Hanjra and Qureshi, 2010), the contribution of irrigation to global food production cannot indeed be understated. The proportion of food production from irrigation technology at the end of the last millennium was more than 25% (Gowing, 2003; Stevens, Devereux and Kennan, 2003). Presently, irrigation agriculture is responsible for about 40% of the global agricultural output (Leathers and Foster, 2004; Hanjra and Qureshi, 2010).

Increasing the scope of investment in irrigation agriculture into the future is important for many reasons. Molden (2007) expounded on the need to invest in irrigation development. Firstly, enhancing the scope of irrigation development in areas whose predominant contributor to the GDP is agriculture (such as sub-Saharan Africa) is one of the most feasible options for reducing poverty and inequality. Secondly, irrigation investment is critical in order to meet the increasing demand for agricultural product and the growing shift in food preferences. Thirdly, investment in irrigation

technology is needed as a response to ongoing societal change particularly typified by increasing industrialization, urbanization and competition for or pressure on environmental resources. Finally, as a response to climate change, irrigation infrastructure becomes necessary in order to store water and to offset for periods of drought caused by climate variability (Molden, 2007).

Nevertheless irrigation technology presents and is also plagued by myriads of problems. Notwithstanding the significant contribution of irrigation agriculture, its potential remains unrealized particularly in sub-Saharan Africa. For instance, the level of irrigated land is presently low. The proportion of irrigated land in sub-Saharan out of the arable land in the region and the globally irrigated land is about 5% and 3% respectively (Gowing, 2003).

It has also been widely asserted that many of the present infrastructure is in deplorable state, with huge maintenance deficit while many projects are uncompleted (Stevens, Devereux and Kennan, 2003). In a similar vein, there is the issue of the underutilization of existing scheme. In terms of the problems irrigation technology poses, it is noted that many of these projects result in socio-political crisis in the form of increased water competition (Armah *et al.*, 2011) and natural resources or water conflict, as well as environmental challenges including flooding, salinity, waterlogging, changes in water flows, water depletion, and worsening water quality (Stevens, Devereux and Kennan, 2003; Hanjra and Qureshi, 2010; Armah *et al.*, 2011).

In Nigeria, in the light of the increasing incidence of drought and the concomitant decrease in precipitation being recorded particularly in the Sudano-Sahel region of the country, irrigation becomes not only important but necessary to guard against the non-cultivation of land for many months in the year. More so, it is reported that it would be impossible for Nigeria to produce enough food to feed her teeming population solely from rain fed agriculture by 2025 (Jamala, Shehu and Garba, 2011).

Majority of the modern irrigation infrastructure in Nigeria are developed by the Federal Government with the objective of increasing agricultural productivity and resolving the persistent food insufficiency issue plaguing the nation. These irrigation projects are managed by the River Basin Development Authorities (RBDAs) with the Federal Ministry of Water Resources playing

oversight functions in the project. The RBDAs were created by the Federal Government of Nigeria in 1977 in a bid to enhance agricultural production and food security, and to accelerate rural development (Akindele and Adebo, 2004; Oriola, 2008; Daneji, 2011; Ugwu and Kanu, 2012). These RBDAS became major policy instrument towards the exploitation of the nation's vast water resources through irrigation development (Akinyele, 2009). Currently, the nation has 12 RBDAS operational in different parts of the country.

As with the global challenges of irrigation development, these issues are also evident in Nigeria. Some are related to water resources management as there is evidence of inefficient water distribution and poor maintenance due to the poor funding (Oriola, 2009). Further, irrigation development in Nigeria has led to incidence of flooding, erosion and conflict over access to natural resources.

2.13 Chapter Summary

The chapter has reviewed the various concepts relevant to the study. It established that food security and poverty do not have unanimous definitions, which consequently results in a plethora of measurement approaches for both concepts. The chapter further explains the nexus between food security and poverty. It alludes to the relevance of agricultural production to economic growth as well as in the fight against food insecurity and poverty reduction. It also emphasizes the importance of context in the debates about farm scale and the enduring significance of smallholder agriculture especially in sub-Saharan Africa. The continued importance of irrigation technology and its contribution towards the promotion of agricultural intensification and productivity was also expounded in the chapter. The next chapter contextualizes the three phenomena (agriculture, food security and poverty) in Nigeria.

CHAPTER THREE

AGRICULTURE, POVERTY AND FOOD SECURITY IN NIGERIA

3.1 Introduction

With a significant proportion of Nigeria's working population employed in agriculture and the sector contributing mostly to the nation's non-oil revenue, agriculture remains a mainstay of Nigeria's economy. The chapter traces the history of agricultural development in Nigeria and points out that the sector has lost its prideful status in Nigeria's international trade outlook. Local production of agricultural commodities has drastically fallen, with an attendant decline in the exploitation of its comparative advantage in the production of some export crops.

The foregoing has taken its toll on poverty and food security status of the nation. The neglect of agriculture has coincided with a steady increase in poverty levels, accompanied with persisting issues of food insecurity. The chapter argues that although some progress have been recorded in the prevalence of undernourishment and food availability, issues of food affordability and accessibility still linger. Furthermore, the progress owed so much to the nation being one of the largest net importers of food in the world. This portends crisis as any system that depends heavily on outside forces cannot be considered to be sustainable.

3.2 Historical Development of Agriculture in Nigeria

Over the years, agriculture in Nigeria has maintained its prominence as the mainstay of the nation's economy, evidently reflected in its contribution to food security, poverty reduction, employment, gross domestic product (GDP), and foreign exchange earnings. This is despite the dwindling performances experienced in the sector over time both domestically and internationally, with agriculture's potential remaining largely untapped. The huge potential for agricultural production is brought about by the convergence of factors such as fertile soil types and abundance of water sources, variety of favourable climatic conditions in different parts of the country as well as high population density especially in rural areas where agriculture is prevalent and majority of Nigeria's teeming population reside.

Indeed, it is arguable that Nigeria has lost its prideful status as a major contributor to global agricultural production and efforts to reclaim its lost glory have achieved abysmal results. The share of Nigeria's export (production) in major agricultural produce has shrunk and the sector's performance both domestically and internationally has dwindled over the years. The performance over the years in the production of some crops where the nation has comparative advantage is summarized in Table 3.1. From the 1960s right through to the early 1970s, Nigeria's agriculture prospered, having a prominent share in global agricultural production. This is particularly pronounced in the production of crops such as palm oil, cocoa and groundnut where the nation was one of the highest producers of these crops in the world. Such was the dominance of Nigeria in the global production of groundnut, oil palm, cocoa, cassava, yam and sorghum in 1961 as shown in Table 3.1, that Nigeria's share of total global production stood at 11.1%, 45.2%, 16.6%, 10.4%, 42.0% and 9.7% for the respective commodities.

From 1967, Nigeria's agricultural production started declining gradually and by 1970, its share of the world production in groundnut, oil, cocoa, cassava, yam and sorghum was 8.8%, 25.2%, 19.7%, 10.4%, 69% and 7.3% respectively. From the mid-1970s to the mid-1980s, Nigeria's declining agricultural production experienced acceleration so much that the share of global agricultural production for the aforementioned commodities shrank to 3.0%, 8.1%, 7.9%, 8.9%, 39.1% and 6.3% respectively. Although production improved slightly from 1985, the story has been that of underperformance as Nigeria has failed to regain its dominance in global agricultural production. As at 2014, the nation's share of global production in groundnut, oil palm, cassava, yam and sorghum was 8.1%, 15.1%, 20.3%, 66.0% and 9.9% respectively.

Table 3.1: Nigeria's Share (%) in Global Agricultural Production of Selected Crops

Year	Groundnut	Oil Palm	Cocoa	Cotton	Cassava	Yam	Sorghum	Maize
1961	11.1	45.2	16.6	0.5	10.4	42.0	9.7	0.5
1962	12.7	43.4	15.0	0.5	10.2	42.1	10.2	0.5
1963	12.5	42.8	17.4	0.4	10.0	47.9	8.8	0.5
1964	11.1	43.1	19.3	0.4	9.7	49.7	9.4	0.5
1965	12.5	43.6	15.0	0.4	9.6	54.4	9.0	0.5
1966	10.4	42.8	19.9	0.4	9.9	58.9	6.0	0.4
1967	8.9	36.0	17.1	0.5	9.7	59.4	6.1	0.3
1968	11.3	32.8	15.4	0.2	9.5	59.4	6.1	0.4
1969	11.1	32.0	15.6	0.5	9.5	63.1	7.4	0.5
1970	8.8	25.2	19.7	0.8	10.4	69.0	7.3	0.5
1971	7.3	23.2	15.7	0.3	9.3	63.9	6.1	0.4
1972	8.2	19.9	16.0	0.3	9.5	55.9	4.3	0.2
1973	5.1	17.8	15.3	0.4	9.4	54.7	4.9	0.3
1974	10.3	17.3	13.7	0.2	9.1	54.3	7.7	0.2
1975	2.4	16.0	13.8	0.4	9.5	59.1	4.7	0.4
1976	2.7	15.8	13.2	0.5	9.7	52.2	4.7	0.3
1977	3.4	14.8	13.3	0.6	9.3	52.2	4.9	0.2
1978	3.8	13.8	10.5	0.3	9.7	48.3	3.7	0.2
1979	2.8	14.4	9.1	0.3	10.0	45.3	4.3	0.1
1980	2.8	12.8	9.2	0.2	9.3	43.7	6.4	0.2
1981	2.6	10.0	10.0	0.2	8.6	43.4	4.6	0.2
1982	2.5	8.1	9.7	0.1	9.1	43.8	5.5	0.2
1983	3.1	8.6	8.7	0.1	7.8	41.7	6.0	0.3
1984	2.7	7.3	8.9	0.1	8.9	37.1	6.5	0.3
1985	3.0	8.1	7.9	0.1	8.9	39.1	6.3	0.4
1986	4.2	7.9	7.0	0.2	9.2	40.2	7.8	0.7
1987	3.2	8.4	7.3	0.3	10.0	38.1	8.4	1.0

Year	Groundnut	Oil Palm	Cocoa	Cotton	Cassava	Yam	Sorghum	Maize
1988	4.0	7.5	9.9	0.3	10.7	53.8	8.2	1.3
1989	4.4	6.5	9.7	0.4	11.4	53.6	8.2	1.1
1990	5.1	6.4	9.6	0.5	12.5	62.6	7.4	1.2
1991	5.7	6.4	10.6	0.5	16.2	62.2	9.6	1.2
1992	5.3	6.2	10.9	0.7	18.0	65.9	8.4	1.1
1993	5.1	5.8	11.4	0.4	18.4	67.1	10.6	1.3
1994	5.1	5.7	12.1	0.4	18.8	69.9	10.3	1.2
1995	5.5	5.4	6.8	0.5	19.4	68.6	12.8	1.3
1996	7.3	4.6	10.0	0.6	19.8	68.1	9.9	1.0
1997	8.6	4.4	10.5	0.7	19.8	67.4	12.2	0.9
1998	7.5	4.6	11.2	0.7	20.1	66.8	12.2	0.8
1999	9.1	4.3	7.6	0.8	19.3	66.4	12.5	0.9
2000	8.4	4.0	10.0	0.8	18.2	66.2	13.8	0.7
2001	7.5	3.6	10.6	0.7	17.6	65.5	11.8	0.7
2002	8.6	3.7	10.9	0.8	18.5	66.0	14.1	0.8
2003	8.4	3.6	10.4	0.8	18.9	67.1	13.6	0.8
2004	8.9	3.6	10.1	0.7	19.0	67.7	14.8	0.8
2005	9.0	3.6	10.9	0.8	20.2	69.1	15.4	0.8
2006	11.5	3.3	11.3	0.8	20.5	69.3	17.1	1.0
2007	7.7	3.3	9.2	0.7	19.1	65.7	14.4	0.9
2008	7.5	3.1	8.6	0.8	19.1	66.2	14.0	0.9
2009	8.0	2.8	8.6	0.6	15.5	61.0	9.3	0.9
2010	8.9	2.1	9.2	0.9	17.5	65.8	11.9	0.9
2011	7.3	1.9	8.4	0.4	18.1	62.4	10.0	1.0
2012	8.4	1.8	8.2	0.4	19.7	60.2	10.8	1.0
2013	5.8	1.7	8.0	0.3	18.0	61.9	9.6	0.8
2014	8.1	15.1			20.3	66.0	9.9	1.1

Source: Author's computation; computed with data extracted from FAO (2016)

Yield per hectare fosters agricultural competitiveness and serves as an indicator for agricultural productivity. In a comparison of yield per hectare indices for all crops between Nigeria and similar developing nations of Brazil, Thailand, Malaysia and Indonesia, FMARD (2011) observes that Nigeria has the lowest productivity with a yield per hectare of 20% compared to 50% and above obtained in these developing. Their analysis further suggests that Nigeria's yield per hectare as at 1961 was higher than that of Indonesia. However, while Indonesia has increased its yield three times and Malaysia recorded a growth rate of 3% in its yield per hectare, Nigeria has fallen behind having a growth rate of 12%.

Nigeria's underwhelming agricultural production has also taken its toll on its agricultural exports. In the 1960s, Nigeria was a leading exporter of cash crops such as groundnuts, cocoa, rubber, oil palm and cotton (Manyong *et al.*, 2005; Daramola *et al.*, 2007; FMARD, 2011). As observed by FMARD (2011:2), Nigeria was the leading exporter of groundnut with a global share of 42% and accounted for 27%, 18% and 1.4% of the world's export of palm oil, cocoa and cotton in 1961, but these were less than 2% for both groundnut and oil palm and less than 10% for cocoa in 2008. In cassava production, it is expected that Nigeria, being the leading producer of the commodity in the world, is supposed to benefit immensely from the export of the produce. However, 88% of cassava exports to the world market, according to Prakash (2005), are provided by Thailand, Vietnam and Indonesia while the remainder is provided by other cassava exporting countries including Nigeria.

Agriculture export taxes in the 1960s were a major source of revenue for Nigeria and the sector accounted for 60% to 70% of Nigeria's total exports in the 1960s. By 1996, agriculture's share of total export was a meager 2% and the average annual growth rates of 3% to 4% achieved in the 1960s declined by 17% from the mid-1970s to the mid-1980s (Daramola *et al.*, 2007). The resultant effect of the foregoing is that Nigeria became a net importer of agricultural commodities from the mid-1970s. In a bid to meet up with the food demand of the nation's ever increasing population, Nigeria has had to rely on import to fill the palpable food demand-supply gap.

3.3 Role of Agriculture in Nigeria's Economy

Despite the unsatisfactory performance witnessed in agricultural production, agriculture remains an extremely important sector of the economy, contributing significantly to the nation's gross domestic product. Over the years, agriculture has contributed a considerable %age to Nigeria's total GDP. For easier analysis of the contribution of agriculture to the economy, the period of analysis, 1981 to 2013, was divided into sub-periods of five years interval and this is presented in Table 3.2.

Table 3.2: Indicators of Agricultural Sector Performance (in mean annual values)

	1981- 1985	1986- 1990	1991- 1995	1996- 2000	2001- 2005	2006- 2010	2011- 2013
Total GDP (N millions) in Current Factor	111251.6	260378.3	1363551.2	4720757.5	10125284.6	24459446.9	40116909
Total Agriculture GDP (N millions)	28109.0	85277.6	436285.4	1565556.3	3429069.3	8035292.7	13238794
Crops	22512.0	74464.1	391617.9	1402365.2	3053384.4	7165544.1	11786105
Livestock	3442.4	7026.1	30646.1	104140.3	218027.3	514313.0	865768.78
Forestry	1179.5	1721.5	4329.2	15133.4	43697.0	98338.0	157411.36
Fisheries	975.1	2065.9	9692.3	43917.5	113960.6	257097.6	429509.11
Total non-oil GDP	97538.0	194046.3	882013.9	2867006.9	6280479.5	15351919.5	25436792
Share of Agriculture in Total GDP (%)	25.3	32.8	32.0	33.2	33.9	32.9	33.0
Share of Agriculture in non oil GDP (%)	28.8	43.9	49.5	54.6	54.6	52.3	52.0
Oil GDP (N millions)	13713.6	66332.0	481537.3	1853750.6	3844805.1	9107527.4	14680117
Share of oil in Total GDP (%)	12.3	25.5	35.3	39.3	38.0	37.2	36.6
Crops share in total Agriculture GDP	80.1	87.3	89.8	89.6	89.0	89.2	89.0

Source: Author's computation; computed with data extracted from CBN (2015)

The table indicates that the mean value of the share of agriculture in total GDP from 1981 to 1985 was 25.3 %. This however increased marginally over the years to about 33% in the 2006 to 2010 and 2011 to 2013 sub-periods. Agriculture's share in non-oil GDP was expectedly higher than its share in aggregate GDP, an indication that apart from oil, agriculture contributes most significantly to the nation's economy. During the 1981-1985 sub-period, the share of agriculture in non-oil GDP stood at 28.8%. However this increased substantially over the years such that agriculture contributed over 50% of non-oil GDP from 1996-2000 sub-period onwards. Also evident from the table is the fact that the crops subsector has consistently dominated agricultural sector GDP for all the sub-periods. The subsector contributed over 80% of the total agricultural sector GDP in all sub-periods under consideration.

Before the advent of crude oil production in Nigeria, agriculture contributed the largest share to the nation's revenue base. This was the period when Nigeria was a leading producer of a number of agricultural commodities, some of which were export crops. Presently however, there is no disputing the dominance of the oil sector in Nigeria's economy as the nation has become highly dependent on the sector. The exploration of crude has brought about structural changes to the Nigerian economy, most notably its exports, imports and revenue base (Daramola *et al.*, 2007; IFAD, 2009; Phillip *et al.*, 2009). The sector contributes over 90% of total exports and nearly 80% of government revenues, while the share of oil in the total GDP rose from 29% in 1980 to 52% in 2005 (Daramola *et al.*, 2007).

The beginning of crude oil production, particularly the boom era of the commodity in the international market in the 1970s heralded the neglect of the agricultural sector in Nigeria. The agricultural sector which was the main source of export earnings and revenue for the government became trivialized and attention shifted away to the oil sector. The sector's share of total GDP was nearly 50% in 1970 but this reduced drastically to about 35% in 2013. The share of agriculture as a %age of total exports fell from about 43% to a little over 7% between 1970 and 1974, and presently stands below 5% of total export earnings (Ebi and Ape, 2014). The effect of the foregoing is that Nigeria became a net importer of agricultural commodities as the persistent importation of commodities the nation hitherto produced locally was financed with the oil windfall that helped guarantee positive current account balances between the 1970s and 1980s (Daramola *et al.*, 2007).

The oil windfall brought about a significant increase in public expenditures as Nigeria prioritized industrialization with heavy investment in capital intensive technology and the development of the manufacturing sector at the expense of the agricultural sector. As Henley (2012) rightly asserts, Nigeria's focus on development planning during the oil boom was not on agriculture and the nation's attempt at diversification was driven by the desire to reduce the nation's dependence not only on the oil sector but also on agriculture. Although industrialization is good for growth and development, it is particularly clear, on hindsight, that the decision was not a well thought-out one as the importance of agriculture as the nation's major employer of labour and its potential to contribute to the reduction of food insecurity and poverty was not given due consideration. The challenge posed by insufficient spending on the agricultural sector was further compounded by the problem of the "Dutch disease." The boom experienced in the oil sector led to an appreciation in the value of the local currency which inadvertently affected the pricing of tradable agricultural commodities, and the consequent decline in the international competitiveness of agricultural export (Phillip *et al.*, 2009).

Oil prices however plummeted in the 1980s which caused a drastic reduction of export earnings from oil. Earnings from oil export reduced from a peak of \$24.9 billion in 1980 to \$5.2 billion in 1986 (Ojo, 1992 in Phillip *et al.*, 2009). The resulting balance of payment problems the nation encountered was a precursor to the Structural Adjustment Programme (SAP) introduced in 1986 in order to salvage the economy from its dependence on oil. One of the objectives of SAP, among others, was the increment of Nigeria's non-oil exports through a renewed focus on production and export of non-oil commodities (Daramola *et al.*, 2007; Phillip *et al.*, 2009). Indeed, it can be said that the inclination of successive Nigerian governments is to prioritize the diversification of the economy away from the oil sector, which had often led to the institutionalization and implementation of programmes and policies in the agricultural sector to raise the productivity of the sector and increase its share of export earnings. This however has not yielded a significant result as agriculture has failed to have the desired impact on the economy. This is not unconnected to the unwholesome commitment of the government to agricultural transformation and the continued dependence on the often unreliable petro-dollars.

It is not atypical of the international oil markets to experience the boom and bust cycle. The latest in this cycle witnessed the crude oil price crash that started in mid-2015. The price of crude oil which reached a peak of \$147 per barrel in July 2008 was \$65 in May 2015 and dropped drastically to about \$28 in January 2016. This has affected the revenue of oil producing countries including Nigeria where the ripple effect of the crude oil price crash was felt in the whole of the economy. Despite the foregoing, it seems Nigeria has not learned its lessons as its overdependence on oil still lingers. Continued attempts at diversification have not yielded the desired results as such attempts have been apathetic, lacking in will and zeal. This is also evident in the agricultural sector that has suffered from the continued reliance on oil revenues. The corollary is in fact that the fluctuation in the performance of Nigerian's economy and the persistent poverty witnessed in the land is not unconnected to the overdependence on oil and chronic neglect of important sectors such as agriculture.

3.4 Factors Constraining the Growth of Nigeria's Agricultural Sector

Besides the overdependence on oil, other factors serving as constraints to the growth and development of agriculture in Nigeria have been extensively laid out in literature (see for instance, the works of Goldman and Smith, 1995; Manyong *et al.*, 2005; Daramola *et al.*, 2007; Phillip *et al.*, 2009; Sanyal and Babu, 2010; Daneji, 2011; Onwualu, 2012; Ugwu and Kanu, 2012). These include:

3.4.1 Inadequate Infrastructural Facilities

Lack of or decaying infrastructure has adversely affected the agricultural sector in Nigeria. Critical infrastructure such as transport, electricity and water are inadequate especially in rural areas where majority are involved in agriculture. This has led to high input and transport costs, thus serving as constraints to agricultural productivity. Many farmers are also not encouraged to increase production due to the limited access they have to feeder roads which consequently affects market access. Past programmes implemented to tackle the issue such as the Directorate for Food, Roads and Rural Infrastructure (DFRRI) and agricultural development projects (ADPs) failed to make the desired impact (Daramola *et al.*, 2007).

3.4.2 Lack of Appropriate Technologies

The use of rudimentary technologies especially among smallholders is a factor that has derailed agricultural production in Nigeria. Access to new and relevant technologies is insufficient and where they are available, there is a level of skepticism in taking up the technologies by some farmers. There is also a problem of insufficient storage and processing facilities. Further to this, outdated nature of machinery and equipment used in some agro processing industries do not make them to achieve optimal production (Onwualu, 2012), thus having an adverse effect on the production of agricultural commodities used as raw materials in such industries.

3.4.3 Issues Relating to Land

Land is a critical factor of production and since every agricultural development takes place on land, its importance cannot be overemphasized. Land tenure system as practiced in Nigeria poses serious challenges of access to land, hence constraining agricultural productivity. As observed by Phillip *et al.* (2009), the predominant tenure system among many ethnic groups in Nigeria is the communal land ownership where individual ownership is embedded in family, clan, or group ownership. Although the system has aided the preservation of such traditional land use practices as bush fallowing, it has brought about issues such as restraint on farmers' mobility and access to credit, limited tenure security among others (Phillip *et al.*, 2009). The lack of an appropriate tenure system also disincentivises investment in agriculture as control and legally enforceable rights to land are lacking (Manyong *et al.*, 2005).

3.4.4 Inadequate Farm Inputs

Another constraining factor to the growth of agriculture in Nigeria is the inadequate supply or access to farm inputs needed to boost production. Prices of critical inputs are increasingly high, resulting from poor infrastructure, high rate of inflation and government reforms (Manyong *et al.*, 2005; Daramola *et al.*, 2007; Phillip *et al.*, 2009). For instance, prior to the 1980s, the issuance of agricultural subsidies particularly in form of fertilizer subsidies was an agricultural policy pursued to increase agricultural productivity. Economic reforms embarked upon during SAP and post-SAP have significantly reduced the subsidies made available to farmers, consequently resulting in increasing cost of fertilizers and an attendant decrease in the usage of the input by farmers.

Although elements of fertilizer subsidy have persisted, this is being increasingly targeted at large scale farmers at the expense of smallholders that are largely in need of the subsidy (Phillip *et al.*, 2009). The foregoing has encouraged the participation of the private sector in supply of agriculture input. Most of these private sector firms are however based in urban areas while majority of end users of the inputs are located in rural areas, thus posing problems of haphazard and inefficient distribution which was also present in the subsidy system. Whatever the source of inputs, whether government or private sector, the thrust of the issue is that demand has greatly dwarfed supply which has adversely affected the performance of the agricultural sector.

3.4.5 Access to Markets

Poor infrastructure especially transportation decreases access to output markets. The perishable or bulky nature of some agricultural commodities limits their production especially in rural areas as transporting such goods to markets or processing plants is problematic.

Coupled with the fact that increasing agricultural production may be discouraged as inadequate infrastructure and high cost of inputs raise the cost of agricultural produce especially at the output markets, lack of information on market opportunities may also constrain agricultural productivity. The development of Nigeria's agricultural value chain is also poor, thus constraining agricultural productivity and resulting in export of primary commodities. Furthermore, it has been established that insurmountable barriers are often imposed on exports including agricultural commodities by importing countries. The indirect effect is that it limits production in agricultural exporting countries including Nigeria (Daramola *et al.*, 2007).

3.4.6 Inadequate Extension Services

Farmers need to be kept abreast of new farming techniques and technologies as well as latest varieties of crops and seeds in order to improve agricultural productivity. Provision of such information is a responsibility of agricultural extension workers. It is for this reason that Daramola *et al.* (2007) likened the provision of extension services to a factor of production, given that it boosts farmers' entrepreneurial skills especially among smallholders. It is however unfortunate that extension services has been inadequately provided in Nigeria as a limited number of extension

workers are engaged to provide these services. This is further compounded by the dispersed nature of farm settlements which has constrained the reach of extensions services (Manyong *et al.*, 2005).

3.4.7 Access to Finance or Credit

Daramola *et al.* (2007) expounded on the problem of lack of access to credit faced by Nigerian farmers especially smallholders who constitute the majority of farmers. According to them, agricultural financing in Nigeria has several categories. First is the credit guidelines stipulated by the Central Bank of Nigeria (CBN) to specific sectors of the economy. Under the guidelines, banks were mandated to lend a minimum proportion to agriculture but these banks refused to do so, preferring to pay the penalties for not adhering to the guidelines. Second is the concessional interest rate policy under which lending to agriculture was concessional prior to 1987, with interest rates matching or below the CBN minimum rediscount rates (Daramola *et al.*, 2007). Normal market rates however applied from 1987 to 2000, while since then, agricultural loans have been disbursed at a maximum rate of 9% under the Agricultural Credit Support Scheme. Whatever the interest rates applied, the cost of capital in agriculture has remained high (Daramola *et al.*, 2007). Third is the rural banking scheme which was introduced in 1977. The scheme was designed to provide access to credit for rural farmers and resulted in the opening of 765 bank branches as at 1992. Although the procedure of locally mobilized funds to rural lending was specified and meant to favour smallholders, loans received by smallholders were largely insignificant as majority of the loans went to cooperatives and large scale farmers (Daramola *et al.*, 2007).

The requirement of a title to land as a collateral to secure most of the available agricultural loans also constitutes a hindrance to credit access for majority of smallholders. In essence, the fact remains that irrespective of the financing policy option or the combination of options, the cost of capital remains persistently high and access to finance is limited, and these pose serious problems for the growth of the sector.

3.4.8 Policy Issues

Evidence abounds that there has been policy discrimination against agriculture in Nigeria, a situation not unconnected with the overdependence on oil (Daramola *et al.*, 2007). In another vein, agricultural policies introduced are characterized by inconsistencies, instability, poor coordination,

management and implementation of the policy instruments (Sanyal and Babu, 2010; Onwualu, 2012; Ugwu and Kanu, 2012). Most provisions of the policies frequently change or are applied inconsistently, resulting in production and price uncertainties and the consequent unpredictability in projecting investment returns (Onwualu, 2012). Agricultural policy flip-flops are not unconnected with bad governance and political instability witnessed over the years in Nigeria (Ugwu and Kanu, 2012). Sanyal and Babu (2010) further highlights two fundamental reasons for failure of agricultural policies in Nigeria. Firstly, there is a lack of public participation in the design, formulation, implementation and evaluation of policies. The result is policies that fail to connect to people's desires and reflect public interest. Secondly, there is a lack of human capacity and other allied resources in the ministries and parastatals saddled with the responsibility of implementing the policies.

3.5 Government's Response to Agricultural Sector's Poor Performance

Successive governments, recognizing the present and potential role of agriculture in Nigeria's economy and in response to the diminishing performance of the agricultural sector, have always prioritized the sector in their developmental efforts. As Manyong *et al.* (2005) aptly note, the inclination of governments has been to initiate policies and programmes geared towards transforming the performance of the agricultural sector.

There are about five distinct agricultural policy and programme phases in Nigeria, significantly influenced by the incessant changing nature (mutability) of the evident agricultural development problems besetting the nation in specific periods of time. The phases are discussed below:

3.5.1 1960 to 1969 Period

This was a period of minimal direct government intervention in agriculture. Production was generally decentralized and major decisions and initiatives in agriculture were taken by regional and state governments, with the federal government merely providing supportive roles in the form of agricultural extension and research, pricing and export crops marketing activities (Manyong *et al.*, 2005; Daramola *et al.*, 2007). Developmental efforts of the sector were a major preoccupation of the private sector and the smallholders that historically constitutes the majority of people involved in agriculture. Marketing boards and smallholder cooperatives were instrumental to

increased food production during this period. While the former helped in extracting surpluses from the sector, the latter by playing an important role in the distribution of inputs contributed to increased agricultural production (Sanyal and Babu, 2010).

During this period, agriculture was the dominant sector and the driver of the nation's economy. Revenue generated for the sector was used to develop other sectors such as education, telecommunication, construction, manufacturing among others. Nigeria was also self-sufficient in food production, and also exports more than its import, thus generating revenue used for the development of the nation. During the late 1960s however, the sector suffered a rise in retail food prices and a decrease in export earnings which consequently resulted in increased food importation. Agriculture's share in the GDP at constant factor also shrunk from 66% in 1960 to 50% in 1970 (Sanyal and Babu, 2010).

3.5.2 1970 to 1985 Period

In the wake of the declining agricultural performance, the 1970 to 1985 period witnessed series of direct government intervention in Nigeria's agricultural sector. The oil boom era coincided with the neglect of agriculture in favour of the more urban based sector such as manufacturing and construction and this led to serious food insecurity issues as Nigeria had to rely on food importation in order to meet local food demand. As Daramola *et al.* (2007) aptly note, the oil windfall was not invested in agriculture but in manufacturing, commerce and construction and this succeeded in attracting factors of production from agriculture, leading to a serious problem of "Dutch Disease." In order to stem the ensuing tide, there was a consensus that the government could no longer pay lip service to the agricultural sector and maximum government intervention was needed in the sector. Consequently, several policies, programs and projects were put in place especially by the federal government in order to boost agricultural production.

In terms of the macro-economic policies pursued, agriculture's share of budgetary allocations slightly increased to accommodate capital and recurrent expenditures, capital expenditure on agriculture declined from 6.2% in 1973 to 4.0% in 1985 while agricultural loans which were given at a concessionary rate of 6% per annum in the 1970s were increased to 9% in the 1980s (Ugwu and Kanu, 2012). Micro-economic policies pursued in the agricultural sector include the

agricultural commodity marketing and pricing policy of 1977 which led to the establishment of agricultural commodity boards, and the 1978 Land Use Decree which vested the ownership of all lands on the government who will hold it in trust and consequently gave farmers access to farmlands. The period also witnessed the introduction of an irrigation policy which led to the establishment of the River Basin Development Authorities (RBDAs) in 1977 in order to boost agricultural production. The objective was to utilize the nation's vast water resources to solve the lingering food insufficiency problem. Other policies are agricultural input subsidy policy on fertilizer, agricultural research policy aimed at coordinating and harmonizing agricultural research and extension activities, agricultural co-operatives policy among others (Ugwu and Kanu, 2012).

A major programme designed by General Yakubu Gowon led government to accelerate the production of grains (such as rice, millet, maize, wheat and cowpea) in 1972 was the National Accelerated Food Production Programme (NAFPP). The programme was motivated by the fact that grains constitute the major staple foods consumed by Nigerians, and increased production of such crops would go a long way in ensuring food security in the nation. The World Bank assisted Agricultural Development Programmes (ADPs), which adopted the concept of integrated agricultural and rural development in its design, was pilot tested in 1972 in the Northern Nigerian towns of Gombe and Gusau, and thereafter spread to other states of the federation given the successes recorded in the pilot projects (Daneji, 2011). The Nigerian Agricultural and Co-operative Bank (NACB) and the Agricultural Credit Guarantee Scheme Fund (ACGSF) were established in 1973 and 1978 respectively to make funds available for agricultural development.

There was also the Operation Feed the Nation (OFN) programme initiated by the General Olusegun Obasanjo Government in 1976 and President Shehu Shagari's Green Revolution Programme launched in 1979. The former was set up to address issues revolving around food insecurity and rural-urban migration and was able to increase awareness of the food insecurity problems, albeit it also focused on sending ill prepared undergraduates to teach both seasoned and unseasoned farmers how to farm. The OFN programme however had the dual objectives of increasing local food production and decreasing food importation. The implementation of these policies and programmes failed to make any long lasting and significant impact in Nigeria's agricultural sector.

3.5.3 1986 to 1992 Period (SAP Era)

The slump in global oil prices in the early 1980s, Nigeria's increasingly huge debt profile, and the widely acknowledged mismanagement of the economy were major precursors to the Structural Adjustment Programme (SAP) adopted in 1986. The rationale behind the adoption of SAP in Nigeria revolved around the need to fix the growing dual deficits in the fiscal and current accounts and to lift the nation out of financial and economic doldrums. Decreasing export earnings from oil and increasing import bills have been largely responsible for current account deficits while budget mismanagement and declining fiscal receipts from oil resulted in the growth of the nation's fiscal deficits (Daramola *et al.*, 2007).

The Structural adjustment policies in Nigeria were targeted at the correction of both the structural imbalances and the existing price distortions prevalent in the economy, as well as the enhancement of the effectiveness of price factors through the promotion of non-price factors (Manyong *et al.*, 2005). The objectives of the SAP included among others, the restructuring and diversification of the productive base of the economy in a bid to reduce dependency on the oil sector, the achievement of fiscal stability and payments viability over the medium term and the promotion of economic growth with single digit inflation rates (Sanyal and Babu, 2010).

As posited by Manyong *et al.* (2005), the SAP as implemented in Nigeria could be sub-divided into four groups. First are policies designed to influence the economy's aggregate domestic absorption through monetary and fiscal policy instruments, and are referred to as expenditure reduction or demand management policies. Second are export switching policies dedicated towards improving the price competitiveness of export commodities and import competing goods while also modifying domestic relative prices to favour tradable goods. The key and conspicuous policy instrument for this group, and perhaps generally under SAP was the devaluation of the national currency. Daramola *et al.* (2007) observe that the exchange rate, which exchanged for 0.639 naira to a US dollar in 1981 and 0.9996 naira in 1985, averaged 3.32 naira and 19.66 naira in 1986 and 1992 respectively.

Thirdly, the SAP era signified the introduction of market liberalization policies initiated to promote the free interplay of market forces and the deregulation of the economy, as well as to reduce

government intervention in price determination and input provision (Manyong *et al.*, 2005; Daramola *et al.*, 2007). Fourthly, policies to remove the constraints that may prevent the effectiveness of other adjustment policies were put in place, and these include among others, policies to improve infrastructure, input delivery systems, technological innovation, resource allocation and investment climate (Manyong *et al.*, 2005).

The period therefore witnessed the scrapping of agricultural commodity boards and the liberalization of agricultural exports as the prominent thinking was that agriculture should be a private-sector initiative, subject to market forces and that government's role should be limited to the provision of the enabling environment and policies to facilitate private sector investment in agriculture. During this era and specifically in 1988, a new agricultural policy which was intended to be operational for the next fifteen years was produced by the Federal Ministry of Agriculture, Water Resources and Development. The policy encompasses options and strategies for the development of agricultural sub-sectors as well as support services such as agricultural extension, finance, mechanization, investment as well as rural infrastructure, water resources and research. The National Agricultural Land Development Authority Decree was also promulgated in 1992 and its objectives include among others, the promotion of the utilization of rural land resources for increased food production, encouragement of economic size farm holdings as well as consolidation of fragmented farm holdings to raise agricultural productivity and the provision of gainful employment opportunities for rural people.

A major programme implemented by the Military administration of General Badamosi Babangida was the rural infrastructure development programme. The Directorate of Food, Road and Rural Infrastructure (DFRRI) was established in 1986 with a view to open up rural areas through construction of access and feeder roads and to provide basic amenities for decent living. It was believed that these generic goals would go a long way in improving the quality of life of rural dwellers, reducing rural-urban migration and boosting agricultural production as access to farm inputs and markets would be enhanced. The programme however made little impact as it was beset with myriads of problems such as bureaucratic bottlenecks, corruption among others. The Federal government in collaboration with the World Bank launched the National Fadama Development Project (NFDP) in 1992 with the objective of increasing sustainably, the incomes of fadama land

and water resource users in an overall attempt to reduce rural poverty and food insecurity. The project which was designed to improve the flooded plains of the savannah through the development of small scale irrigation farming systems was initially implemented in five states. Presently, the scheme has entered its third phase, covering all states of the federation owing to the successes recorded in the first and second phase.

The naira devaluation of the SAP period led to a significant increase in producer prices, without an accompanying increase in agricultural output. The effect of the devaluation, as Ugwu and Kanu (2012) posit, was felt more on the distribution of farm incomes than on agricultural productivity and growth. As a result, the agricultural sector failed to witness any significant growth during the SAP era despite the many policies put in place. The nation further experienced declining export earnings and economic growth while unemployment and the food supply-demand gap steadily increased. There was also an increase in food prices to 20% during 1980 to 1989 from 2.6% recorded in 1970 to 1979 (Ugwu and Kanu, 2012).

3.5.4 The Post-SAP Era (1992-1999)

The period was significantly marked with political crises in the nation which took its toll on economic and development planning. The regime of General Babangida which presided over the SAP period continued in the early 90s but was confronted with political dilemma relating to its continual hold onto power and the annulment of the 1993 general elections. The subsequent regimes headed by Chief Ernest Sonekan, General Sani Abacha and General Abdulsalam Abubakar also continued to contend with the political conundrum and focused more on stabilising the polity. As a result, there was little in form of economic policies that were implemented and agriculture also suffered neglect. There were no new agricultural programmes while old ones were abandoned. Some of the implemented programmes indirectly connected to agriculture include the Family Support Programme (FSP) which was established in 1994 to promote social and economic well-being of Nigerian families, targeting the health, education and agriculture sectors. It also focused on improving women's productivity and incomes through easier access to micro-credit. The government also set up the Community Action Programme for Poverty Alleviation (CAPPA) in 1997 with the objectives of improving the living conditions of the poor, enhancing their productivity and improving household food security. Despite these efforts, agriculture production

and productivity failed to grow during this period due to the unwholesome focus on agriculture (Daramola *et al.*, 2007).

3.5.5 The New Democratic Era (1999 to Date)

With the embrace of democracy in Nigeria in 1999 has come a renewed focus on the agricultural sector. This is evident in the agriculture related policy documents that are being launched in the nation. These include the 2004 Rural Sector Strategy (2004) and National Economic Empowerment Development Strategy (NEEDS) I and II. The NEEDS programme lasted from 2003 to 2011, focusing on value reorientation, sustainable poverty reduction, wealth creation and employment generation. In 2001, a new agricultural policy was instituted to replace the former policy which had been operational since 1988. As observed by Manyong *et al.* (2005), the objectives of the new policy are similar to the former policy, albeit it is more focused and better articulated. The overarching aim of the policy is to ensure sustainable growth in agricultural productivity (Daramola *et al.*, 2007). The attainment of food self-sufficiency and food security in the nation, increase in the production of export crops and agricultural raw materials, application of modern technologies and improved quality of life for the rural populace were part of the objectives of the new policy. The policy emphasized among others, strategies to ensure self-sufficiency and improvement in the level of economic and technical efficiency in food production, thus according due consideration to small scale farmers and recognizing their roles and potentials as the major food producers in the nation. Plans for the development of necessary rural infrastructure, the introduction of a more robust agricultural insurance scheme and the proliferation of agricultural extension services were also set out in the policy.

Several programmes have also been launched to drive agriculture sector growth in Nigeria since the era of democracy. The President Olusegun Obasanjo government set up Presidential initiatives on selected agricultural commodities, and these emerged out of the need for the nation to leverage on its comparative advantage in the production of some agricultural crops. For instance, while the Presidential Initiative on Cassava (PIOC) was established in 2002 to boost Nigeria's production of cassava and tap the crop's value chain potentials, the Presidential Initiative on Rice (PIOR) was targeted at ensuring the nation's self-sufficiency in rice production by 2005, and the ability to export by 2007 (Phillip *et al.*, 2009).

Under the short-lived Umar Musa Yaradua administration, the Commercial Agricultural Development Programme (CADP) was introduced with the objective of increasing agricultural production and facilitating access to market for targeted value chains among small and medium scale commercial farmers. The programme, according to Onwualu (2012), comprised two components. First was the acceleration of agricultural production and commercialization of agriculture through the development and adoption of appropriate technologies as well as the development of staple crop production support systems. Secondly, the programme focused on the development of rural infrastructure including the construction of roads, rehabilitation of existing ones in an overall attempt to open up the rural areas.

The National Programme for Food Security (NPFS) was launched in 2008 and its vision was to “ensure sustainable access, availability and affordability of quality food to all Nigerians and for Nigeria to become a significant net provider of food to the global community” (FMWR, 2008:31). Important features of the NPFS include boosting agricultural productivity, market development, development of storage and processing capacity, development of agriculture value chains, encouraging small, medium and large scale commercial farming as well as private sector involvement among others.

In an attempt to meet the objectives of the NPFS, agriculture was included in President Goodluck Jonathan’s (Seven Point) Transformation Agenda which aimed at transforming Nigeria’s economy. To achieve the agricultural targets defined in the Transformation Agenda however, a five point agenda, tagged Agricultural Transformation Action Plan (ATAP) was introduced in 2011. This served as a road map on how to achieve the broader agricultural targets set out in the Seven Point Agenda. The plan focused on increasing the productivity in five crops (cassava, cocoa, cotton, rice and sorghum) and was expected to create 3.5 million jobs within four years. Essentially, the plan was geared towards making agriculture not merely a development issue, but more of a business with the active involvement of the private sector. The plan also sought to remove fertilizer subsidy being given to farmers as the government opined that the fertilizer subsidy policy has been largely ineffective, but has only resulted in distortion in the distribution channels. Indeed, for the most part, fertilizer failed to reach smallholders who constituted majority

of farmers as supplies were hijacked by people with political connections who resold the fertilizers at higher prices in the market.

According to Adetiloye (2012), five major programmes emanated from the agricultural action plan. These are the Developing Agricultural Policy and Regulatory System (DAPRS) programme which aims at reforming and refining key agricultural policies, Agricultural Commodity Exchange Market (ACCOMEX) programme which focuses on the establishment of the agricultural exchange markets in order to achieve efficient marketing and pricing information systems, Raising Agricultural Income with Sustainable Environment (RAISE) programme which addresses issues of sustenance of the environment as well as infrastructure deficit especially in the rural areas. Others are Maximizing Agricultural Revenue in Key Enterprises (MARKETS) programme which aims at improving Nigeria's competitiveness in the agriculture sector and developing value chains potentials of the sector, and Water, Aquaculture and Environment Resource and Management (WAERM) programme which focuses on sustainable conservation and the development of water resources potential of the nation through the construction of small dams as well as irrigation and aquaculture facilities.

Although Nigeria is far from reaching its potential and reclaiming its dominance in agriculture, some progress has been recorded with the reintroduction of the democracy. Corruption in fertilizer distribution has been significantly curtailed through the use of an electronic wallet system, providing subsidized farm inputs to farmers using mobile phones, although the initiative was not felt in all quarters. Private sector involvement in agriculture has gathered pace while the nation's food production has also increased. The policy emphasized strategies to ensure self-sufficiency and improvement in the level of economic and technical efficiency in food production, which accorded due consideration to small scale farmers, recognizing their roles and potentials as the major food producers in the nation.

3.6 Agriculture, Poverty Reduction and Food Security in Nigeria

Nigeria's failure to transform the lives of the poor that make up the majority of its population despite the profusion of resources is indeed a developmental tragedy. With a landmass of 923,728 square kilometres (Azuibuike, 2009), a population of about 178 million (UNDP, 2015) and natural

endowments such as fertile agricultural land, solid minerals as well as oil and natural gas deposits that makes it Africa's largest producer and the 13th largest producer of the same commodity in the world (EIA, 2014), it is appalling to note that poverty still pervades the nation.

The most recent economic growth trajectory witnessed in Nigeria has indeed not translated into better lives for Nigerians. The National Bureau of Statistics NBS (2016) reports that Nigeria's real gross domestic product (GDP) growth rate which was 5.45% in 2013 grew to 6.23% in 2014 but dropped to 3.05% in the first three quarters in 2015. The World Bank (2013) also posits that Nigeria's GDP has grown at an average rate of 8 per cent over the last decade. The recent rebasing of Nigeria's GDP raised the size of her economy by 75 per cent, thus making the country the biggest economy in Africa and the 28th largest economy in the world (Deutsche Bank Research, 2014; NBS, 2014). Despite these achievements, the nation is struggling to develop as it has a high and persisting poverty rate, and was not able to reach the Millennium Development Goal (MDG) poverty reduction target by 2015. According to the NBS (2010), about 61 per cent of Nigerians still live below the one dollar poverty line as at 2010 and this was an increase from 51.6 per cent recorded in 2004. The poverty rate has however increased to 64.2 per cent as at 2013 (World Bank, 2013:9).

The Human Development Report of the UNDP paints a clearer and more recent picture of the dire situation Nigeria is presently facing with regards to poverty and development. The report stresses that the evaluation of the development of a country should transcend economic growth, recognizing people's capabilities to "do" and "be" desirable things in life as the critical criteria in such assessment. In 1996, Nigeria was ranked 137th among the 174 countries listed with a Human Development Index (HDI) score of 0.384. The 2015 report however ranked Nigeria 152nd out of 188 countries in 2014 with a Human Development Index (HDI) score of 0.514. The average annual HDI growth between 2010 and 2014 was 1.06% as the HDI score barely improved from 0.493 to 0.514, while the Multidimensional Poverty Index (MPI) was 0.279 with 50.9% of Nigerians categorized as multidimensionally poor and 62% of the population living below the globally recognized income poverty line of 1.25 dollar per day (UNDP, 2015).

The severity of poverty in Nigeria however differs by region. Indeed Nigeria's poverty profile by geopolitical zones indicates that poverty is most profound in Northern Nigeria, particularly the North West and North East geopolitical zones. These two regions have suffered the most neglect over the years and development programmes have failed to make the desired impact in the lives of the masses. Figure 3.1 presents a multidimensional analysis of poverty across the geopolitical zones by the Nigerian Bureau of Statistics. Evidently, the incidence of poverty in all dimensions considered was most prevalent in North West Nigeria. About 51.8% of the total population living in North West Nigeria were food poor, while 70% and 77.7% respectively were categorized as living in absolute poverty and relative poverty. The North East region followed closely with food poverty incidence affecting 51.5% of the population, and 59.5% and 67.5% considered to be absolutely poor and relatively poor respectively. Food poverty incidence affects 38.6% of the population in North Central Nigeria, and proportion of the population considered to be absolutely poor and relatively poor were 59.5% and 67.5% respectively. Contextually, the poverty situation is a little better in Southern Nigeria where food poverty affects 41%, 35.5% and 25.4% of the population in South East, South South and South West regions respectively. The South East and South South regions have a relative poverty incidence of 67% and 63.8% respectively and an absolute poverty incidence of nearly 60%. The South West region however has the lowest prevalence of poverty in the nation with 49.8% and 59.1% of the region's population affected by absolute poverty and relative poverty respectively.

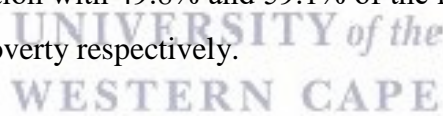
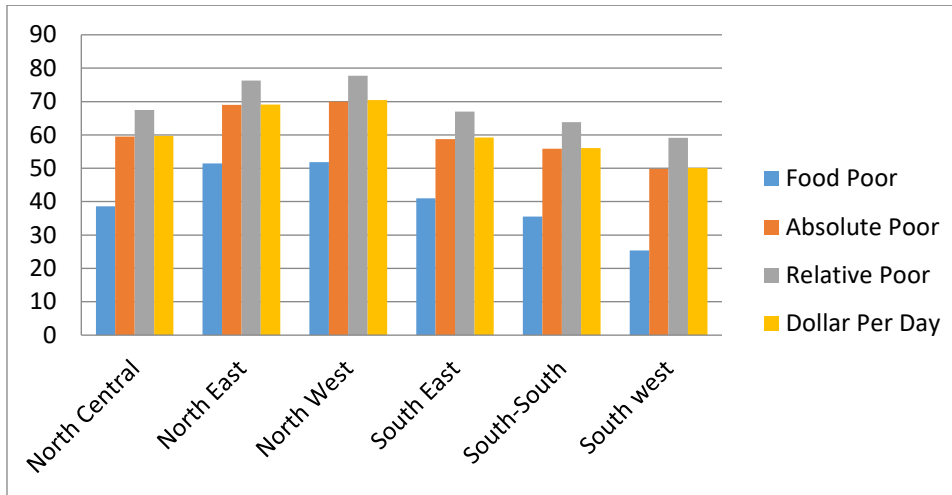


Figure 3.1: Nigeria's Poverty Profile by Geopolitical Zones.

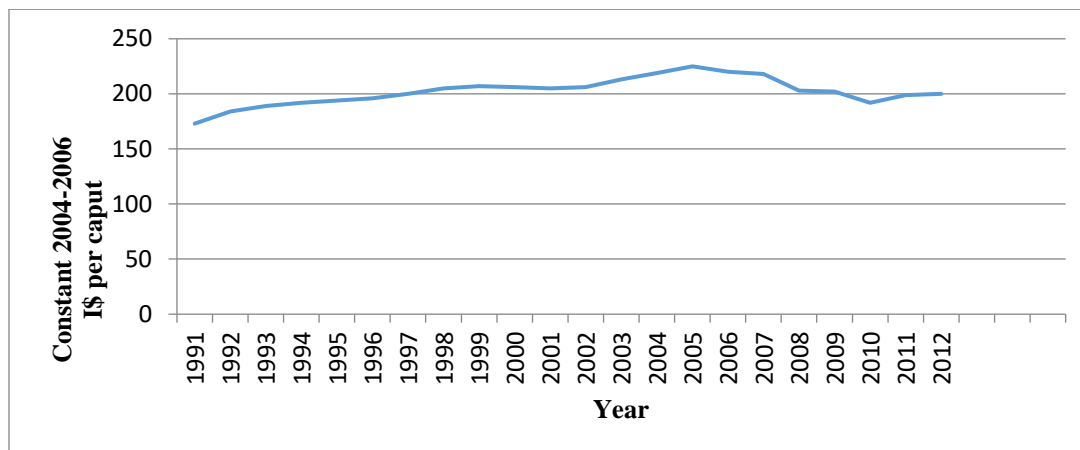


Source: NBS, 2010

In the wake of the recent oil price crash of 2015/2016, Nigeria's recent significant progress in terms of economic growth has stalled, thus having a worsening effect on the quality of life of the Nigerian populace. It is thus clearly evident that despite Nigeria's natural riches, the nation is not only languishing in poverty, but also retrogressing especially with particular reference to poverty reduction. It is a conundrum of such as the level of poverty seems incongruous with Nigeria's immense wealth, and also, because the poverty situation persists despite the huge human and material resources that have been committed to poverty reduction.

Directly linked to the poverty situation is the issue of food security Nigeria is presently grappling with. Despite the numerous investments, policies and programmes implemented to achieve food security, the nation's food security situation has left little to be desired (Akinyele, 2009). Indeed Nigeria is far from being food secure as can be seen from several indicators. Food availability is a critical dimension of food security. Although inadequate on its own, ensuring sufficient supply of food is a pre-requisite for achieving enough access to food for individuals (FAO, IFAD and WFP, 2013). Food availability is measured through the average dietary energy supply adequacy (ADESA) and average value of food production. The former represents the dietary energy supply as a %age of the average dietary energy requirement (ADER) of the country, while the latter is the total value of annual food production expressed in international dollars per caput.

Figure 3.2: Nigeria's Average Value of Food Production (per caput).



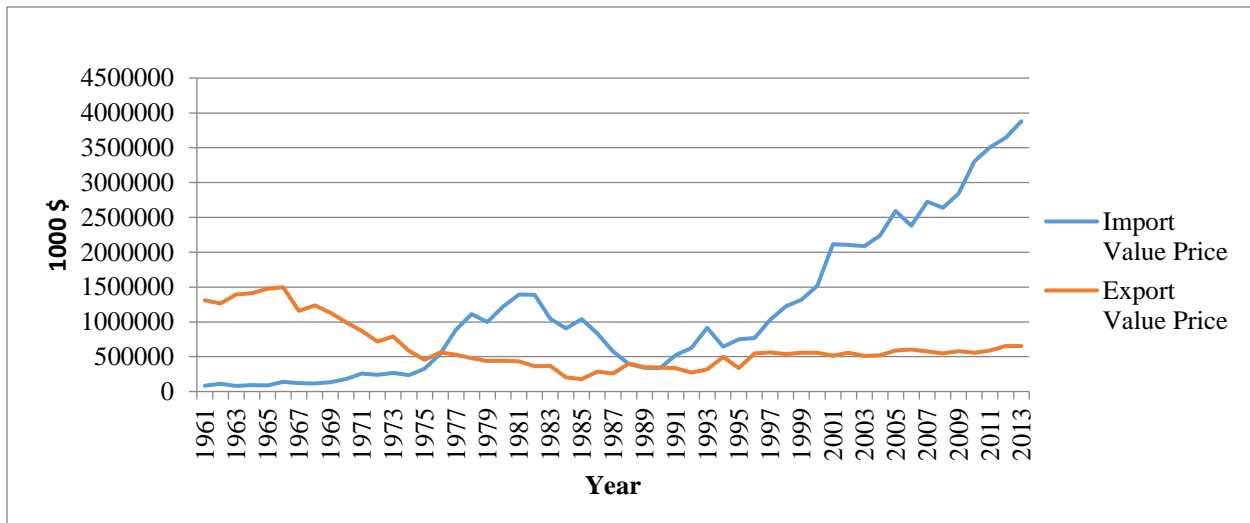
Source: Author's computation; computed with data extracted from FAO (2016)

Average value of food production for Nigeria (Figure 3.2) in 1991 was \$173 per caput. This steadily increased and reached its peak in 2005 when it was \$225 per caput. It was \$218 per caput in 2007 but declined sharply to \$203 per caput in 2008. This may not be unconnected with the global crisis of 2007/2008 which witnessed the world food prices soaring significantly. In other words, as world food prices increased, food production declined in Nigeria, and in sub-Saharan Africa it declined from an average of \$158 to \$157 per caput. As at 2012, average value of food production in Nigeria was \$200 per caput, and this pales in comparison with some other developing countries. For instance, the average value of food production in per capita terms for Cameroon, Ghana, Mali and South Africa were \$234, \$287, \$220 and \$239 respectively. With the exception of Algeria and Western Sahara, all other countries in North Africa had higher per capita food production than Nigeria.

Furthermore, growth in food production between 1991 and 2012 increased at 0.7% per year in Nigeria compared to Cameroon (2.4%), Ghana (3.1%), Mali (1.8%) and South Africa (0.6%). Annual agricultural production growth has been lower in Nigeria compared with developing countries in general which increased at a rate of 2.3% per year. Evidently, Nigeria does not produce enough food to feed its population and has had to rely on import to fill the food demand-supply gap. From Figure 3.3, it is evident that Nigeria's agricultural exports surpassed its imports in monetary value up until 1976. The trend however was reversed from 1977 to 2013 (albeit with the exception of years 1988-1990 when Nigeria was a net exporter of agricultural commodities) and

this period saw Nigeria spending more on agricultural imports than the total monetary value of its exports. By 2013, Nigeria’s agricultural export value was about \$655 million, while its import was around \$3.88 billion, thus recording an agricultural trade deficit of about \$3.2 billion.

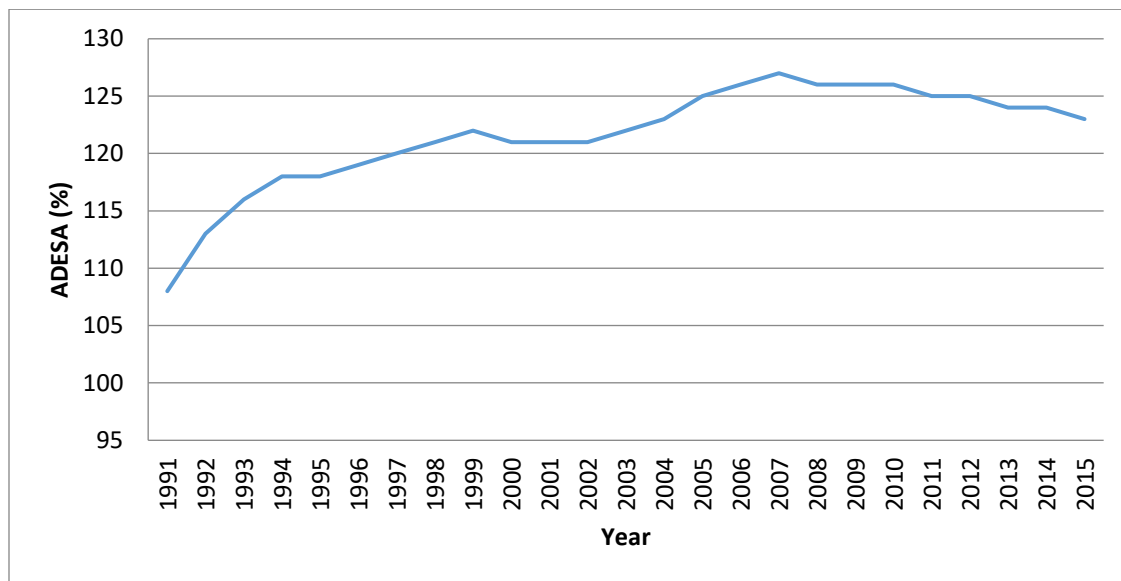
Figure 3.3: Nigeria’s Agricultural Trade Indices.



Source: Author’s computation; computed with data extracted from FAO (2016)

The average dietary energy supply adequacy (ADESA) value in Nigeria indicates an increase from 108% to 123% between 1991 and 2015. An ADESA value greater than 100 in any country points to the fact that on average, there is surplus total dietary energy supply available, sufficient to meet the needs of the population for a healthy life. The ADESA value for Nigeria in 1991 implies that the available dietary energy supply was 8% more than the average requirement, but grew to be 23% more than the average requirement in 2015. The 2015 ADESA value is similar to the global ADESA as a whole, but higher than that of the developing countries (120%) and Africa (117%). However, some similar developing countries such as South Africa, Ghana and Ivory Coast had higher ADESA values than Nigeria, with 131%, 150% and 131% ADESA values respectively. The foregoing suggests that indeed there is enough food in Nigeria to go round the population and meet their needs for a healthy life. This is partly due to a slight increase in local food production, and partly due to the nation being a net importer of food to augment its food deficit.

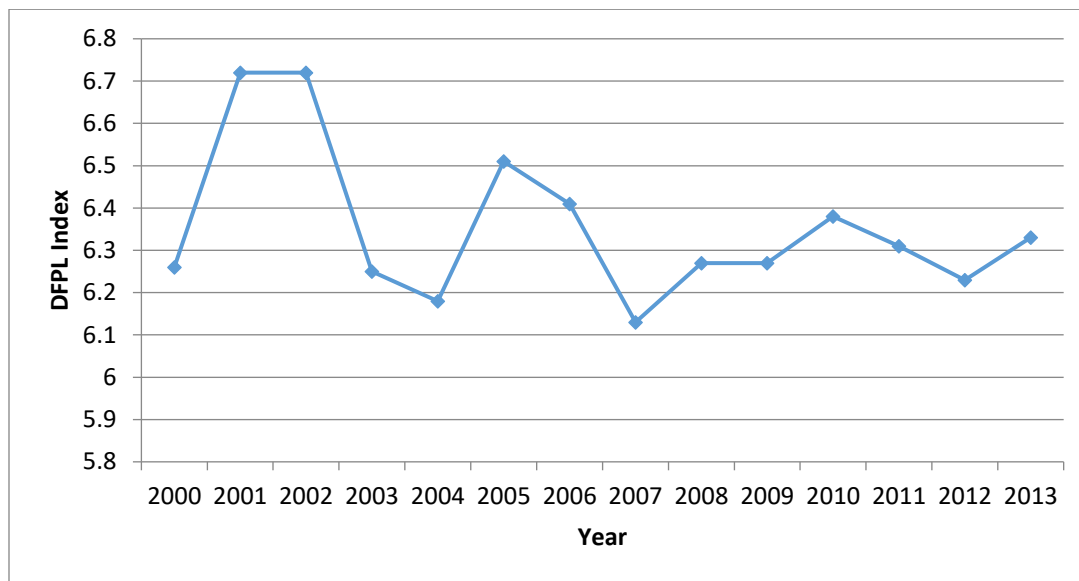
Figure 3.4: Nigeria's Average Dietary Energy Supply Adequacy (ADESA) Values.



Source: Author's computation; computed with data extracted from FAO (2016)

An adequate supply of food in a country however does not guarantee that every individual will have sufficient food to eat. There may exist problems of access to food for some individuals, consequently resulting in undernourishment. The domestic food price level index, according to FAO (2013), represents a measure of economic access to food and is the ratio of the food purchasing power parity (FPPP) to the general PPP, and further used to capture the extent of exposure to real income swings. Nigeria's domestic food price level index is presented in Figure 3.5. The index was 6.26 in 2000, reached its peak of 6.72 in 2001 and 2002 and was 6.33 in 2013. The relative progress made in 2007 when it was at its lowest (2007) became eroded during the 2007/2008 rise in food prices as it started experiencing a steady increase. Nigeria's domestic price of food is also higher relative to some similar countries. The average domestic food price index for Nigeria between 2000 and 2013 was 6.48, higher than that of Africa (5.5), sub-Saharan Africa (5.5), developing countries (3.9), developed countries (1.7), but lower than Western Africa (6.6).

Figure 3.5: Nigeria's Domestic Food Price Index.



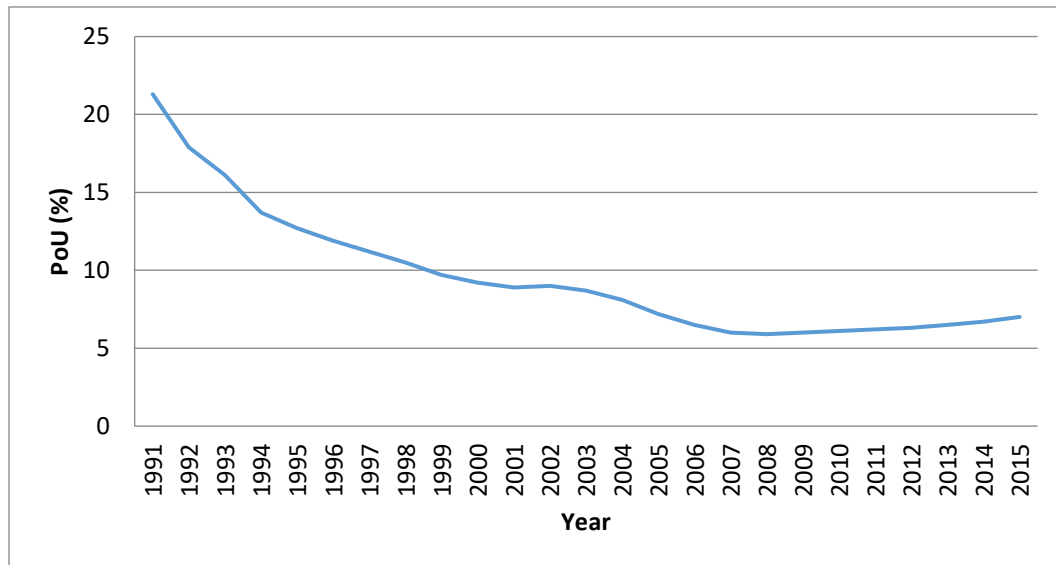
Source: Author's computation; computed with data extracted from FAO (2016)

It is apposite to reiterate at this juncture, that Nigeria is heavily reliant on food imports to meet domestic demand and is often at the mercy of the mutable international prices. This reliance has taken its toll on the price of food in the nation, and is partially responsible for the high food price level indices recorded. For a country heavily dependent on food import, there is a tendency that due to higher international prices, substantial pressure can be exerted on governments and household budgets, subject to the pass-through from international prices as well as the level of domestic consumption subsidies (World Bank, 2012). Undoubtedly, this pressure would be more felt in households that spend a significant proportion of household earnings on meeting their food needs.

Undernourishment is an outcome of a complex interaction between several factors spread across all food security dimensions including availability, accessibility and stability. An examination of the progress made over the years indicates that 20.8 million people, representing 21.3 % of Nigeria's total population, were undernourished in 1990-92. The situation was however different in 2000-02, as 11.2 million (8.9 %) Nigerians were undernourished. For the 2005-07, 2010-12, 2014-16 sub-periods, the total number of undernourished Nigerians were 9.3 million (6.5 %), 10.2 million (6.2 %) and 12.9 million (7.0 %) respectively (FAO, IFAD and WFP., 2015:45). As such,

Nigeria was able to achieve the MDG 1c target of halving the proportion of undernourished people by 2015, but failed to achieve the WFS target of halving the total number of undernourished people by 2015.

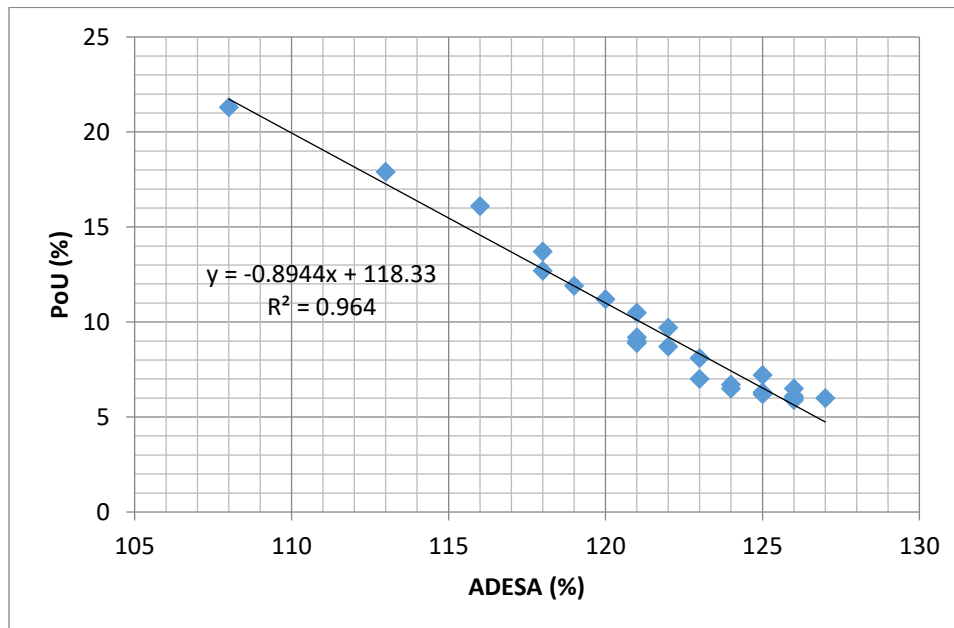
Figure 3.6: Prevalence of Undernourishment in Nigeria.



Source: Author's computation; computed with data extracted from FAO (2016)

When the ADESA, an indicator for food availability is plotted against prevalence of undernourishment (PoU), result shows a strong association between two indicators. Figure 3.6 indicates that high ADESA values are strongly correlated with low PoU rates (with an R^2 of 0.964). In other words, the continuing increase in Nigeria's average dietary energy has corresponded with sustained decrease in the prevalence of undernourishment. This is consistent with findings in most countries where food supplies generally exceed the amount of food required by the population (FAO, IFAD and WFP., 2015:45).

Figure 3.7: Average Dietary Energy Supply Adequacy ratio and Prevalence of Undernourishment in Nigeria.



Source: Author's computation; computed with data extracted from FAO (2016)

The 2015 Global Hunger Index (GHI) score computed by IFPRI which uses a multidimensional approach to assess hunger indicates that Nigeria has a GHI score of 32.8, was ranked 91st out of 104 countries, and only did better than 13 countries in the list of countries. It must be noted that a higher index score indicates higher prevalence of hunger and developed nations and countries with a GHI score less than five were not included in the list. Considering the trend from 1990 to 2015 however indicates slight and gradual improvement in hunger reduction over the years. Nigeria's GHI score which was 47.7 in 1990 was 47.1 in 1995, 41.0 in 2000, 35.2 in 2005 and 32.8 in 2015 (IFPRI, 2015:18). The progress notwithstanding is lost in the global picture as a GHI score of 32.8 is one of the highest in the world and the hunger prevalence, IFPRI (2015) asserts, portends serious hunger crisis for the nation.

The progress evident in food security in Nigeria, particularly in the proportion of undernourished people, owed much to the significant economic growth the nation experienced in recent years and domestic reforms which enhanced incentives for agricultural commodity producers (FAO, IFAD and WFP, 2015). Added to this is the increased availability of staple foods, often financed through

imports and which, according to FAO, IFAD and WFP (2015), fail to address critical dietary imbalances. The consequence of this is that while the proportion of undernourished people has reduced significantly in Nigeria, there has been no corresponding reduction in the prevalence of underweight children under five years, as 19.8% of children under the category were underweight in 2014.

A major reason for the slow progress in reducing food security in Nigeria is not farfetched as it has been established that poverty causes hunger, and conversely, inadequate nutrition results in ill health which can cause poverty (FAO, 2008). As such both serve as causal factors of the other and it is safe to assume that the persisting levels of poverty in Nigeria are a direct cause and effect of food insecurity. For instance, Akinyele (2009) reports a higher food-energy poverty incidence among the poor (54.7%) than the non-poor (45.3%) in Nigeria. This is more valid of the northern geopolitical zones where the poor had a higher incidence of food-energy poverty than the non-poor. Conversely, the incidence of food-energy poverty in the southern geopolitical zones was more prevalent among the non-poor than the poor. When the food-energy poverty incidence was disaggregated by location, it was found to be higher among the rural poor than the rural non-poor and higher among the urban non-poor than the urban poor (Akinyele, 2009). Indeed, Nigerians that are food insecure are found in both urban and rural areas, albeit most are located in the rural areas where majority of Nigeria's poor live.

As observed by Akinyele (2009), reasons for continued food insecurity in Nigeria also include the subsistence nature of the agriculture practiced by some farmers, lack of access to education, land, credit, and technology especially for women who are critical to diet and nutrition issues and also make up a considerable proportion of the total number of people involved in agriculture (Akinyele, 2009). Others include unending rapid population growth as well as low productivity, often influenced by lack of access to market and drought, and which inadvertently affects competitiveness and makes the nation susceptible to import surges (FAO, IFAD and WFP., 2015).

The increasing poverty rates, undernourishment and a hunger prevalence categorized as serious are testament to the fact that all is not well with the quality of life of majority of Nigerians. There is no gainsaying that inadequate attention accorded to the agriculture sector has resulted in a lower

quality of life for many Nigerians and this is a reflection of the serious structural issues plaguing the Nigerian economy. It is unsurprising that the ousting of the agricultural sector that employs about 60% of the nation's total work force (Manyong *et al.*, 2005; Omojimite, 2012) by the oil sector which employs only 4% of the work force (Daramola *et al.*, 2007), has coincided with the increase in the incidence of poverty and continued food insecurity. As attention and investment is diverted away from agriculture to other sectors, unemployment rate has also been soaring, driven by the millions of Nigerians entering the labour market annually and the continuing rural-urban migration. The general unemployment rate, according to (FMARD, 2011), was 12.3% in 2006 but increased to 20.6% in 2010, reflecting an annual increase of 11%. From the foregoing, it is evident that agriculture's neglect has brought more harm than good to Nigeria.

The prospects for reducing poverty in Nigeria, according to Daramola *et al.* (2007), hinges on agriculture in view of the share of total labour force employed in agriculture and value chains potential of the sector. For instance, agriculture can provide employment which helps to lead people out of poverty and also achieve food security. It is possible that a farmer may not produce all that is needed to feed himself and his household. He may therefore need to rely on the market to get some other agricultural commodities that is readily not available from his farm. Revenue generated from his agricultural output can provide him with the funds needed to purchase the commodities. As such, agriculture as a source of employment can help achieve food security. The fact that agriculture serves as a major source of income for majority of the rural poor who make up a significant proportion of Nigeria's population further reinforces the foregoing. As the main source of food and livelihood in Nigeria, the potential of agriculture towards achieving food security and poverty reduction cannot be overemphasized. Hence there must be a central focus on agricultural investment to help lead people out of poverty and to achieve food security.

The importance of focusing on agricultural investment to help lead people out of poverty and to achieve food security cannot therefore be overemphasized.

3.7 Irrigation Agriculture Development in Nigeria

The overt and latent role irrigation plays in Nigeria's agriculture cannot be overemphasised. The nation is identified as one of the countries that are incapable of meeting their food needs solely

from rainfed production at low level of inputs, and even if the inputs reach the intermediate level (Oni, 2009). Fertile soils are ubiquitous in Nigeria but rainfall is unpredictable, unreliable and insufficient in some climes, thus making it impossible to engage in all year round farming. This is more pronounced in the semi-arid regions of Northern Nigeria where desertification and issues revolving around climate change have drastically reduced the amount of precipitation available annually (Jamala, Shehu and Garba, 2011; Yila and Resurreccion, 2013). By means of supplying water to farms all through the year, irrigation development makes it possible for crops to be planted more than once a year and for farmers to practice all year round farming. Furthermore, where precipitation is not available throughout the year, the irrigation system helps to boost and improve agricultural yield, especially in moisture deficient environments (Oriola, 2008, 2012). Evidently therefore, irrigation projects are imperative to achieving growth in Nigeria's agricultural production which is germane to the nation's overall attempt to reduce poverty and food insecurity.

Nigeria occupies a total area of 92.4 million hectare, consisting of 91.1 million hectare of land and 1.3 million hectare of water bodies (Adetunji, 2006). The World Bank (2008) estimated that about 75 per cent (68 million hectare) of the total land area has potential for agricultural activities with about 33 million hectares under cultivation. Similarly, only about 293,000 hectare (9 per cent) of the approximately 3.14 million hectares of irrigable land area is utilised (FAO, 2017a). The extent of irrigated land area is not in the same level as some other developing nations despite huge investments in irrigation infrastructures by successive governments. For instance, Oni (2009) asserts that India irrigates nearly 45 times as much land compared to Nigeria, despite having about 3.5 times the land mass of Nigeria.

Irrigation practices in Nigeria dates back to the precolonial era where water was rudimentarily applied to land for dry season farming in the Northern part of the country. The government of Nigeria however began to seriously consider investment in irrigation after independence in 1960. Between 1976 and 1990, Nigeria invested over \$2 billion on the development of public irrigation projects, ranging from large to medium scale projects. The spending include the ones for the development of the Chad Basin Scheme, the Kano River Irrigation Scheme and the Bakolori Scheme which are the three pilot schemes and are located in the semi-arid regions of the nation. The success of the schemes and the drought that lasted between 1970 and 1975 in some parts of

the country contributed to the establishment of the RBDAs and development of several irrigation schemes throughout the country (Oni, 2009).

The Federal Government of Nigeria, through the Federal Ministry of Water Resources (FMWR) has recently put in place a National Irrigation Policy and Strategy to serve as a framework for irrigation development in the country. Under this policy, irrigation activities in Nigeria were put under the administration of the River Basin Development Authorities (RBDAs), with the Ministry of Water Resources playing a supervisory role. There are currently twelve RBDAs in Nigeria (Oriola, 2008), and these are responsible for implementing the irrigation development policies of the Federal Government.

The River Basin Development Authorities (RBDAs) were established by the Federal Government of Nigeria in 1977 in order to improve agricultural production and ensure food security in the nation (Akindele and Adebo, 2004; Oriola, 2008; Akinyele, 2009; Daneji, 2011; Ugwu and Kanu, 2012). The establishment of the RBDAs, according to Akinyele (2009), represents a major irrigation policy instrument initiated for the exploitation of the vast water resources for fishing and agricultural purposes. A major rationale for the establishment of the RBDAs was the need to encourage large-scale agriculture in order to boost food production. The Nigerian government, in an attempt to solve the persisting problem of food insufficiency in Nigeria, established the RBDAs to accelerate food production and diffuse agricultural innovation in the rural areas (Akindele and Adebo, 2004). Along similar lines, the institution of the RBDAs was also necessitated in a bid to stem the tide of the short rainy seasons that have restricted crop production in many parts of the country (Daneji, 2011).

Adekalu and Ogunjimi (2003) highlight the main functions of the RBDAs established by the federal government. These include the carrying out of comprehensive development of surface and ground water resources for wide ranging uses such as irrigation, fisheries, water supply among others. This is to be achieved through the construction of dams, dykes, irrigation and drainage systems, boreholes, the controls of floods and erosion as well as the management of water resources and other related services such as agricultural extension. An additional function of the RBDAs is the construction, operation and maintenance of essential infrastructures such as bridges and roads

serving as link to the projects undertaken by the RBDAs, and hence opening up rural areas for development purposes. The RBDAs were in essence charged with the responsibility of developing Nigeria's vast water and land resources and empowered to develop rural areas.

As noted by Oriola (2008), 18 RBDAs were created in 1986 but these were eventually harmonised into 11 as some of them were not viable. The Federal Government, because of the size of the Niger River Basin Development Authority, especially in terms of the geographical areas covered and the profusion of natural resources in such areas, in 1994 split the Niger Basin Development Authority into two, namely the Lower and Upper Niger River Basin Development Authorities (Oriola, 2008; Adeniyi and Dinbabo, 2016). The nation thus presently has 12 RBDAs in operation covering different parts of the country.

3.8 Chapter Summary

The chapter has laid bare the interconnectedness between agriculture, poverty and food security in Nigeria. The prospects for reducing poverty in Nigeria hinges on agriculture in view of the share of total labour force employed in agriculture and value chains potential of the sector. The chapter has shown that lack of due attention to agriculture has resulted in reduced agricultural productivity, high food demand-supply gap and unemployment, with a consequent effect on poverty and food security status. The fact that agriculture serves as a major source of income for majority of the rural poor who make up a significant proportion of Nigeria's population further reinforces the foregoing. As the main source of food and livelihood in Nigeria, the potential of agriculture towards achieving food security and poverty reduction cannot be therefore be overemphasized. The next chapter proceeds to present a combination of theoretical ideas adapted for the study.

CHAPTER FOUR

THEORETICAL FRAMING

4.1 Introduction

The focus of this chapter is on the theoretical works adapted for this study. Three bodies of theoretical work was adapted and these underpin the research. These are the political economy of food and agriculture, political ecology and sustainable livelihoods approach. The rationale therefore is to frame and locate the analysis within the three bodies of theoretical work as well as provide a nuanced understanding of the political, economic, ecological and social processes influencing agricultural production, food security and livelihoods of smallholder households. The theoretical works are expanded on in the following sub-sections.

4.2 Political Economy of Food and Agriculture

In studying production systems within a community, it is imperative to consider the dynamics of the larger political economy in order to comprehend the forces driving local production, accumulation and livelihoods strategies. The section discusses theoretical debates and concepts derived from the political economy of food and agriculture. It must be stated that although not all of the concepts and theoretical notions described would be utilized in this empirical work, it is however important to understand the narratives and trajectories that have shaped the knowledge of food and agriculture using the political economy framework. Much of the work on agrarian political economy builds from Marxian political economy. Karl Marx's theoretical analysis of the origins of capitalism in agriculture and how agrarian change has been shaped by capitalism represent an important point of departure for any political economy analysis of the nature of agriculture.

Capitalism here is defined as “a system of production and reproduction based in a fundamental social relation between capital and labour: capital exploits labour in its pursuit of profit and accumulation, while labour has to work for capital to obtain its means of subsistence” (Bernstein, 2010:1). It is basically a system in which producers and those who appropriate the surplus labour of direct producers are reliant on the market for the basic conditions of their survival and self-

reproduction (Wood, 2009). Capitalist mode of development has brought about the notion of class relations and its mutable nature, where class is seen as a group of people occupying a shared structural position within the social relations of production (Manenzhe, 2015).

Agrarian political economy is thus preoccupied with the investigation of “the social relations and dynamics of production and reproduction, property and power in agrarian formations and their processes of change, both historical and contemporary” (Bernstein, 2010:1). Quoting Marx, Bernstein (2010) notes that political economy is not technology, but is rooted in the social conditions of production, an allusion to all the interactions among people which determines how production is organized including its technical conditions. This strand of political economy thus describes how farming and agriculture is transformed into capitalist entities via the actions and influence of the states, other capitals, as well as the historical and contemporary productive forces within agriculture (Genis, 2015). The approach is therefore useful to understand the complexities of the social relations within a productive agricultural society as well as the class positions of the various actors within such society.

The nature of capitalism’s involvement in agriculture is analysed through the lens of the “agrarian question” which has evolved overtime but remains hotly debated and widely contested (Akram-Lodhi and Kay, 2009; Cousins, 2013). A synthesis of the agrarian question would help uncover distinct analytical issues that could be of importance in understanding the nature of smallholder irrigation agriculture in the study area. Emerging from the synthesis would be influential perspectives relevant for this research which includes the notion of social differentiation, as well as the dynamics of accumulation and diversification. Contemporary issues such as the corporate food regime, the emergence of capitalist transnational agricultural corporation, the global division of labor in agriculture, and their relationships with states and political processes are also considered.

4.2.1 The Agrarian Question: Classical Formulations

The agrarian question has its origin in the first volume of Karl Marx’s seminal work, *Capital* (initially published in 1987) where Marx theorised about the class basis and dynamics of capitalist farming through an in-depth analysis of the concept of ‘primitive accumulation’ which led to the

emergence of capitalist agriculture in England (Bernstein, 2006; Akram-Lodhi and Kay, 2009). According to Denis (1982), Marx's work on agriculture is rooted in the law of value, ground rents and the equalization of the rate of profit, with a particular emphasis on the distributional tendencies of value resulting from capital. His analysis focuses on how pre-capitalist agrarian social formations (predatory landed property and peasantry) were being transformed by capitalist social relations of production, displacing predatory landed property and dispossessing peasantry (Bernstein, 2006). Essentially, Marx predicted the eventual disappearance of simple commodity agriculture in the wake of the emergent capitalist industrialisation of agriculture (Denis, 1982; Bjørkhaug, 2012).

According to Akram-Lodhi and Kay (2010a), Marx opined that the development of capitalism would lead to the impoverishment of peasants, as they are left with no choice but to inculcate coping mechanisms employed by petty commodity producers under capitalism. Inherent in the nature of capitalist agriculture, as construed by Marx, is its potential to give rise to both 'dispossession by displacement' and 'peasant dispossession by differentiation' largely propelled by the inevitability of markets to exploit labour, improve productivity and reduce production costs (Akram-Lodhi and Kay, 2010a:183). He avers that peasants were showing traits of differentiation as better-off rent paying peasants exploits agricultural wage labourers to the extent that it is possible for these group to graduate to become future capitalists (Marx, 1981). Moreover, in his analysis of Russian peasantry, he observes that as Russia becomes increasingly linked to the global market in which capitalist production dominates, a clear setting emerges in which an interventionist state, intruding capitalists, merchants and landed proprietors combined to relegate the peasantry (Akram-Lodhi and Kay, 2010a). In essence, capitalism has the inherent potential of enriching a particular group while leaving others behind.

The agrarian question was further interrogated in the writings of Friedrich Engels, Karl Kautsky, and Vladimir Lenin in the late nineteenth century. Engels was basically preoccupied with the question of how and why capitalist production was essentially destroying peasantry, a fundamental factor of production, population and political power. Engels argued that the incipient globalization of the food system due to imperialism has led to the increasing availability of cheap grains and this was slowly leading to the dissolution of the peasantry in Europe and their concomitant

dispossession from the land (Akhrām-Lodi and Kay 2009; 2010a). He advocated for a political response to the impending crisis, suggesting an alliance between the urban working class and the peasantry in order to save small production in agriculture. For Engels therefore, the agrarian question was that of labour and the demonstration of its agency and not necessarily about capital (Akhrām-Lodi and Kay 2009; 2010a).

Kautsky along with Lenin, differed from Engels in their opinion of what was responsible for the rural transformation that was in progress then. They suggest that the enabling processes leading to the emergence of capital and capitalist industrialization was behind rural transformation and agrarian capital (Petit, 1979; Akram-Lodhi and Kay, 2010a). As such, theirs was an agrarian question of capital as pre-capitalist mode of production became subjugated to capitalism and its unwavering promotion of productivity improvements and cost reductions which were essentially driven by market imperatives (Akhrām-Lodi and Kay, 2010a). The classic agrarian question is traced to Kautsky who re-examined Marx's earlier hypothesis and asked "is capital, and in what ways is capital, taking hold of agriculture, revolutionizing it, smashing the old forms of production and of poverty and establishing the new forms which must succeed?" (Banaji 1980, quoted in Akhrām-Lodi and Kay, 2009:5). For Kautsky, it is insufficient to ask only about the survival of the peasantry, but to interrogate all the transformations being experienced by agriculture owing to capitalist production (Petit, 1979). The processes facilitating this transformation, as well as outcomes and responses to such transformation were major thrusts of Kautsky and Lenin's study.

Both Kautsky and Lenin did not subscribe to the notion that capitalism impose path-dependence on agriculture; that agriculture, following industry, would yield to capitalism. Hence farm distribution may not necessarily change overtime and peasants can overcome the technical efficiency drive of capitalism by working more intensely (Akhrām-Lodi and Kay, 2009, 2010a). Kautsky was unable to find support that peasantry or family family would be out phased (Bjørkhaug, 2012), but clarifies the feasible co-existence of small peasant farms alongside large farms and the continuing resistance of the former, alluding to the possibility of peasants obtaining additional income as waged labour in larges farms and where such opportunities are unavailable, by working more and consuming less (Petit, 1979; Akram-Lodhi and Kay, 2009). Kautsky also asserts that the distinctness of agriculture particularly relating to land as a fixed entity and quantity,

competition from agricultures (oriental and settler agriculture) elsewhere in the global arena, as well as state interventions in terms of policies favouring the middle peasantries would forestall agriculture's subordination to capital (McMichael and Buttel, 1990).

The ability to work longer and harder thus depressing real wages, coupled with seasonal and biological factors would make agro-industrial capitalists resort to investing in inputs and processing industry as well as rural financial systems (Akram-Lodhi and Kay, 2009; Bjørkhaug, 2012). The foregoing is what is referred to as the *subsumption* of petty commodity production, wherein capital through the use of science, technology and money would penetrate and dictate agricultural production to the extent that peasantry would be at the mercy of agro-industrial capitalists. As Lenin understood, capitalist industrialization increasingly commodified agricultural production and dismantled pre-capitalist labour regimes in both rural and urban areas due to the growing need and thirst for a waged labour force. Capitalist relations of production thus led to the emergence of exploitation; the extraction of surplus value from labour which serves as the basis for rural accumulation (Akram-Lodhi and Kay, 2009). Several other mechanisms promoting accumulation and rural transformation were identified by Lenin and Kautsky and are described below.

4.2.1.1 Specialisation and Class Differentiation

It is noteworthy to state that capitalism promoted specialization and social differentiation within the rural community which was brought about by the mechanisms of the market. People increasingly felt that some of their needs could be met via the markets, which led to an overreliance on the markets and social differentiation on the basis of the ability or otherwise to be competitive in the market. Those who were able to sustain their competitiveness were able to increase accumulation while non-accumulating households were those who were unable to compete successfully in the market and were thus subordinated to labour and products market, with many forced to liquidate their assets (Akram-Lodhi and Kay, 2010a). Peasant accumulation brought about the transformation of the social and material conditions of petty commodity production as peasants became “proto-capitalist and fully capitalist employers of not only themselves and their households but, crucially, waged labour” (Akram-Lodhi and Kay, 2010a:187).

Cousins (2013) points out that a notable feature of the classic agrarian question was the dynamics of class differentiation. This was prominent in the theoretical discourse of Marx, Lenin and Kautsky. For Lenin, there was a growing differentiation within the peasantry and class polarization within agriculture, resulting in the creation of conflicting classes of agrarian capitalists and rural workers (Buttel, 2001). Lenin (1966) identified the emergence of six distinct rural classes. First is the big landowners, descendants of feudal lords or rich magnates who exploit wage-labour and the neighbouring small peasantry either directly or through their tenant farmers. Next are the big peasants; capitalist entrepreneurs who hire labour and also work the farm themselves while only connected to the peasantry in terms of culture and habits of life. Middle peasants are able provide subsistence for the family, occasionally hire labour and have little surplus which may be transformed into capital. The remaining three are the clearly exploited and top of this strata are the small peasantry who from their own land or rented land are only able to meet the subsistence need of the household and do not hire labour. Semi-proletarians are those who combine cultivating their own plots with waged labour in order to meet livelihood needs of their households. At the lowest rung of the ladder are the agricultural proletariats who obtain their livelihoods working in agricultural capital enterprises as waged labour.

Suffice to state however, that social differentiation may not be uniform and straightforward as it has been construed. Referring to O’Laughlin’s (1996) dissection of the agrarian question in Mozambique, Cousins (2013) notes that social differentiation of rural households did not proceed in a direct and precisely stratified manner but combined two analytically divergent process; “(a) a ‘diversification of rural livelihoods’ via variable combinations of own production and different forms of wage labour; and (b) ‘class stratification’, the emergence of sharp differences in control of land, cattle and implements (the means of agricultural production)” (Cousins, 2013:121). Cousins (2008), in his agrarian class analytic of South Africa, identifies different typologies of smallholder farmers; capitalists whose major income is not from farming, small-scale capitalist farmers, petty commodity producers, worker-peasants, allotment-holding wage workers and supplementary food producers. As a result of the foregoing, it would be apposite to maintain that although there exist a general inclination towards class differentiation, complexities exist. Therefore heterogeneity observed in class is influenced and/or shaped by other conditions that are not uniformly distributed across space, and hence contingent on an array of locally specific

dynamics, which includes the concatenation of class with other social differentials such as age, , race, ethnicity, religion and gender which is the most widespread (Bernstein, 2010).

4.2.1.2 Scale Economies and Land Size

Scale economies occurs when production per farmer increases over time owing to technical changes, thus consequently reducing average cost of farm products. For Kautsky and Lenin, scale economies was an essential feature of the capitilisation of agriculture, as it enhanced the extraction of surplus labour value. However, they placed less emphasis on land size as the differentiating factor in agrarian transformation, arguing that large scale holdings did not necessarily require large plots of land (Akram-Lodhi and Kay, 2009). For Lenin, a sole focus on the size of the land could be misleading as it does not reflect the scale of operations, the intensity of cultivation and associated improvements on the land. In a similar vein, Kautsky opines that ‘a small holding cultivated on an intensive basis can constitute a larger enterprise than a bigger farm that is exploited extensively’ (Banaji 1980:75, quoted in Akhram-Lodi and Kay, 2010a:190). The foregoing gives credence to their notion that the rise of agrarian capital may not lead to an outright dispossession of petty commodity production as there arises the possibility for survival and subsumption of small and semi-proletarian peasants to agrarian capital (Akhram-Lodi and Kay, 2010a). Disavowing continuing debates about land size however, Akhram-Lodi and Kay (2010a) argue that context matters and that technical conditions that governs agricultural production can only be comprehended within the ambit of social relations of production.

4.2.1.3 Tenancy Relations and Debts

Changes in the mode of land holding may be another mechanism of rural transformation. Alluding to Lenin’s argument, Akhram-Lodi and Kay (2009, 2010a) note that class differentiation of the peasantry might manifest itself in mortgage decline and rise in tenancy as the class interest of landowners serves as a compelling factor for the allocation of land to workers. The foregoing could possibly be in the form of leasing out land either by large-scale enterprises in order to ward off labour shortages during peak periods or by the landowners in order to obtain high prices and high rents, thus taking advantage of the oppressed condition of the peasant (Akhram-Lodi and Kay, 2010a).

Debt was also another important mechanism of rural transformation, and as Kautsky and Lenin observed, there is an obvious distinction in the types of debt incurred by the poorer and richer peasants. In what I refer to as progressive debt, debts are incurred by richer peasants in order to expand their production or productive capabilities. As Akhram-Lodi and Kay (2009, 2010a) posit, the bulk of the spending of big peasants in the market went to production oriented goods and as a result of their more secure financial position, they were able to secure credits for large investments. However poorer peasants, though consuming relatively less than rich peasants, became dependent on the market for subsistence as they spend relatively more on basic wage goods (Akhram-Lodi and Kay, 2009; 2010a). This I refer to as regressive debt as debts became incurred for survival purposes and to meet basic needs. In a nutshell, the rise of agrarian capital led to the emergence of distinct forms of debt; 'one was a sign of precariousness, the other increasing consolidation and capitalisation' (Akhram-Lodi and Kay, 2010a:192).

4.2.2 Contemporary Approaches to the Agrarian Question

Over the years, there have been various debates over the nature and relevance of the classic agrarian question which have resulted in diverse rethinking of the understanding, as well as a renewed analysis of the mechanism of capitalism in agriculture. This is what can be referred as contemporary formulations of the new agrarian question. The new agrarian question is differently understood but well elucidated by several scholars in an edited text; *Peasants and Globalization: Political Economy, Rural Transformation and the Agrarian Question*, edited by Haroon Akhram-Lodhi and Cristobal Kay (2009).

Bernstein (1996) dissected Terrence Byres' (1991) work on the agrarian question in capitalism development and identified three problematics emanating from the nature of the agrarian question. First is the problematic of accumulation, a problematic that focuses on understanding and explaining the contributions of agriculture to industrialization. In other words, it seeks to explain the degree to which productive surpluses emanating from agriculture can be appropriated to support industrialization, accumulation and the development of capital. Second is the problematic of production, which explores the emergence of rural capitalism (the transformation from pre-capitalist to capitalist mode of production), and the associated dynamics of such development such as the alteration in the labour processes, technological requirements and the rise of class

differentiation among the peasantry. Finally, there is the politics problematic which explores the degree to which rural struggles for self-actualisation impacts on agrarian transition and structural transformation. The significance of the latter problematic lies in the fact that factors enabling or constraining agrarian change apparent in the first two problematics shape or can be shaped by rural struggle (Akram-Lodhi and Kay, 2009).

Taken together, these problematics examines the processes that enables or constrains the emergence of agrarian capital and rural capitalism, whose fundamental dynamic process in their emergence was the transition or otherwise of pre-capitalist peasantry into labour-power through intricate forces of dispossession (Akram-Lodhi and Cristobal Kay, 2010b). Emanating from Bernstein's deconstruction of Byres formulation is the notion that understanding the pattern of capitalist development in a social unit hinges on a careful examination of how accumulation, production and politics enable or constrain agrarian transition. Byres (1996), suggesting that in order to prevent agriculture from standing in the way of the transforming tendencies of capital, the agrarian question must be resolved by some manner of agrarian transition. He defines agrarian transition as the manifestation of "those changes in the countryside of a poor country necessary to the overall development of capitalism and its ultimate dominance in a particular social formation" (Byres, 1996:27).

Suffice to state at this juncture that holding a homogenous view of the workings of capital in agriculture globally is reductionist and inappropriate. As Cousins (2013) asserts, a direct application of the conceptual models inherent in the classic agrarian question without due consideration of time (era) and space (geographical location) is indeed problematic. Globalization, for instance, is presently impacting upon the relations and forces of production, with increasing implications for the agrarian question and transition (Akram-Lodhi and Kay, 2009; Akram-Lodhi and Kay, 2010b; Cousins, 2013). As new forms of capital increasingly dominates agriculture on a global scale including smallholder farming and high productivity levels achieved in some climes, so also are there high levels of food insecurity, poverty, inequality, and environmental degradation (Cousins, 2013). Consequently, contemporary and diverse formulations of the agrarian question have emerged and these are summarized in Table 4.1.

The first approach, the “class forces agrarian question”, argues that relations between class forces are shaped by and shape agrarian transitions in production system and productive forces. The approach holds that it is imperative to understand the diverse ways in which capitalism transforms or fails to transform production and accumulation, and the implication of such transformation on class relations (Akram-Lodhi and Kay, 2009). Under the formulation, Bagchi (2009) suggests that in a bid for surplus appropriation, colonialism puts in place or reinforced a structure of capitalist relations of production and labour commodification in rural areas of many developing economies. Important analytical variables in the perspective include “the nature, extent and progress of social differentiation found within the peasantry, the nature of the landlord class and other dominant class forces, including capital, the severity to which the law of value and the market imperative applies and shapes the actions of class forces and the process of rural change, and the role and character of the state” (Akram-Lodhi and Kay, 2010b:266). Also critical in the analysis, according to Watts (2009), is the transformation of the world food system, the changing nature of relations between urban and rural areas, the development of new modes of rural inequality due to the internationalization of capital accumulation and agriculture, and the overarching effect of the foregoing on class relations and political struggle.

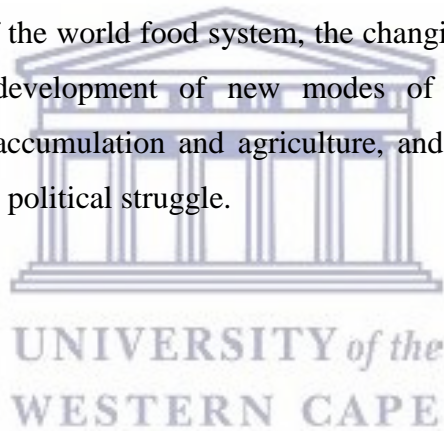


Table 4.1: Contemporary Agrarian Questions

Table: Contemporary agrarian questions (AQ)

	Rural production	Rural accumulation	Rural Politics
AQ1: class forces	Asset differentiation restructured rural labor-processes and facilitates the emergence of agrarian capital, but is highly contingent	Dependent upon the emergence of the capital-labour relation	Class struggle shapes and is shaped by the character of production and the traits of accumulation
AQ2: path-dependent	Capitalism in agriculture is developing the forces of production, albeit unevenly, as labour commodification proceeds	Will occur as agrarian capital emerges	Class struggle is over the terms and conditions of wage labour as capitalism develops
AQ3: decoupled	The emergence of agrarian capital is no longer relevant	Rural accumulation is not to global capitalism	Class struggle is over the terms and conditions of livelihoods facing fragmenting classes of rural labour
AQ4: global reserve army	Increasingly subordinated to the law of value operating on a world-scale through the enclosure food regime	An outcome of dispossession and/or displacement as rural populations are marginalized and/or expelled from agriculture	Focuses on the terms and condition by which agrarian labour reproduces as the value of its labour-power is depressed and the global reserve army of labour increases
AQ5: corporate food regime	Must be located within the dynamics of the global food regime financialisation, neoliberalism and supermarketisation produces a commodity fetish	The corporate food regime is predicated upon an accumulated fetish	Politicize economic processes to incorporate global peasant resistance that situates the class struggles of the dispossessed in the terms and conditions of access to and control over food
AQ6: gender	Shapes and is shaped by gender relations	Shapes and is shaped by gender relations	Shapes and is shaped by gender relations
AQ7: ecology	Shapes and is shaped by the biophysical ecology	Shapes and is shaped by the biophysical ecology	Shapes and is shaped by the biophysical ecology

Source: Akhram-Lodi and Kay (2010b:265)

The second perspective, referred to as the “path-dependent agrarian question”, suggests that although assymmetrically, imperialism has developed capitalist relations of production globally and has consequently introduced and sustained an ubiquitous and dynamic process of labour commodification in developing capitalist countries production forces (Kiely, 2009). The foregoing has resulted in the transformation of the agrarian production system in the rural sector of developing nations due to the continuing entrenchment of capital and its associated dynamics (Akram-Lodhi and Kay, 2009). Under the perspective, the terms and conditions of wage labour is at the core of class struggle.

The third position is termed the “decoupled agrarian question of labour” and is outlined in the works of Henry Bernstein (2006, 2009). For Bernstein, the agrarian question of capital which is basically the fulcrum of the classic agrarian question has been resolved. Bernstein (2009) argues that owing to globalization and the large-scale development of the productive forces in advanced capitalist agriculture, the significance of the agrarian question to industrialization is no longer relevant for international capital. It is no longer important for capital to reorganize agriculture as capital does not have to depend on, and could bypass surplus agricultural resources to facilitate accumulation. Bernstein argues that the relevant agrarian question is that of labour and its struggles for livelihoods generation amidst the entrenchment of capital (Akram-Lodhi and Kay, 2009). Bernstein (2009) notes that globalization and the internationalization of capital have led to the increasing emergence of a fragmented classes of labour which is ‘decoupled’ from transnational capital. This fragmented labour classes rely on insecure, oppressive and scarce waged employment for their own daily reproduction, and these are often combined with diverse unstable small-scale farming and informal sector survival activity, hence the crisis of labour translating to a crisis of reproduction (Bernstein, 2009:250-251). Pervasive in the agrarian question of labour, in this sense, are class tensions and contradictions which are deeply inherent in petty commodity production in farming or other informal activities (Cousins, 2013). The perspective thus considers the class struggle that emerges as a result of contention for livelihoods and as Akram-Lodhi and Kay (2010b) argue, gives precedence to the politics problematics ahead of the production and accumulation problematics.

The fourth perspective, which is referred to as the “global reserve army of labour agrarian question” emanates from the analysis of Araghi (2009), who argues that the global enclosures of postcolonial neoliberal globalism have brought about the development of an enormous reserve army of migratory labour (Araghi, 2009:134). The enclosure food regime, a construction of neoliberal globalization, creates and allocates value on a global scale with overarching effect on the value of labour power and the creation of surplus value on a global scale. The resultant effect of this is the establishment of subsidized consumption and overconsumption of classes in the global North and the creation in the global South, of an enormous reserve army of migratory labour as the processes of dispossession by displacement, facilitated through market imperatives, takes root (Akram-Lodhi and Kay 2010b:267). Agrarian capital in the neoliberal era has resulted in the intensification of depeasantization through displacement on a world scale and the enclosure regime, being a spatial regime of dispossession, “devours national agricultures, land and means of subsistence, and frees labour power for global consumption” (Araghi, 2009:135).

The fifth position is termed the “corporate food regime agrarian question” and stems from the writings of Harriet Freidman and more particularly Philip McMichael. Friedmann and McMichael's (1989) seminal work focused on the concept of global food “regimes”, which is rooted in the disparity in the distribution of power and resources across space. The seminal work focused on two regimes. First is the colonial era starting around 1870s which involves the colonial importation to Europe from the tropics as well as grain and livestock importation from the settler colonies. Second is the regime that came into being after the Second World War, in which the U.S. hegemony and imperialist nations dominates, leading to the export of surplus food from these countries to the countries of the global South (Pechlaner, 2010). Presently, the existing regime has been dubbed the corporate food regime. McMichael (2009) insists that the agrarian question is still about labour and capital relations. For McMichael, the problematic of the contemporary agrarian question needs to be defined not in terms of labour or capital, but in terms of food. Ensuring this requires the reframing of the agrarian question in two manners. Firstly, the agrarian question must be considered through the lens of the new world-historical conjuncture neoliberalism, financialization and the creation of a global corporate food regime. Secondly, capital must be taken as the basis of analysis on the proviso that it is seen as a relation of production and circulation at which point the politicization of the economic can be observed (Akram-Lodhi and Kay, 2009).

The politicization of the economic however, “must also analytically incorporate global peasant resistance, which has developed a praxis premised on a critique of the conditions of the global movement of capital at this historical conjuncture, focusing upon the global politics of food in an effort to transform as well as transcend capital’s relations of subjection and its developmentalist teleology” (Akram-Lodhi and Kay, 2010b:268).

The agrarian question of food, McMichael (2009) notes, is germane to unravelling the accumulation and commodity fetishization evident in agriculture, and the concomitant negative socioecological consequences. For McMichael, the corporate food regime relegates public good for private profit through the mechanism of free markets with its exclusionary tendencies of leaving out and dispossessing agrarian populations (Akram-Lodhi and Kay, 2009). The food regime paradoxes are not limited to class relations but include political relations that facilitate the global movement of food on a large scale, enriching some while others are impoverished, dispossessed of land and livelihoods, and have their ability to socially reproduce undermined (McMichael, 2009). Teubal (2009) for instance, alludes to the domination by transnational corporations and agro-industries of food technology, processing and distribution within a capitalist system thus subjugating and displacing peasants from agriculture. Consequently, the corporate food regime is not only about accumulation and production, but also about politicizing and denaturalizing food relations, which opens up the possibility of transforming rural production which is built upon the quest for social and ecological justice, as evidenced by the food sovereignty movement and class struggles that embodies the contemporary nature of accumulation (McMichael, 2006, 2009). The notable feature of the food regime envisioned as a political project as against its earlier conception as merely an analytical project, is evident in the formulation of “the peasant way” as an essential antithesis to a world controlled and damaged by capitalist transnational corporations (Bernstein, 2016:639).

The sixth perspective, termed “gendered agrarian question,” underlines the importance of gender dynamics in the production, accumulation and politics within capitalist agriculture. According to O’Laughlin (2009), challenging politically the ideals of neoliberal market is critical to providing answers to the agrarian question, but gender considerations must be imbued in such analysis about class, accumulation and politics. She notes that gender is a relation of production and reproduction,

while also highlighting the significance of gender relations in the working of both formal and informal political institutions (Akram-Lodhi and Kay, 2009). Gender, O’Laughlin points out, “is a social relation and thus intertwined with, but not reducible to class. Like class, it is a relation of inequality, and thus a site of contradiction and resistance. However, gender is also a relation of cooperation based on gendered division of labour” (O’Laughlin, 2009:206). Consequently, any agrarian question must fundamentally examine the nature of gender relations and its bearings upon the resolution or otherwise of the agrarian question as failure to do this render any understanding of the agrarian question incomplete both analytically and politically (Akram-Lodhi and Kay, 2010b).

The final position, referred to as “the ecological agrarian question” argues for the interrogation of the ecological dynamics within a capitalist system in any agrarian question. The perspective is grounded in the notion that the biophysical agroecological setting and resources affect, and is affected by, processes of rural production, accumulation and politics. For instance, agroecological resources can constrain or enable production and accumulation. The position maintains that the political ecology of struggle and agrarian change shapes, and is shaped by, biophysical contradictions in capitalism that are integral to any understanding of the agrarian question (Akram-Lodhi and Kay, 2010b:270).

Conclusively, Akram-Lodhi and Kay (2009) offers three constructive conclusions that can be drawn from the divergent approaches to the agrarian question. First is that there has been an alteration in agrarian production system brought about by neoliberal globalization, which has accordingly restructured the rural production process and accelerated the commodification of rural economic activity under the market imperative. Secondly, changes evident in the rural production process have affected, and been affected by, processes of accumulation, structural change and the reduction of poverty. This is evident in the globalization process, remarkably the entrance of agro-food transnational corporations into the global South and their attendant influence on states and institutions, thus reconfiguring rural lives and the accumulation process in the countryside. Of increasing concern is thus the internationalization of food production and the domination and control of how food is produced, processed, traded and consumed by multinational corporations (Mier y Terán Giménez Cacho, 2014). Finally, the nature and extent of transformations evident

in rural production and accumulation are country-specific, but with overarching implications for rural politics. However, the way in which the latter interjects with production and accumulation is dependent on the relationship within and between the peasantry, the rural elite and the state (Akram-Lodhi and Kay, 2009:334-35).

4.3 Political Ecology

Political ecology analyses the relationships between political, social and economic factors with environmental change and phenomena. It examines and views the dynamics of social and environmental change as brought about by the nature of the interconnected and divergent economic, social and ecological processes functioning or acting at discrete scales (Taylor, 1999). This is an indication of the multiplicity of factors and stakeholders involved in environmental and societal change. Political ecology, as it is presently construed, has its root in the quest to explain local environmental problems in their social context (Schubert, 2005). Two major theoretical thrusts which guide political ecology are political economy with its emphasis on the political and economic processes particularly production dynamics within a society, as well as ecology which highlights the bio-physical processes of environmental change.

Unlike apolitical conceptions of ecological processes, political ecology emphasizes the politicization of environmental phenomena and issues. Rather than being a coherent 'grand' theory, political ecology integrates and incorporates diverse interpretations from several (and sometimes diametrically opposed) ideologies, such as from the political left (Neo-Marxist thought) to the political right (Neo-classical thought) based on concepts drawn from political economy (Sridhar, 2010). More importantly however, it is an exact lens through which the interactions between the society and environment can be examined (Schubert, 2005). Epistemologically, political ecology shares a similar position to critical realism, as "it examines relations between events, structures and mechanism through a stratified sense of reality in which theory-building and theory-reconstruction precisely deploys a toolkit to explain the world" (Watts and Peet, 2004:16).

Political ecology as a framework for analysis was introduced in the 1970s through a paper by Eric Wolf but became popularized in the 1980s through the works of Piers Blaikie who merged a broadly defined political economy with ecological concerns through his work on soil erosion

(Blaikie, 1985) and land degradation (Blaikie and Brookfield, 1987). Blakie's *Political Economy of Soil Erosion in Developing Countries* (1985) explores the social and institutional influences on environmental knowledge, noting that soil erosion will not reduce substantially in developing countries until it begins to erode the accumulation potential of the dominant classes, while it however recognizes that the roots of degradation are quite diverse (Forsyth, 2008). Blakie and Brookfield's *Land Degradation and Society* (1987), according to Peet and Watts (1996), has three extensive themes which illustrate the interaction between poverty and degradation. First is the concept of marginality which exemplifies the self-reinforcing aspects of political, economic and ecological marginality, and more particularly that degradation is a cause and consequence of social marginality. Secondly, owing to the production pressure on resources, land manager makes excessive demands which in effect becomes transmitted to the environment through social relations. Third is the heterogeneity of the explanations of degradation; that there are multifarious perceptions of the phenomenon and that one person's degradation would be another's soil fertility (Peet and Watts, 1996:6).

Blakie and Brookfield's work has however been criticized for not placing emphasis on politics. (Peet and Watts, 1996:8) notes an inadequate treatment of the means whereby "control and access of resources or property rights are defined, negotiated and contested within the political arenas of the household, the workplace, and the state." Of great importance to political ecology, Watts and Peet (2004) argue, is an emphasis on the processes of surplus extraction, as well as the politics of ownership and control which forms the spine of the analysis of poverty. Forsyth (2008) however contends that politics was not altogether discounted by Blakie and was more evident in his latter works. Blakie, he argues, has sought to replace Marxian political economy and ecocatastrophism that was stressed in his earlier writings with an alternative approach that incorporates and interrogates the understanding of environmental crisis and social vulnerability. The latter draws largely from two concepts. Firstly, there is the model of 'Pressure and Release' which recognizes the diverse levels of structural causes of vulnerability (such as lack of institutions and prolonged poverty), and which consequently increases the vulnerability of people or locations to negative physical events. Secondly, there is the 'Access' model that relies heavily on Amartya Sen's concept of entitlements and capabilities, and suggests that peoples' inability to use or command the use of resources to secure livelihoods both in pre-disaster and disaster times constitutes access

constraints and makes people socially vulnerable (Forsyth, 2008:759). Other scholars have also improved efforts to integrate political action into questions revolving around resource and control, as well as the environment (Watts and Peet, 2004).

In another vein, there have also been arguments to the contrary on the overemphasis of ecology at the expense of politics. Indeed, some scholars have argued that political ecology is too much preoccupied with exploring social structures at the expense of understanding environmental change (Forsyth, 2008). Walker (2005) further notes that political ecology has come full circle, from where it was conceived and treated as a 'structuralist' approach with an emphasis on the ecological part at the expense of politics to viewing it from a 'poststructuralist' lens with adequate consideration of politics but with insufficient consideration of the ecological concerns. Watts and Peet (2004) however rejects this notion, contending that political ecology over the years has increasingly turned to nature itself. Political ecology, Watts and Peet note, is all about the dialectics of Nature and Society, which appreciates the pluralism of approaches to the environment.

The foregoing arguments notwithstanding, the multidisciplinary and multilevel scope of political ecology has solidified its appeal and use as a framework to explain the dynamics of environmental change vis-à-vis its interaction with and significance to different actors within society (Sridhar, 2010). Central to any political ecology approach is the consideration of important factors which are the contextualization of human-environment relations, the analysis of state-intervention which shapes land-use at local level, the appreciation of regional variability and investigation of the local-specific peasants and other socially disadvantaged groups in struggles for the protection of the environment and in extension livelihoods, as well as a historical and contemporary analysis of struggle (Basset 1988, cited in Schubert, 2005; Sridhar, 2010).

Research using political ecology starts with the interrogation of the strategies for livelihoods within an environment, while also examining the socio-economic setting and the dynamics of such environment (Batterbury, 2015). Questions emanating from a political ecology analytical framework may include how nature shapes and is shaped by societal structures and how both determine access to natural resources, how human-environmental relationships are shaped by the constructed concepts of nature and society, the interrelationships between access to and control

over resources on the one hand and environmental change on the other, and finally the social implications of environmental change (Schubert, 2005:9). The foregoing call for due consideration of the complexities of the negotiation and contestation over the use of natural resources, which includes due attention to the strategies for livelihoods of farmers and the associated concatenation with dynamic nature and political economy processes (Mier y Terán Giménez Cacho, 2014).

The political ecology approach therefore offers a theoretical lens for examining smallholder irrigation agriculture particularly relating to access to, control and management of natural resources (in this case water and land), changes in land and its use, nature-human interactions, farmers' livelihood strategies, state policies and interventions, and the interaction of the diverse stakeholders involved in irrigation farming.

4.4 Sustainable Livelihoods Approach

Sustainable livelihoods represents a comprehensive and integrated approach of understanding and examining the several factors and processes that enable or constrain people's ability to make a living in an economically, socially and ecologically sustainable manner. The Sustainable livelihoods approach is more people-centred especially in its analysis of welfare and well-being of rural communities. By taking a holistic perspective of the sources of income and other critical resources available to individuals and households, it thus intrinsically differs from the hitherto predominant income-centric view of livelihood promotion.

Sustainable livelihoods had its origins in the cross-disciplinary rural studies starting from the mid-twentieth century which were locally-embedded, integrative and characterized by profound field engagement and a dedication to action (Scoones, 2009). However the perspective began to receive closer attention with the publication of a working paper by Chambers and Conway in 1992. This follows the criticism of the conventional approaches to poverty analysis and reduction strategies, and a growing recognition that due consideration must be paid to the underlying factors that enable or constrain people to make a living. The SLA thus represents an analytical structure for coming to terms with livelihoods complexities in order to identify areas where interventions can be made (Chambers and Conway, 1992). It gained further traction with the adoption by UK's Department

for International Development (DFID) of a strategy that focuses on the elimination of poverty and the creation of sustainable livelihoods for poor people.

The approach, which is people-centred (Bebbington, 1999; Allison and Horemans, 2006), indicates how people's strengths can be strengthened through its focus on people's livelihood activities and the assets or capital they have, rather than on what they lack (Altarelli and Carloni, 2000), as well as what they can do to improve their way of life (Chambers and Conway, 1992). It is modelled to transform lives and holistically considers the multifarious causes, influences and strategies that could be applied in the reduction of poverty (Duncombe, 2006).

It is apposite however, to define livelihood before attempting an elucidation of SLA. Livelihood is defined as the capabilities, assets and activities required for a means of living (Chambers and Conway, 1992; Carney, 1998). It connotes multifarious activities and interactions that reflects the different ways people make a living (Scoones, 2009). It includes income, gender relations, social institutions, gender relations, property rights, as well as access to and benefits derived from public and social services (Ellis, 1998). A livelihood is said to be sustainable when "it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base" (Carney, 1998:4). It refers to people's means of making a living or their strategy for achieving a certain degree of well-being (Bezemer and Lerman, 2004). Chambers and Conway (1992) adds that livelihood is sustainable when it is able to provide sustainable livelihood opportunities for the next generation, while also contributing net benefits to other livelihoods both locally and globally over the short and long term.

Of critical importance in the definition is the notion of assets and capabilities. Capabilities are defined in terms of the valuable "beings and doings". The foregoing is what Sen (1989) refers to as "functionings", a term which links quality of life to the capability to function. The appraisal of the quality of life is therefore the evaluation of various functionings (of human life) and the capability to function. As posited by Sen (1993), functionings signifies the things a particular individual manages to do as to be seen to be leading a life, representing parts of the state of a person. On the other hand, capability refers to the various combinations of functionings an

individual can achieve, hence a reflection of the individual's can achieve. It is therefore freedom to choose between different alternatives of living, and what Alkire (2005) refers to as an individual's or group's freedom to promote or achieve valuable functionings.

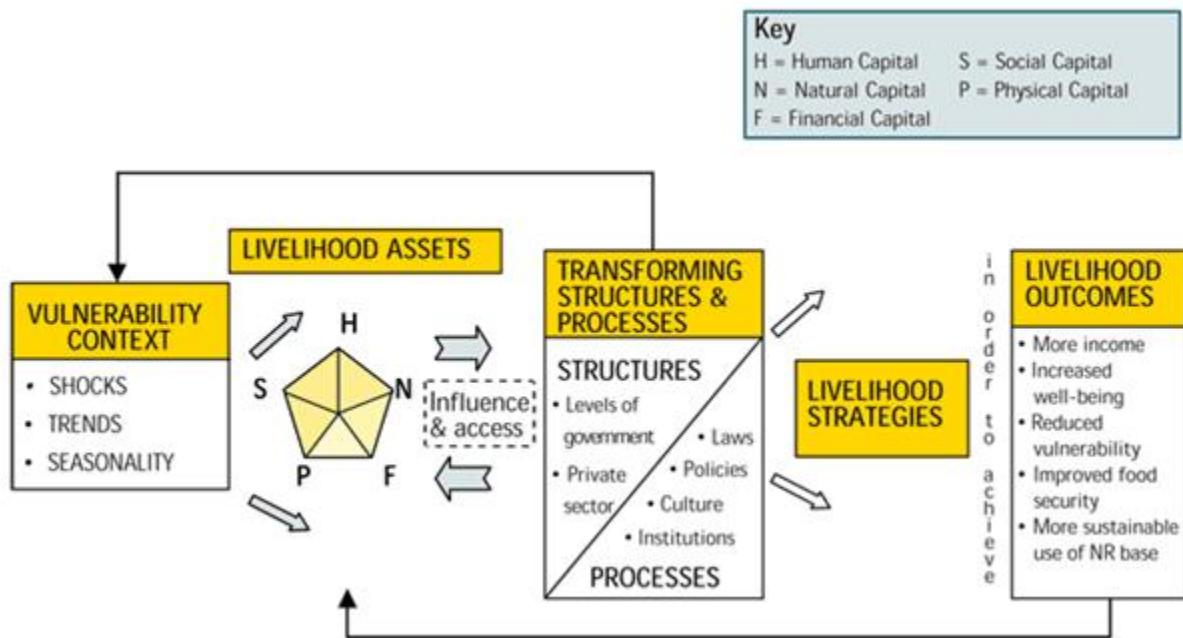
SLA is broadly based on a multidimensional understanding of people's lives, which recognizes the different assets and entitlements that people hold in relation to the wider context of institutions, regulations and cultural norms (Toner, 2003). The SLA does not consider sustainability in constant terms but embraces the ever-changing aspects of people's lives, thus viewing sustainability as the adaptability to change of different components of a livelihood system and their ability to withstand shocks (Allison and Horemans, 2006). As such, the vulnerability context which comprises trends and shocks outside the control of the households is also an important consideration in livelihood sustainability. Vulnerability is also referred to as great exposure to shocks, risk and stress as well as susceptibility to food insecurity (Ellis, 1998; Allison and Ellis, 2001). Factors influencing the vulnerability of the poor include but are not limited to inadequate access to resources, lack of economic opportunities, social exclusion, and climatic factors (Duncombe, 2006).

Rather than view sustainability in unvarying terms, SLA encompasses the dynamics of people's lives, and hence considers sustainability through the lens of the adaptiveness of the different elements of a livelihood system to change and their ability to withstand shocks (Allison and Horemans, 2006). Moreover, the SLA provides a linkage between inputs, outputs and outcomes. While input refers to assets or capitals, outputs are livelihood strategies which are connected to outcomes, relating to welfare and well-being indicators (Scoones, 2009).

At the heart of SLA are assets on which individuals or households draw on to build their livelihoods. These assets make up a stock of capital which augments income but not totally consumed in use, and can be accumulated, stored, exchanged, depleted or put to work to produce an income stream or other benefits (Rakodi, 2002). Furthermore, the assets are viewed as 'vehicles for instrumental action (making a living), hermeneutic action (making living meaningful) and emancipatory action (challenging the structures under which one makes a living)' (Bebbington, 1999:22). Assets, Bebbington (1999) asserts, are not only means whereby livelihoods are met but also are reflections and constituents of the meaning people create via their livelihood strategies.

Livelihood assets thus comprise different types of capitals which are human capital (such as health, education, knowledge, skills), social capital (networks and association memberships), physical capital (including house, electronics, vehicles etc), financial capital (credit, savings, insurance) and natural capital (such as land owned, livestock etc) (Carney, 1998; Rakodi, 2002; Allison and Horemans, 2006; Duncombe, 2006)

Figure 4.1: Sustainable Livelihoods Framework .



Source: Adapted from (DfID, 2002)

Assets are not only things that enable survival, adaptation and survival but also provide the capability to be and to reproduce, and contest the rules that regulate the use, control and transformation of resources (Bebbington, 1999). Access to these assets are shaped by the institutional as well as vulnerability context including shocks and trends that are beyond the control of the household (Allison and Ellis, 2001). Institutions, policies and processes, according to Scoones (2009) mediate livelihood strategies and pathways, are regulated by politics and power, and provide the setting where access, rights and governance are contested.

Furthermore, the levels and extent of activities generated from the assets are basically referred to as livelihood strategies (Biederlack and Rivers, 2009). Livelihood strategies thus refer to a

portfolio of activities which people engage in, utilising their assets in order to make a living. Fundamentally, the asset base of a typical household will determine the household's choice of strategy (Allison and Ellis, 2001; Krantz, 2001; Soltani et al., 2012). Diversification of livelihood is an element of livelihood strategy which entails the expansion or variation of people's activities in order to increase their income stream or other benefits. Livelihood diversification is described as the process whereby households "construct a diverse portfolio of activities and social support capabilities in their struggle for survival and in order to improve their standards of living" (Ellis, 1998:4). Diversification may happen either as an intentional approach to increase household's standard of living or as a compulsory response to crisis (Ellis, 1998; Loison, 2015). While the former is referred to as diversification for accumulation, the latter is termed diversification for survival (Ellis, 1998). Diversification of rural livelihoods are majorly categorised by location (on-farm or off-farm), sector (farm or non-farm) or by function (self-employment or wage employment) (Loison, 2015).

Institutions, policies, and processes are also important components of the livelihoods framework as these enable or constrain access to both assets and activities for individuals and households. They mediate livelihood strategies and pathways, are subject to politics and power and provide the setting for the contestation of access, rights and governance (Scoones, 2009). Krantz (2001) adds that institutions could be either formal or informal, and often exhibit the feature of ambiguity and are permeated with power.

SLA is a departure away from the traditional income-centric view of livelihood promotion as it takes a holistic view of the sources of income of individuals as well as other critical resources for households. Ansoms and Mckay (2010) highlight several ways in which SLA has been innovative. First is the move away from the singular focus on people's well-being which is often reduced to income or consumption measures. Second is the recognition of the capability of people as social actors to shape their own livelihoods. Thirdly, the approach emphasises the dynamic and continuing interactions among humans, resources and strategies. SLA entails a multidimensional approach which involves the understanding that policies, institutional and socio-economic environments have a huge influence on individual/household livelihoods (assets, strategies and outcomes). The approach comes with an understanding that the poor are equipped with a range of

assets and strategies which are utilised to cope with vulnerability, and are encompassed with external structures and processes that contribute in shaping their lives (Duncombe, 2006).

Toner (2003) observes that an improved assessment of the vulnerability of the poor to external shocks and stresses such as market collapses or drought is realizable through an engagement with the complexity and integrated nature of people's livelihoods. Livelihoods frameworks can thus be seen as analytical tools which have the inherent ability to capture the interaction between livelihood assets, vulnerability and transforming structures (such as policies and institutions) (Toner, 2003). The framework also allows for the assessment of livelihood outcomes. As Allison and Horemans (2006) notes, a livelihood can be said to be sustainable if it translates to the maintenance or improvement of people's standard of living (in terms of income and well-being), lowers their vulnerability to trends and shocks, while ensuring that their activities do not jeopardise the longevity of the natural resource base. Consequently, the framework establishes a nexus between inputs (indicated as capitals and assets), outputs (livelihood strategies), and outcomes (income, well-being and sustainability). It is important to note that the relationship between assets and outcomes is not static, but dynamic and interdependent (Soltani et al., 2012).

The livelihoods approach has however been criticized in literature. Scoones (2009) provided a summary of the critique of the approach. Firstly, there is an under-appreciation of, and a lack of engagement with, the processes of globalization. The dynamics of the global markets however have profound effects on the local that is being emphasised by the SLA. Secondly, the SLA ignores debates about power, politics and governance in its analysis. Thirdly, there has been a partial attempt to incorporate issues of environmental change and conditions into SLA analysis, despite the use of the word 'sustainable' in its conceptualization. Finally, the SLA has failed to interrogate issues relating to long-term shifts in rural economies and agrarian change (Scoones, 2009:181-183). Responding to these criticisms, Scoones (2009) notes that it is impossible for livelihoods perspective to be able to interrogate every rural problem and one might need to consider alternative approaches for some issues. Livelihood perspective however, he insists, offers a unique point of departure for an integrated analysis of complex, highly dynamic rural contexts (Scoones, 2009:183).

Globally, there have been diverse attempts to appraise the livelihoods of smallholders. Tapela (2008) researched into livelihoods in the wake of agricultural commercialisation in South Africa's poverty nodes using a case of small scale irrigation projects in the Limpopo Province. She argued that small-scale irrigation farming is expected to play a progressively larger role in rural development and to help reduce some inequalities. Investigating vulnerability and marginalisation in selected small-scale irrigation schemes in Limpopo Province, she found that existing approaches to agricultural commercialisation may not necessarily reduce rural poverty and inequality. She thus further argued that although these approaches contributed in integrating resource-poor irrigation farmers into globalised commodity production sectors, they could undermine the livelihoods of the poorest and most vulnerable in these communities.

Although there have been attempts at examining the outcomes of agricultural projects in Nigeria, there is a dearth of existing literature on the examination of outcomes using a sustainable livelihoods framework. For instance, Manza and Banta (2014) analyzed the impact of sustainable agriculture project on livelihoods of farmers in Southern Borno State Nigeria. They found that the project led to improved crop management techniques, while it also had a positive impact on access and use of agricultural credit, farm income, access and use of agricultural credit as well as agro-processing in the project area.

Ahmed and Philip (2012) examined the impact of the Fadama II project on the standard of living of Dadin-Kowa community in Gombe State, Nigeria. Their findings revealed that benefits derived by beneficiaries include increased assets and increased ability to provide their wards with education. Bature et al. (2013) attempted an evaluation of the impact of Fadama III project on the income and wealth of beneficiaries in Gwagwalada Area, FCT Abuja, Nigeria. They observed that the project led to increase in the productive assets of beneficiaries, although net farm income failed to increase.

Although the foregoing studies touch on some aspects of livelihoods, they fail to consider the entire dimensions of livelihoods. In other words, they did not undertake a holistic analysis of the different capitals that make up the livelihoods framework. It is this gap in literature that the study will also

intend to fill by assessing the outcomes of the Tada Shonga irrigation projects using a sustainable livelihoods framework.

4.5 Chapter Summary

The chapter has outlined and discussed the theoretical bodies of work adapted for the study. Using the SLA approach, the research is able to focus on smallholder households' endowment of capital, livelihood strategies in which these capital assets are employed, and the level of well-being assessed subjectively. These were also linked to other production, socio-economic and food security characteristics of the smallholder households. Analysis of other issues relating to the effect on smallholder households, of macro-economic processes as well as environmental change and conditions were consolidated in the research using the political economy and political ecology approach.



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CHAPTER FIVE

PHILOSOPHY AND METHODS OF RESEARCH

5.1 Introduction

The chapter discusses the philosophical perspective and the methodological processes that guided the research. Critical realism was identified as a philosophical position that can bridge the gap between the hitherto popular philosophical positions often used for the discrete quantitative and qualitative research methods. Further, the research design, population and sampling, data collection and analysis process including procedures for achieving reliability, validity and reflexivity are expanded on in the chapter. The ethical considerations in conducting the research are also outlined.

5.2 Philosophy of Research: Critical Realism

Critical realism is a philosophical position which lays emphasis on the dialectical relationship between individuals and social structures as well as the accounts of these individuals in interpreting their world. A distinctive feature of this philosophical perspective is its view of humans at the centre of a combination between two models hitherto thought incompatible. The human being is viewed firstly, as a causal agent who makes things to happen, and secondly, as a meaning maker capable of interpreting the world in diverse ways (Sayer, 2010).

The most prominent and perhaps most influential figure in the development of critical realism is Roy Bhaskar, who is often referred to as the founder of the philosophical position. Bhaskar (1978) points out that a main contention of critical realists is that progress is possible because the intransitive dimension of reality (enduring structures and processes) offers the basis for the testing of theories. Bhaskar's consideration of the philosophies of science and social science therefore led to the development of the philosophical position which emphasizes the critical and emancipatory potential of scientific and philosophical enquiry (see Bhaskar, 1989).

Critical realism thus represents a radical alternative to several established but deficient philosophical and methodological positions such as positivism, interpretivism and empiricism

(Sayer, 2000; Crossley, 2005; McEvoy and Richards, 2006). For example, Njihia (2011) describes critical realism as both a philosophy and an implicit social theory, integrating previous concepts from positivism, interpretivism and critical theory into a single coherent social system. Although critical realists share the same sentiment with positivist that there is a world out there that humans must understand, there are however three main points of divergence between the two philosophical positions. First, positivists believe that science is simply a practice of observing and recording constant conjunctures between phenomena, regarding those conjunctures in a closed system detached from external influences. For critical realists however, the real world functions as a multidimensional open system (McEvoy and Richards, 2006), and science is not merely a practice of recording constant conjunctures between phenomena but further involves the theoretical accounts between phenomena (mechanisms, essences and natures). The foregoing entails the scientist making reference to those essences, entities and mechanism that are unobservable (Crossley, 2005).

The notion of ‘observables’ constitutes the second point of disagreement between realism and positivism (Crossley, 2005; McEvoy and Richards, 2006). Positivists focus on observable events, and strongly opposed the notion of unobservables believing it to be unscientific and metaphysical nonsense. On the contrary, critical realists argue that references to essences, entities and mechanisms could be unobservable at one moment, but may become observable at a later point in time (Crossley, 2005). The third area of disagreement is in the application of scientific method to the social world as positivists stress the notion that the nature of scientific method must be strictly adhered to. Critical realists on the other hand argue that although social science should be scientific, this should not necessitate the copying of any given natural scientific method. Social science, like every other science has had to do, must be able to develop its own approach to scientific analysis (Crossley, 2005).

Critical realism also differs from empiricism that takes the world as what men can experience. Roy Bhaskar, widely acknowledged as the founder of critical realism, opposed the empiricist view that whatever men currently experience is undoubtedly the world, arguing that such stance is an epistemic fallacy and leads to “false conceptions which cause men to see, in philosophy, everything in relation to themselves and their present knowledge” (Bhaskar, 1978:61). For realists,

the world exists independently of our own experience or descriptions, and hence could not be reduced to the range of our senses (Sayer, 2000). In another vein, realism and empiricism differs in the analysis of causal relations in that while empiricism is majorly preoccupied with detecting constant conjunctions between events, realism focuses on the analysis of causality by looking at the nature of things and their interactions including their causal powers (Outhwaite, 1987).

Critical realists argue that the failure of some interpretivists to link discourses to the underlying social structures which may serve as enabler or constraint to individuals' actions or to the social networks within which social actors act is a shortcoming of the philosophical position (McEvoy and Richards, 2006). Indeed, critical realism offers an alternative to the interpretivist reductions of social science to the interpretation of meanings. For realists, although interpretative understanding is an essential component of any social science as meaning has to be understood, this does not preclude the scope of causal explanation. This is owing to the need to explain material changes in society as well as the fact that reasons can also be causes, prompting humans to do things (Sayer, 2000). Critical realism thus sought to combine positivism's emphasis on causal explanations with interpretivism's preoccupation with hermeneutics – the interpretation of meaning.

McEvoy and Richards (2003:412-414) presented a summary of the four main features of critical realism as proposed by Bhaskar. First is the notion of generative mechanisms which refer to the structures, powers and relations that explain how things work. For critical realists, generative mechanisms are real, albeit not directly observable, but are identifiable through their effect. It is what Outhwaite (1987) refers to as the generative processes by which a causal relationship takes place. Second is the recognition or consideration of the social world as stratified or multilayered, and the consequent operation of causal mechanisms at different levels or strata of reality. Thirdly, critical realists lay emphasis on the interdependence of structure and agency. While the agency is associated with human creativity and social action and an agent is an entity that in principle has the means of formulating, taking and acting upon decisions, structure refers to patterned relations with constraints upon action and with macro-social phenomena (Sibeon, 2004). For realists, although social structures provide resources that enables and constrains individual action and behaviour, they do not serve as the only determining factor of individual action and behaviour, as humans as agents have the ability to transform social structures through a creative response to the

situations in which they find themselves (McEvoy and Richards, 2003) Fourth is its development of a critique of the prevailing social order, one which according to McEvoy and Richards (2003), emphasizes the ability of human actors to identify and challenge inequalities and sources of oppression.

Another distinguishing characteristic of critical realism lies in his strong emphasis on ontology, and as Outhwaite (1987) puts it, critical realism is a common sense ontology. As a result, critical realists argue that the world should not be conflated with our experience of it, for it exists independent of our experiences. Dimensions of knowledge were classified by Bhaskar (1975) into the transitive and intransitive. Intransitive dimension of knowledge are the object of science, in the sense of the things which are not invented by humans but which we study such as social phenomenon and physical processes. On the other hand, transitive phenomena are discourse and theories that constitute media and processes of science, albeit they may also be treated as the object of study (Sayer, 2000). Rival theories, Sayer (2000:10-11) avers, “have transitive objects, but the world in which they attempt to describe and analyse is the same... When theories change (transitive dimension) it does not mean that what they are about (intransitive dimension) necessarily changes too.”

Critical realism also differentiates reality into the domains of the real, the actual and the empirical. This stratified ontology thus distinguishes critical realism from empirical realism which conflates the real with the empirical and treats the world as consisting of observable atomistic objects, lacking in structure or powers or hidden characteristics (Sayer, 2000; Zachariadis, Scott and Barrett, 2010). While the real is defined as the structures and powers of objects, the actual refers to the changes that take place when those powers are activated. The empirical however is defined as the domain of observation. Although existence does not depend on observability, Sayer (2000) asserts that the latter increase our confidence about what we think exists. Critical realists however acknowledge that there is also a causal criterion (Collier, 1994).

What can be inferred from the foregoing ontological position is the possibility for the existence of unexercised powers. As a result, any occurrence or known occurrence, Sayer (2000) posits, does not exhaust what could occur or have occurred. In effect, “realist ontology therefore makes it

possible to understand how we could be or become many things which currently we are not” (Sayer, 2000:12).

Critical realism also differs from some other philosophical positions that view causation from the premise of constant conjunctions of events. In their analysis of causality, critical realists contend that the natural world functions as a multi-dimensional open system, and that activation of generative mechanisms may be contingent on time and specific conditions (Outhwaite, 1987; Collier, 1994; Sayer, 2000; McEvoy and Richards, 2003). Indeed, analysis of causality from the realists’ perspective “can account for the interaction of various causal tendencies within the complex and open systems among which we live, and which we ourselves are” (Outhwaite, 1987). Critical realism in its attempt to offer more thorough understanding of phenomena therefore emphasizes the search for in-depth explanations of causal mechanisms and how they exert an effect and under what conditions such effects are triggered (Wand, White and Patching, 2010). The logic behind the foregoing is referred to as ‘retroduction’, defined as “a mode of analysis in which events are studied with respect to what may have, must have, or could have caused them. In short, it means asking why events have happened in the way they did” (Olsen and Morgan, 2004:25). It entails the movement from the level of lived experiences and observations to postulating about the underlying mechanisms and structure that are accountable for the phenomena involved (Mingers, 2003; Fletcher, 2017). The research also set out to explore the generative mechanisms responsible for the observed events in smallholder irrigation agriculture.

Critical realism, and in extension critical social science, have an emancipatory potential. Indeed, Jurgen Habermas who developed critical theory and Bhaskar are in agreement that knowledge should serve an emancipatory purpose (Wilson and McCormack, 2006). Habermas advocates for a combination of causal explanation and hermeneutics in his proposal for a critical theory which is centrally concerned with the evaluation of problems and potentials of modern society, with the overall aim of contributing to people’s self-emancipation (Baert and Carreira Da Silva, 2010). According to Collier *et al.* (1998) however, critical realism allows for a concurrent engagement in a critique of generative mechanism’s role in and influence on social action by providing an explanatory critique (explanation of the generative mechanisms that produces events and institutions). Furthermore, critical realism is also characterised by the need to recognize the factors

that serve as enablers or constraints to individual actions in order to respond appropriately to such enablers or constraints (Trigg, 2001). By unearthing previously unidentified constraints on human action, critical social science (and realism) stresses the notion that knowledge cannot only be explanatory and descriptive, but can be critical, evaluative and emancipatory (Sayer, 2010). The research applies this notion by seeking to to examine the constraints and enablers of agricultural production among smallholder farmers.

Indeed, it is arguable that adopting or adapting critical realism for a mixed methods (combination of quantitative and qualitative) research will bode well for such study. This is because of the emphasis by realists on the need to combine causal explanations (stressed by positivists) with hermeneutics – the interpretation of meaning (accentuated by interpretivists). Certainly, many philosophical positions fall short of the ability to combine multiple research methods. Critical realism however is able to combine qualitative and quantitative methods as a result of the different domains of its stratified ontology (Zachariadis, Scott and Barrett, 2010). McEvoy and Richards (2006) note that many critical realists suggest a combination of quantitative and qualitative methods because of the merits in combining both. From a critical realist perspective, the strength of quantitative methods is that they are sometimes used to develop reliable descriptions and comparisons, they are able to identify associations and patterns that may otherwise be concealed and are useful in testing out how theories about causal mechanisms play out under certain conditions while qualitative methods have the advantage of being open ended, thus allowing the emergence of unanticipated themes and helping to unearth or clarify complex concepts and relationships that may not be captured by quantitative methods (McEvoy and Richards, 2006).

5.3 Research Design

Research design provides a blueprint or plan on how a researcher intends to undertake a research. It entails a plan on how to conduct a specific research (Babbie, 2008; Creswell, 2009). Research design is “based on bringing together a worldview or assumptions about research, the specific strategies of inquiry, and research methods” (Creswell, 2009:20). Research methods relates to how data is collected, analysed and interpreted by researchers for their studies (Creswell, 2009). Furthermore, Kumar (2010) views research design as a procedural blueprint applied by the researcher to seek valid, objective, accurate and economic answers to research questions.

Further influencing the choice of a research design are the research problem, the researcher's personal experiences as well as the audience for whom the research intends to capture (Creswell, 2009). The plan adopted and executed in the study's research process is subsequently explained.

5.3.1 Mixed Methods Research Design

Mixed methods research has, over the years, increasingly gained popularity and recognized as the third major research paradigm or approach, alongside quantitative research and qualitative research (Johnson and Onwuegbuzie, 2004; Onwuegbuzie and Leech, 2005; Leech and Onwuegbuzie, 2009; Mayoh and Onwuegbuzie, 2015; Onwuegbuzie, Gerber and Abrams, 2017). Mixed methods research is defined as a method of research in which the researcher combines qualitative and quantitative research techniques, approaches, methods, concepts or language into a study (Johnson and Onwuegbuzie, 2004). Defining mixed methods research, Johnson, Onwuegbuzie and Turner (2007) noted:

Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration (Johnson, Onwuegbuzie and Turner, 2007:123).

Furthermore, Onwuegbuzie, Gerber and Abrams (2017) in their definition stated:

Mixed methods research involves the collection, analysis, and interpretation of numeric (i.e., quantitative) and nonnumeric (i.e., qualitative) data in various combinations, either concurrently or sequentially within the same research study in a manner that optimally is continuous, iterative, interactive, dynamic, holistic, and synergistic (Onwuegbuzie, Gerber and Abrams, 2017:1-2).

The aim of mixed methods is thus to achieve convergence, integrating and connecting both qualitative and quantitative data (Johnson and Onwuegbuzie, 2004; Creswell, 2009). A major significance of mixed methods research is that it advances methodological pluralism or eclecticism, thus bringing about superior research (Johnson and Onwuegbuzie, 2004). Since every

method is inherently limited, the weakness of any method could be offset by the inclusion of another method. Triangulation, defined as the combination of methodologies in the investigation of a research phenomenon (Onwuegbuzie and Leech, 2007b), is thus achieved through the combination of both methods as well as the integration of their results. One of the major importance of Mixed methods, according to Creswell (2009), is that it allows for more insightful research as well as a nuanced understanding of the research problems than either form by itself.

The study uses the concurrent triangulation mixed methods research design. This entails the merging of both quantitative and qualitative data in a bid to offer a detailed and thorough analysis of the research problem. It involves the simultaneous collection of both kinds of data and the integration of the information emanating from both to inform major research findings (Creswell, 2009). This is sometimes referred to as the “Concurrent Triangulation Design”, in which case qualitative and quantitative data are collected simultaneously, analysed separately and results integrated to inform major research findings. Creswell (2009) refers to it as a process whereby the researcher collects both quantitative and qualitative concurrently and then compares the two databases to determine if there is convergence, differences, or some combination (Creswell, 2009:213).

This was done in order to gain or derive an in-depth understanding of irrigation smallholder agriculture and to be able to fulfill the diverse objectives of the research. Onwuegbuzie and Collins (2007) allude to the appropriateness of a concurrent design if a major purpose of the mixed methods research is to achieve triangulation. Also, one of the advantages of the approach is the manageability and time-saving characteristics of the approach. Using this approach, the mixing actually comes up during the interpretation or discussion section where findings are merged, integrated or compared (Creswell, 2009).

5.3.2 Research Setting

The Middle Rima Valley Irrigation Project is one of the irrigation development of the Federal government of Nigeria. The scheme is under the direct supervision and management of the Sokoto Rima River Basin Development Authority (SRRBDA) with the Federal Ministry of Water Resources playing an oversight function on the project. Located in Goronyo Local Government

Area of Sokoto State, Nigeria, the scheme is designed to provide water resources for all year round cultivation for farmers. The project is located downstream of Goronyo Dam which is the key structure for irrigation and agricultural development of the area. Built across River Rima, the Goronyo Dam is a multi-purpose storage dam with a storage capacity of 942 million cubic metres of water for irrigation and development of downstream areas.

The Middle Rima Valley Irrigation Project lies between longitudes 5° 39' and 5° 50' East and latitudes 13° 25' and 13° 33' North. The project area lies on the banks of River Rima between the towns of Gidan Alwali and Tuluske on the right bank and Goronyo and Keta on the left bank. The scheme was intended to provide water for irrigation on an area covering about 5,360 hectares, although this is yet to be fully realised. Surface irrigation which involves the application and distribution of water over the soil surface by gravity is the form of irrigation being practiced on the scheme.

Climate in the study area is characterized by wet and prolonged dry season. Incidence of periodic droughts is frequent as rainfall is mostly irregular and controlled by the erratic movement of the inter-tropical discontinuity (ITD) (Eniolorunda, Mashi and Nsofor, 2017), hence the irrigation in the study area. According to Yahaya (2002), the mean annual rainfall ranges from 500 to 1300mm. There is however claims that the annual rainfall presently stands around 600mm, hence the area is one of the most affected by the incidence of climate change (Eniolorunda, Mashi and Nsofor, 2017). Temperature is high throughout the year with long-term daily maximum temperature of about 36 °C. At the peak of the heat, the temperature gets as high as 44 °C between February and April and the lowest is recorded during the harmattan season where it can get to around 17 °C (Eniolorunda, Mashi and Nsofor, 2017). The vegetation of the area has been described as the Sudano-Sahel Savannah type composed mainly of shrubs and grasses. According to Eniolorunda, Mashi and Nsofor (2017), soils are basically hydromorphic and clayey.

Farmers operating under the scheme are smallholders who are organized in farm families and have access to the irrigation facilities provided by the SRRBDA. Over the years, the presence of the River Rima has led to the expansion of settlements around the basin and the development of intensive cultivation (Eniolorunda, Mashi and Nsofor, 2017). Majority of residents around the

project is involved in farming and petty trading while the area is also characterized by poor health and educational facilities and low quality housing. Major crops grown in the study area include rice, millet, wheat, guinea corn, onions, garlic, sorghum and some vegetable crops. Farm sizes are generally small, mostly less than a hectare and land is majorly transferred by inheritance or transferred to other parties by sale or lease.

Figure 5.1: Map of Sokoto State Showing Goronyo Local Government.

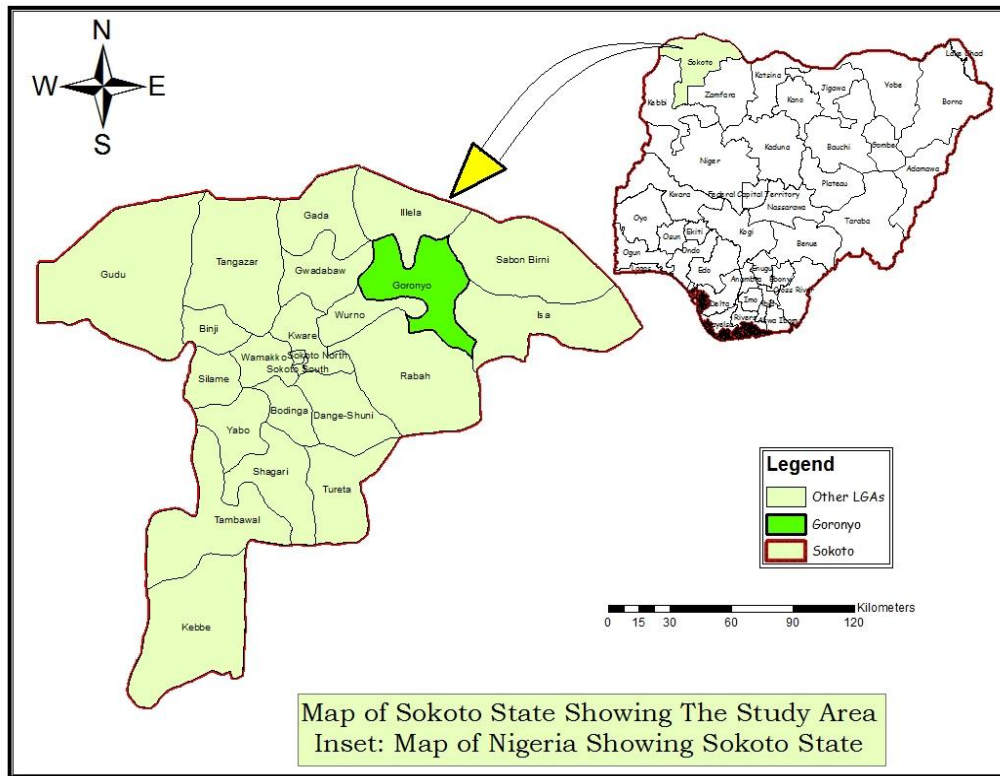


Figure 5.2: Map of Goronyo Local Government Showing the Study Area.

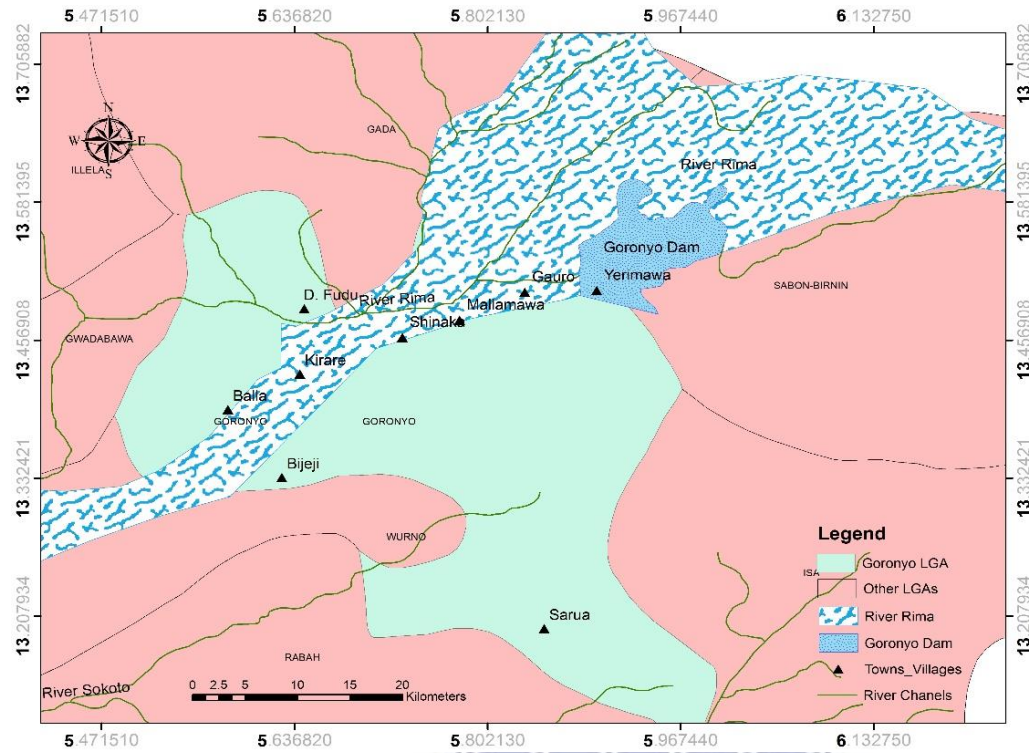
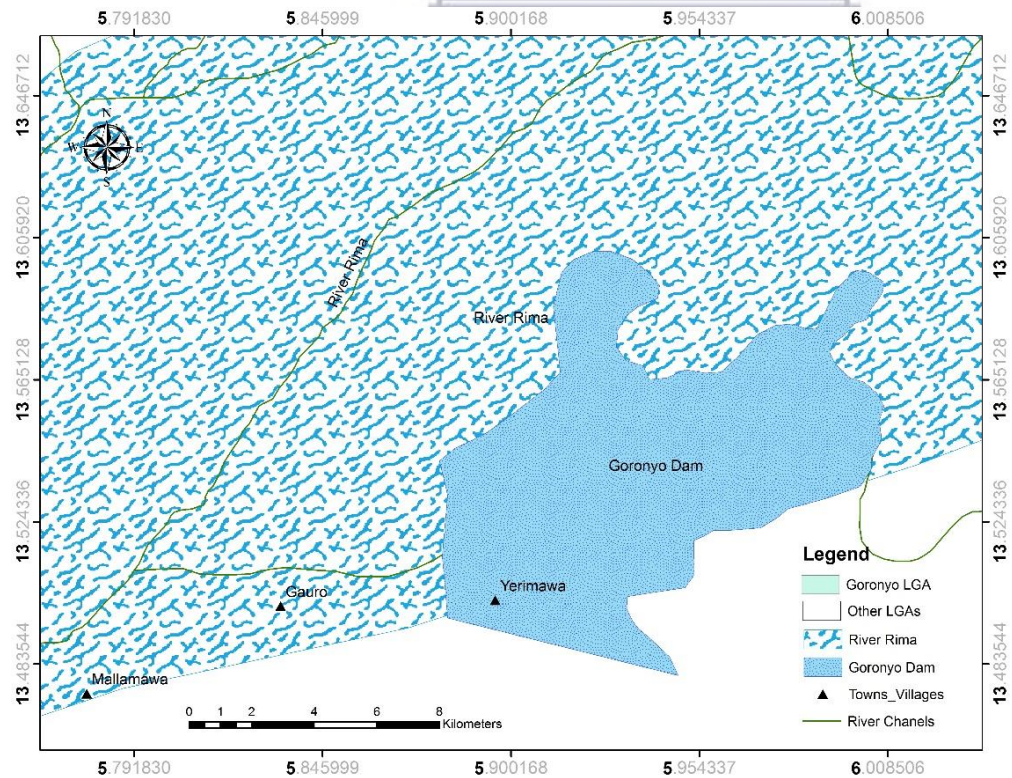


Figure 5.3: Map Showing the Study Area.



5.3.3 Data Collection Methods

The section describes the processes adopted to collect both the qualitative and quantitative data for the research. For the study, data collection took place between February 2016 and April 2016. The study utilized both secondary and primary data. While secondary data was gathered through a review of relevant literature including articles, government documents and the Middle Rima Valley Irrigation Project documents, primary data was collected with the use of semi-structured interviews and questionnaire administration. The methods of primary data collection is expanded below.

5.3.3.1 Qualitative Data Collection Methods

Qualitative research involves the process of collecting, analyzing and interpreting nonnumeric data from sources such as documents (data that are in text form), observations, images, positioning or nonverbal communication (Onwuegbuzie, Gerber and Abrams, 2017). Some of the characteristics of qualitative research are that they occur in natural settings and data emanating from them are descriptive, reported in words or pictures rather in numbers (Creswell, 2009). Qualitative research centres on the perceptions and experiences of participants, and the way they make meaning of their lives while it also focuses on both the process that is taking place and the outcomes (Creswell, 2009).

Qualitative research relies on text and image data, drawing on various strategies of inquiry. It involves the collection of data by researchers through the examination of documents, observation of behavior or the interview of participants (Onwuegbuzie and Leech, 2007a; Creswell, 2009). It is a means whereby the meaning individual or groups attribute to a human or social problem is explored or understood (Creswell, 2009). The main purpose of qualitative research is the making sense of and recognizing patterns in words so as to come up with valid findings and conclusions without compromising its quality (Leung, 2015). It allows for a thorough study of cases, making provision for explaining and describing cause and effect, as opposed to proving cause and effect (Blackstock, Kelly and Horsey, 2007).

For the qualitative aspect, a case study design was utilized for the collection of data through in-depth key informant interviews with a total of eight respondents comprising four implementation

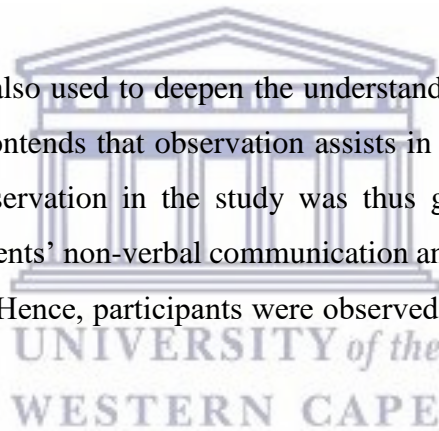
staff members and four purposefully selected smallholders based on their knowledge and position. Case Study is a method of inquiry which entails an in-depth exploration of a program, activity, event, process or individual(s) (Creswell, 2009). Cases, Creswell (2009) notes, are time and activity bound and involve the collection of detailed information by researchers using diverse data collection techniques over a period of time.

The method of data collection for the qualitative aspect of the research was through interviews. These interviews were conducted with the aim of collecting information relating to irrigation smallholder agriculture at the Middle Rima Valley Irrigation Project. Qualitative methodology, through semi-structured interview, was adopted in the study in order to deepen the understanding of the productivity and sustainability of irrigation agriculture, and its relationship with food security and livelihoods. Interviews were conducted face-to-face with participants and these involved a number of semi-structured and open-ended questions which aimed at eliciting opinions and perspectives from participants. Elicited responses were recorded using a tape recorder and a check-list, and this was supplemented with note taking, in order to ensure that the interview was “flexible, iterative and continuous” (Rubin and Rubin, 1995).

Purposive sampling was utilised to select participants interviewed owing to the fact that it allows for the selection of subjects based on some pre-defined characteristics. Babbie and Mouton (2001) note that a purposive sample involves the selection of participants on the basis of the purpose of the study and the knowledge of a population. Leedy and Omrod (2005) further allude to the importance of selecting respondents based on their ability to make available relevant information (both in quantity and quality terms) for the study. To this end, semi-structured interviews were conducted with participants who are knowledgeable about the project and those that are beneficiaries of the projects. Interviews were carried out between February and March, 2016. Participants were staffs of the SSRBDA assigned to the scheme and smallholders involved in the irrigation scheme. Convenient times were arranged for the interviews based on participants' availability. During the course of the interview sessions, participants were permitted to express themselves in either English language or Hausa language (the local language).

A total number of eight participants comprising four implementation agency staffs and four smallholders were interviewed. A minimum of 3 to 5 participants has been recommended for case study research (Creswell, 2002 in Onwuegbuzie and Collins, 2007; Onwuegbuzie and Leech, 2007a). *Participant one (P1)* is the Project Manager of the Middle Rima Valley Irrigation Scheme, and is therefore responsible for the direct implementation of the project; *Participant two (P2)* is the Assistant Project Manager (Civil Engineering) of the Middle Rima Valley Irrigation Scheme; *Participant three (P3)* is the Chief Irrigation Officer of the Middle Rima Valley Irrigation Scheme; *Participant four (P4)* is an Irrigation Officer of the Middle Rima Valley Irrigation Scheme; *Participant five (P5)* is a smallholder under the irrigation scheme; *Participant six (P6)* is a smallholder under the irrigation scheme and the Secretary of the Water Users Association; *Participant seven (P7)* is a smallholder under the irrigation scheme and a leader of the Water Users Association; and *Participant eight (P8)* is a smallholder under the irrigation scheme.

Furthermore, observation was also used to deepen the understanding of emerging processes and phenomena. Neuman (2000) contends that observation assists in improving and galvanizing the phenomenon under study. Observation in the study was thus geared towards gathering non-verbalised data such as respondents' non-verbal communication and actions, as well as the project area's physical characteristics. Hence, participants were observed all through the process of data collection.



5.3.3.1.1 Reliability and Validity in Qualitative Research Methods

Qualitative validity is the process of ensuring the accuracy of research findings through the use of certain procedures, while qualitative reliability reflects the consistency of the researcher's approach vis-à-vis similar projects and research. The basis of validity in qualitative research is the determination of the accuracy of research findings from the position of the researcher, readers of the account and participants (Creswell, 2009). Validity in qualitative research is achieved when a research is "plausible, credible, trustworthy, and, therefore, defensible" (Johnson, 1997:282). For Leung (2015), it refers to the suitability of the processes, tools and data. Onwuegbuzie and Leech (2007b) however argue that qualitative study cannot be assessed for validity, but that validity is proportionate to purposes and circumstances. What can be assessed, according to them, is the level or degree of the truth value of qualitative research.

In a bid to ensure validity, some approaches were employed and this followed some strategies outlined by Johnson (1997:283) and Onwuegbuzie and Leech (2007b). First is the triangulation of data which entails the collection of data from multiple sources. In addition to interviews, data triangulation was achieved by including observation, document analysis and survey in the data collection process. Secondly, peer examination was done as a fellow doctoral student served as a peer examiner for the qualitative analysis and presentation. This was supported with the discussion and assessment of the findings and interpretations by the doctoral supervisor. Thirdly, there was the use of low inference descriptors which entails the utilization of description that is phrased very close to the participants' accounts. This was achieved through direct quotations of participants from transcribed interviews. Onwuegbuzie and Leech (2007b) alludes to this as involving rich and thick description of data which often necessitate the use of interview transcripts verbatim. Fourthly, theory triangulation was done with the use of several theories in order to better interpret and explain the data. Fifthly, reflexivity was also practiced by the researcher to eliminate potential bias. Finally, two translators were given the data recorded in the local language in a bid to guarantee consistency between the Hausa interviews and the English transcription.

Reliability, Leung (2015) posits, focuses on the consistency of research findings. Some of the reliability procedures utilized in this research are as specified in Creswell (2009) and Leung (2015). They include the examination of the transcripts several times to eliminate apparent mistakes during the process of transcription, comprehensive usage of data, constant data comparison, and the avoidance of drifting in codes definition or meaning during the coding process. The latter was facilitated by the writing of memos regarding the codes and their definitions.

5.3.3.2 Quantitative Data Collection Methods

Quantitative research entails the process of collecting, analysing, interpreting and interpreting numeric data derived from diverse sources in a bid to quantify specific attributes with an overarching view to explore, explain, describe, predict and influence phenomena (Onwuegbuzie, Gerber and Abrams, 2017). It is a means whereby objective theories are tested through the examination of the relationship among variables.

Survey was used to collect quantitative data, through the administration of a structured questionnaire. Survey research describes quantitatively or numerically trends, opinions or attitudes of a population through the examination of a sample out of the population (Creswell, 2009). Surveys are used for the generation of quantifiable data which can be statistically analysed with a view to measuring, aggregating, modelling and predicting relations and behavior (Gambarino and Holland, 2009). Survey, Creswell (2009) further posits, uses questionnaire administration for data collection with the main aim of generalizing from the sample to the population.

The quantitative sample for the study was drawn using the systematic random sampling. This sampling technique entails the systematic selection of every “*k*th” element in the population. Information gathered from an inventory of farmers by the Sokoto Rima River Basin Development Authority (SRRBDA), the authority responsible for the scheme, indicates that about 10000 smallholders were operating under the project. Systematic random sampling was therefore used to select smallholder households from the list obtained from SRRBDA.

To arrive at the sample size, the Raosoft software was used for the calculation of an appropriate sample. As noted by MacIntosh (2006), the Raosoft sample size calculator implements standard statistical formulae to determine sample sizes for a given confidence level for attribute sampling. It requires the input of a population size and several assumed values: means and standard deviations.

In the Raosoft calculator, the sample size “*n*” and margin of error *E* are given by

$$\begin{aligned}
 X &= Z(c/100)^2 r(100-r) \\
 n &= N x / ((N-1)E^2 + x) \\
 E &= \text{Sqrt} [(N - n)x / n(N-1)]
 \end{aligned}$$

where *N* is the population size, *r* is the interested fraction of responses, and *Z*(*c*/100) is the critical value for the confidence level *c*. For this research, the parameters for the Raosoft sampling calculation is the following: The confidence level was set at 95%, error level was set at 5% and the distribution level was set to 50%.

Using the Raosoft sample size model (calculator, which is also available online at www.raosoft.com), 370 smallholder households were sampled for the study. The first smallholder was therefore selected at random from the list obtained and subsequent subjects were every 27th smallholder. In other words, one out of every 27 smallholders was selected for questionnaire administration. Questionnaires were administered using structured and semi-structured questions from February 2016 to April 2016. However, 306 questionnaires were successfully completed and returned, representing an 83% response rate.

Questionnaire administration, which represents effective means of data collection from a large number of respondents with a view to analysing data statistically (Langdrige and Hagger-Johnson, 2009), was used to elicit relevant information from smallholders. Such information include inter alia, livelihood outcomes, agricultural productivity and efficiency, food security and socio-economic attributes of the households.

5.3.3.2.1 Reliability and Validity of Quantitative Data

Validity in quantitative research refers to the degree to which a measure assesses what it claims to assess (Reinard, 2006). As the study did not involve psychometric measures or Likert scale questions, the study did not find ways of using or justify the use of both construct and content validity. However, face validity, a procedure which entails coming to the conclusion after the examination of the content of a measure, of whether or not, on its face, the measure assesses what is claimed (Reinard, 2006) was done for the quantitative data collection instrument. The instrument was critically reviewed by the research supervisor and two other experts to make sure that it captures the variables relevant to answering the research questions and achieving the research objectives.

Reliability in quantitative research implies the replicability of the research processes and findings (Leung, 2015). In the study, the questions in the questionnaire are divided into sections to capture specific construct per section as an evaluation of internal reliability. Furthermore, pre-testing of instruments generally assist in making such tools reliable and dependable. A pilot study was

conducted in the Kampe (Omi) Dam Irrigation Project in Kogi State, North Central Nigeria to test the instrument particularly the understanding of the smallholders regarding the questions.

5.3.4 Data Analysis Procedure

The section describes the processes adopted to analyse both the qualitative and quantitative data for the research. This entailed an iterative process geared towards accomplishing the objectives of the project.

5.3.4.1 Qualitative Analysis

Creswell (2009) suggests a concurrent process of data collection and analysis in qualitative research so as to allow for the refining of questions and further interrogation of views and perceptions emanating from the data collection process. This was done as much as possible during the data collection process for the study. Interviews were transcribed and preliminary analysis done to draw out emerging patterns for further interrogation in subsequent interviews.

The qualitative data was analysed inductively. The inductive approach involves the analysis of data to identify any emerging patterns that is indicative of relationships between variables (Gray, 2014). Creswell (2009) refers to inductive approach to data analysis as involving the building of patterns, categories and themes from the bottom up, through the organization of data into “increasingly more abstract units of information” (Creswell, 2009:175). It involves some form of interpretive inquiry in which case researchers make meaning of what they hear, see and understand.

Following the explanation of Gray (2014), using the inductive approach in this study involved taking several instances and basing conclusions on plurality of instances or cases as opposed to one. The data analysis process involves the preparation of data for analysis, doing different analysis, making, presenting and re-presenting the data, as well as interpreting or making meaning of the data. This process is basically an iterative process - going back and forth, involving constant reflection about the data, interrogating the data and writing memos all through the study (Creswell, 2009).

The data from the study was analysed using thematic content analysis. First, the recorded interviews were transcribed verbatim and these were reconciled with the fieldwork notes to make sure that there was no omitted data. Editing and familiarization with the data was thereafter done by going through the data and iteratively reading the scripts several times. Subsequently, the edited data was loaded into Atlas.ti version 8 software for analysis. The following steps were thereafter taken in the analysis process:

1. Initial codes were generated by highlighting connected ideas and systematically assigning potential codes using Atlas.ti software. For the coding process, In Vivo coding and open coding using process codes and descriptive codes were used (Saldaña, 2013, 2015).
2. With due consideration and being conscious of the research question, the generated codes were assigned into categories. The categories were then assigned into sub-themes and related sub-themes were merged into meaningful themes.
3. The themes which formed the basis of drawing meanings from the data were reviewed to ensure coherence.
4. The identified themes were thereafter named based on their meanings.

Quotations from each categories and themes were thereafter exported from Atlas.ti software to produce the report.

5.3.4.2 Quantitative Analysis

In the study, data derived from the administered questionnaires was subjected to statistical analysis, with an overarching aim of describing phenomena and for the identification and examination of relationships. A plethora of data analysis techniques were used to accomplish several research objectives of the study. This also necessitated the use of diverse statistical software programmes. While majority of the data analysis was done using the Statistical Package for the Social Sciences (SPSS) Version 24.0 and Stata Version 14, Microsoft Excel was used for the graphical representations and Frontier 4.1 program was used for the efficiency analysis.

In achieving the objectives of the research, the study used both descriptive and inferential statistics for the quantitative analysis. Descriptive statistics are used for the explanation, description and

summary of a given data set, whereas inferential statistics utilize statistics obtained from a sample to infer to a population from which the sample is drawn (Singh, 2007). Smallholders' demographic and other socio-economic characteristics of their households were summarized using descriptive statistics. The descriptive statistics were presented using tables and cross tabulations, frequency distributions, charts and graphical representations. Household Dietary Diversity Score (HDDS) and Food Consumption Score (FCS) were adopted to assess the food security status of smallholder households.

Quite a number of inferential statistical techniques were adopted for the study. These include Pearson Chi-square test (see section 8.8.2.2) which was used to assess the association between active savings and credit access, and Pearson correlation which was adopted to examine the relationship between efficiency, income and food security. The Stochastic Production Function was used to assess the technical efficiency of smallholders (see chapter 6, section 6.4). Multivariate linear regression (chapter 7, section 7.3.3) was used to examine the socio-economic determinants of smallholder households' food security status. Logistic regression and canonical correlation were used to examine the livelihood factors and strategies that contributes to wellbeing of smallholders and their households (chapter 8, section 8.7). Finally, cluster analysis and multinomial regression were respectively used for categorizing households into clusters and determining those socio-economic characteristics of households that affect smallholder typologies (chapter 9, section 9.3.3). The methods and techniques used for data analysis are explained in detailed in the relevant sections.

5.3.5 The Researcher's Role and Reflexivity

The researcher's role as the instrument for the data collection demands the recognition at the beginning of the research, of personal assumptions, biases and values that may affect the research process and outcomes. As Grbich (2004) posits, "the self is the transitional compilation of an individual's internal and external conversations both past and present, of this person's desires, fantasies, wishes, interactions, and social and cultural values and understandings acquired and continually being adapted and adjusted in a range of contexts" (Grbich, 2004:69). It is therefore imperative to be conscious of "self" during the research process.

My perceptions of smallholder agriculture has been shaped by my personal experiences, knowledge and understanding, especially of smallholders' struggles and challenges. With grandparents that were farmers, I have seen first-hand their struggles to eke out a living for themselves and their households. This took its toll on their health and their children's education as some of them had delays in completing their education while some were not able complete their higher education. My Masters' research also focused on the process of monitoring and evaluation in smallholder agriculture in North Central Nigeria where I understood further some of the challenges confronting Nigerian smallholders. Due to these previous experiences and my knowledge, I brought some biases to the study.

Nevertheless, all efforts were made to remain objective, although the biases may have influenced the way I view, understand and interpret the data. As such, reflexivity which is a process of critical self-reflection and self-awareness (Johnson, 1997) was done throughout the entire research process, was adopted and imbibed by the researcher. Reflexivity is also defined as viewing critically and in a detached manner, the self and the data collection and interpretation processes via internal dialogue and a continuing critical examination of "what I know" and "how I know it" in the generation of knowledge claims (Grbich, 2004:71). This process of reflection throughout the research period and activities assisted me in understanding myself better and as Grbich (2004) puts it, enabled me to recognize those discourses that have influenced the lenses through which I view the worlds and the participants under study. In essence, self-reflexivity helped me to be aware and to consciously work at removing or reducing all potential biases and sentiments that may affect the research process and outcomes.

5.4 Ethics Considerations

Ethics are the moral principles that guide an individual's behavior or the conduct of an inquiry or activity. The study was carried out in accordance with the ethical research standards of the University of the Western Cape. By implication, the study only started after approval was granted by the University of the Western Cape Senate, the Faculty of Economics and Management Sciences Board, and the Institute for Social Development. Permission was also sought from the project implementing agency, the Sokoto Rima River Basin Development Authority (SRBDA), the leadership of the Water Users Association (the smallholders' association), as well as individual

smallholders themselves. Consent to administer questionnaires and conduct interviews were sought from research participants using instruments in Appendix 3 and 4 respectively. Information sheets (Appendices 5 and 6) which describe the objectives and scope of the research as well as the rights of participants were also provided for participants.

The study did not aim to cause any harm to any party involved, hence respondents' participation was voluntary and this was communicated to them. The researcher also made clear, at all stages of data collection, the purpose and objectives of the study to everyone that participated in the study. Finally, the researcher made clear that anonymity would be ensured and that all gathered information would be kept confidential and used for the proposed purposes of the study only. The foregoing were adhered to all through the entire process of the research.

5.5 Chapter Summary

The chapter has expanded on the philosophy and methods of research adopted for the study. Critical realism, particularly its process of *retroduction* was expanded upon and its relevance to the study was explained. Also, purposive sampling and systematic random sampling were respectively used to sample respondents for the qualitative and quantitative aspects of the research. While thematic content analysis was used to analyse the qualitative data, quantitative data was analysed using both descriptive and inferential statistics. The chapter ends with a section on the researcher's role, the need to be reflective and how this was achieved, as well as an ethics statement which is a non-negotiable requirement for undertaking a research.

Based upon the theoretical, philosophical and methodological approaches outlined, the next chapter and indeed some subsequent chapters present empirical findings emanating from the research.

CHAPTER SIX

ANALYSIS OF TECHNICAL EFFICIENCY OF SMALLHOLDER IRRIGATION FARMERS IN SOKOTO STATE, NIGERIA

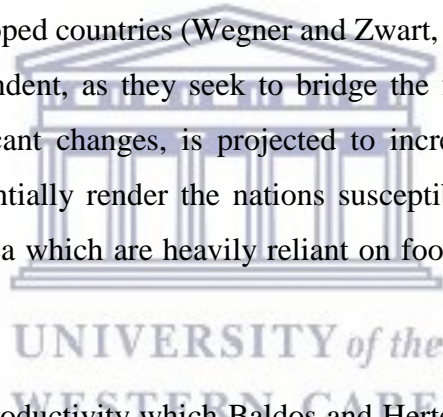
6.1 Introduction

Despite agriculture's significant contribution to Nigeria's GDP and total labour force, the potential of the sector in transforming the lives of the nation's teeming masses remains largely unfulfilled. Issues relating to resource underutilization and productivity have been persisting challenges characterizing the sector. The chapter analyses the technical efficiency of smallholder farmers involved in irrigation agriculture in the Middle Rima Valley Irrigation Project, Sokoto State, Northern Nigeria using the stochastic frontier production function. The chapter is expected to clarify the efficiency levels of the farmers and determine factor influencing difference in efficiency levels.

6.2 Background

Progress in global agricultural production is both paradoxical and unsatisfactory, masking issues relating to regional unevenness and sustainable production. Although the world currently produces enough food to feed its population, the sustainability of this is presently being threatened as a result of rapid population growth, changing diets owing to rising incomes and urbanization rates, as well as the increasing pressure on earth's finite resources. As Molden (2007) aptly describes, crises is imminent if the current food production rate is merely maintained and environmental trends are allowed to continue unabatedly. With global population forecasted to reach 9 billion by 2050, the world needs a 70-100% increase in food production to meet future food demand (Godfray, et al., 2010; Tschardt et al., 2012; Tomlinson, 2013; Grote, 2014). Variations in temperature and precipitation resulting from climate change is predicted to have mixed impact on crop yields across regions (Rosegrant and Cline, 2003; Baldos and Hertel, 2014), while unlimited expansion of water and land resources into the future is unrealistic (Schneider et al., 2011; Godfray and Robinson, 2015).

Indeed, it is noteworthy that despite adequacy in global food production, a significant number cannot afford or access the food, as there are about 815 million undernourished people in the world with 22.7% of sub-Saharan Africa population presently undernourished (FAO et al., 2017). Food availability concerns are further compounded by the unevenness in food production across regions of the world. In many developing countries, production growth rates lags behind the demand rates for agricultural commodities, thus resulting in recurrent years of deficits in agricultural trade (Dorward et al., 2004; FAO, 2013). That the deficit anticipated for developing countries in cereal production will be offset by importation is almost a given. Globally, production of cereal is projected to rise by 56% by 2050 while the demand growth rate for cereal for developing countries is put at 93% (Rosegrant and Cline, 2003). Africa's cereal self-sufficiency ratio is one of the lowest in the world, while the region also has the highest projected population growth rate (van Ittersum et al., 2016). Furthermore, agricultural productivity is stalling in sub-Saharan Africa despite growth observed in most developed countries (Wegner and Zwart, 2011). An upshot of this is that many countries are food dependent, as they seek to bridge the food demand-supply gap. The foregoing, barring any significant changes, is projected to increase into the future for many developing countries and potentially render the nations susceptible to international food price spikes especially those in Africa which are heavily reliant on food imports (Wegner and Zwart, 2011).



To forestall this, agricultural productivity which Baldos and Hertel (2014) observed is presently rising at the global level needs to be enhanced. This is critical in order to meet the increasing demand for food and to compensate for the yield losses associated with climate change that are anticipated in several developing countries (Wegner and Zwart, 2011). Indeed, there have been growing calls for increased food production especially where the hungry live (Tscharntke et al., 2012). Coincidentally, developing regions of the world where majority of the hungry are found is also home to a sizeable proportion of the world's smallholder farmers. Smallholders are certainly critical to ensuring global food security. They presently constitute 50% of the world's undernourished people, with majority farming on less than two hectares of cropland (Wegner and Zwart, 2011; Tscharntke et al., 2012).

Suffice to say that if food production is to be enhanced within the limits of available resources, it is not enough to ask who the producers are. More importantly, issues relating to the constraints or enablers of expanding production must be unpacked. As Cousins (2008) rightly points out, smallholder agriculture can only make a meaningful impact on poverty reduction when smallholders are able to engage in ‘accumulation from below’, that is when they are able to produce a marketable surplus and successfully reinvest part of the profit emanating from the surplus for future expansion of production. The foregoing is very much associated to efficiency in production. It is imperative that attempts at enhancing agricultural production of smallholders bear in mind strategies or approaches that maximizes productivity and/or ensures efficiency.

An important question to interrogate therefore is whether smallholders are efficient or otherwise, and what factors are responsible for their efficiency status. As Tijani (2006) asserts, the concept of efficiency is a critical component of productivity growth especially in resource constrained environments as it helps to unpack the possibility of increasing productivity through efficiency improvement without necessarily enhancing the resource or technology base. The study seeks to assess the technical efficiency of smallholder farmers in the Middle Rima Valley Irrigation Project of North West Nigeria, and to identify farmer-specific characteristics explaining variations in efficiency of individual farmers. Insights from such analysis could provide stakeholders with information that could help in increasing agricultural productivity of Nigeria’s smallholders.

Considering the potentials of irrigation agriculture in contributing to food security and poverty reduction in Nigeria, it is noteworthy that irrigation development has not had the anticipated impact on agricultural development, and in extension on economic growth and national food security. That a meagre 7% of the 3.24 million hectares of potentially irrigable land is under cultivation (World Bank, 2008:1), is certainly a persuasive indicator of the under-exploitation of irrigation agriculture in Nigeria. For the irrigation projects that are currently working (in operation) however, it is imperative to take cognizance of their performance, a step that is certainly crucial to their improvements and sustainability. The concept of technical efficiency represents a relevant measure that can be used to assess irrigation agriculture performance.

Quite a number of studies have been carried out to measure technical efficiency of farmers in Nigeria (for instance, the works of Tijani, 2006; Idiong, 2007; Osawe, Akinyosoye and Omonona, 2007; Shehu and Mshelia, 2007; Amos, 2007; Ogundari, 2008; Omonona et al., 2010; Akanbi, Omotesho and Ayinde, 2011; Adama, 2014; Okoruwa et al., 2014), although these pale in comparison to the number of studies carried out in developed countries. Omonona et al. (2010) estimated technical efficiencies of cowpea farmers in Osun State, South West Nigeria using the Cobb-Douglas production function and found the mean efficiency to be 87%. Key contributory factors to efficiency estimates were farm size, labour, fertilizer and pesticides. Furthermore, significant variables influencing technical inefficiency were associational membership and years of experience. Tijani (2006) assessed the technical efficiency of rice farmers in Ijesha, also in Osun State using the Translog production function. Average rice output was found to be lower by 13.4% than the maximum achievable as mean efficiency was 86.6%, and farm size, pesticide use, extension services and off-farm income were the variables that significantly influenced inefficiency.

Technical efficiency estimates of rice farmers involved in a government irrigation scheme in Duku, Kwara State, North Central Nigeria were analysed by Akanbi, Omotesho and Ayinde (2011) using the Cobb-Douglas production function. The average efficiency was exceptionally high, estimated at 98% and this was linked to the receipt of government assistance in terms of input-output linkages by the farmers. Furthermore, years of experience, educational level, access to credit, associational membership were among the significant determinants of inefficiency found among the farmers. Ogundari (2008) conducted an analysis of both the technical and allocative efficiency of rain fed rice farmers in Akure, Ondo State, South West Nigeria. Using the translog production function, he found that about 25% of yield is lost due to inefficiency as mean technical efficiency was estimated to be 75%. Inputs such as seeds, herbicides, fertilizer and land (farm size) were the major contributor to efficiency, while labour contributed least to efficiency estimates. Variables that significantly influence technical inefficiency are access to extension services and credit. He observed, in terms of allocative efficiency, that none of the farmers used their inputs optimally as there was a disequilibrium between marginal value product and price of the factor inputs.

Amos (2007) observed technical inefficiency in cocoa production among 250 farmers in Ondo State with mean efficiency level of 72%. Significant determinants of inefficiency were age of farmers, educational level and family size. Specifically, age of farmers and age of farms were negatively correlated with efficiency levels of farmers. Okoruwa et al. (2014) reports on plantain farmers' efficiency in Ogun State, Nigeria and observed the mean technical efficiency to be 83.5%. They further noted that production was at a decreasing positive return to scale stage. Farm size, quantity of fertilizers, quantity of agrochemicals, and quantity of planting material used were all significant determinants of farm output. Furthermore, age, household size, education and extension contacts were significant factors influencing technical inefficiency.

Osawe, Akinyosoye and Omonona (2007) conducted a study on technical efficiency of fish farmers in Ibadan, South West Nigeria and found the average level of efficiency to be approximately 91%. Pond size, total quantity of feed used and stocking rate were significant contributors to efficiency estimates. Furthermore, feeding regime, educational level, years of experience, pond type and cooperative membership significantly affects technical inefficiency. While feeding regime had a negative influence on efficiency, increase in educational level, years of experience and being a member of a cooperative society were estimated to lead to a decrease in technical efficiency.

Adama (2014) assessed the determinants of technical efficiency of 240 smallholders in Kogi State, North Central Nigeria using the Cobb- Douglas production function. Mean levels of efficiency was estimated to be 64% although predicted technical efficiency varied widely, ranging from 19% to 93%. He observed that age, educational and farming experience were significant determinants of technical inefficiency, and concluded that education should be a key policy directive to improve efficiency.

Idiong (2007) investigated technical efficiency of 112 small scale farmers involved in swamp rice production in Cross River State, South East Nigeria. Average level of efficiency was 77%, hence a 23% prospect for improving efficiency. Labour, farm size and seed significantly contributed to efficiency estimates, and significant and positive determinants of efficiency were education, associational membership and credit access. In a study of the technical efficiency of cassava

farmers in South East Nigeria, Iheke (2008) estimated technical efficiency range of between 59% to 95% with mean efficiency levels of 77%. Age, education, farming experience, association membership, access to credit, farm size and household size were among the factors that significantly influence technical inefficiency. He concluded that policies aimed at enhancing farmers' education and credit access should be pursued.

Shehu and Mshelia (2007) assessed the technical efficiency of 180 rice farmers in Adamawa State, Northern Nigeria. They found that land and labour were the two most important factors in the efficiency estimates, and average level of efficiency was approximately 96%. Education was estimated to be the only significant factor influencing technical inefficiency and also had a positive relationship with technical efficiency. The corollary of this, the authors note, is that with better education, technologies could be better comprehended which could potentially move the farms closer to the frontier.

From the foregoing review, it is apparent that there is a dearth of literature on technical efficiency of irrigation agriculture in Nigeria as majority of the studies on technical efficiency focused on other aspects of agriculture. The limited studies which centred on irrigation agriculture were not preoccupied with smallholders involved in mixed cropping but on farmers involved in single cropping. The study thus seeks to bridge the existing gap by assessing the technical efficiency of smallholders involved in the cultivation of several crops in the Middle Rima Valley Irrigation Project, Sokoto State, Nigeria.

6.3 Analytical Framework

The concept of efficiency has developed immensely over the years, evidently motivated by the desire to achieve optimal utilization of resources. Farrell's (1957) seminal work on the empirical measurement of productive efficiency detailed how to decompose efficiency into its technical and allocative components. Technical efficiency refers to the ability to maximize output from a given amount of inputs, or the ability to minimize input used to obtain a given output under a given technology (Kumbhakar and Lovell, 2000). For any given firm, technical efficiency signifies "the ratio of the observed output to the corresponding frontier output, conditional on the level of inputs used by the firm" (Battese, 1992:191). A firm is said to be technically efficient if it is absolutely

unfeasible to increase output and/or decrease inputs. Allocative efficiency is the ability of a firm to choose optimal input proportions for given factor prices. The product of technical and allocative efficiency is termed economic or total efficiency and this is what Farrell (1957) refers to as a firm's capacity to produce a quantity of output that is predetermined given certain technology levels.

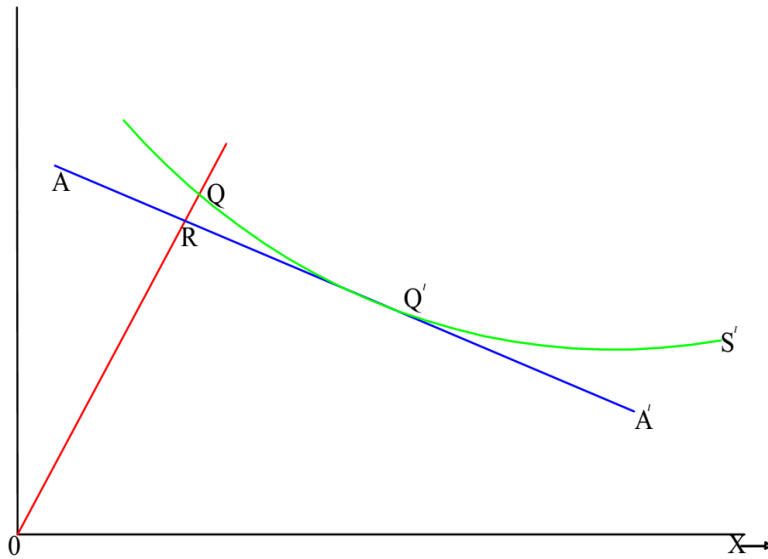
Following from the definition of technical efficiency (TE), two measures of technical efficiency emerge which are input oriented and output oriented measures. The notion of TE was well laid out in Farrell's work and can be illustrated using an example involving firms utilizing two inputs (x_1 and x_2), to produce an output (q), under the conditions of constant returns to scale (Figure 6.1). Understanding the unit isoquant SS^1 which represents fully efficient firms will enable the estimation of technical efficiency (Coelli et al., 2005). A firm using amounts of inputs defined by P , would have its technical efficiency represented by the distance QP , which connotes the quantities by which all inputs can be proportionately reduced without a decrease in output. The foregoing is generally expressed in percentage terms by the ratio QP/OP , denoting the percentage by which all inputs must be lowered to realize technically efficient production. For any given firm, technical efficiency is determined by the ratio:

$$TE = \frac{OQ}{OP} = 1 - \frac{QP}{OP}$$

Equation 6.1

The technical efficiency of a firm ranges between 0 and 1, with a value of 1 indicative of a fully technically efficient firm. A firm on point Q is said to be technically efficient since it lies on the efficient isoquant (Coelli *et al.*, 2005:52).

Figure 6.1: Input-oriented measure of technical efficiency.



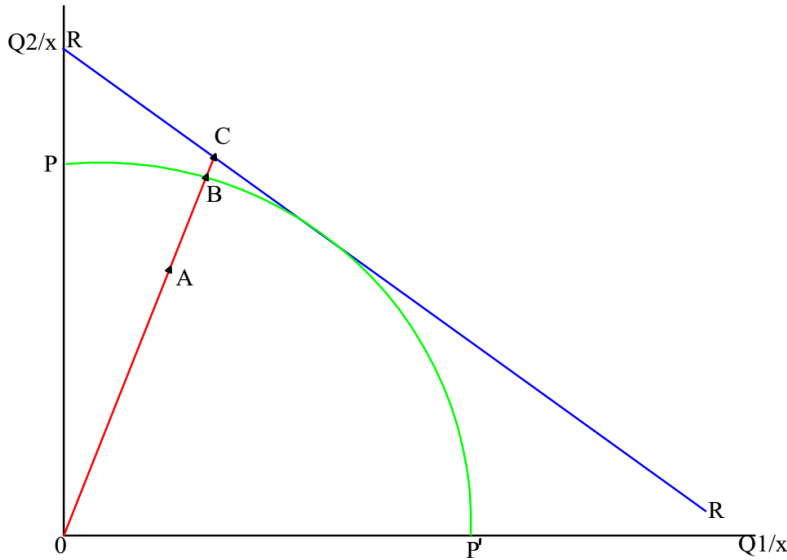
Source: Coelli et al. (2005)

Conversely, it is possible to be interested in how much output quantities can be increased without changing the amount of inputs used, which primarily is the function of output-oriented measures. Given constant returns to scale on a single input x , and two outputs (q_1, q_2) , curve PP^I (in Figure 6.2) represents the unit production possibility curve and point A which lies below the curve exemplifies an inefficient firm. Technical inefficiency is represented by the distance AB , which is indicative of the quantities by which output can be increased without increasing input. An output-oriented technical efficiency is therefore given by the ratio:

$$\mathbf{TE} = \frac{0A}{0B} = \mathbf{d}_o(x, q) \quad \mathbf{Equation\ 6.2}$$

Where $d_o(x, q)$ is the output distance function at the observed input vector x and the observed vector q (Coelli et al., 2005:54-56).

Figure 6.2: Output-oriented measure of technical efficiency.



Source: Coelli et al. (2005)

Frontier models used in measuring economic efficiency are generally classified into parametric and non-parametric. The latter is referred to as data envelopment analysis (DEA) models and rely on mathematical programming techniques to develop a non-parametric frontier from the data. The major characteristics of DEA methods is that unlike the parametric models, they do not require the restrictive functional form specification for the technology (Bravo-Ureta et al., 2007; Liverpool-Tasie, Kuku and Ajibola, 2011). The limitation of DEA methods however is that they are significantly affected by outliers and estimated efficiency scores could be potentially sensitive to the number of observations and the ambit of the frontier (Bravo-Ureta et al., 2007). Furthermore, DEA does not allow for non-constant returns to scale as well as the range of uneconomic activities of the production function in which the efficiency index is undefined, while it also is not sufficiently adaptable to standard statistical tests of significance (Coelli et al., 2005).

Parametric models require the specification of the functional form and are divided into deterministic and stochastic models. Deterministic models assume that any departure from the frontier is as a result of inefficiency while the stochastic approach takes into account statistical noise. Accordingly, embedded in the one-sided component is any error in measurement, and any additional source of stochastic variation in the dependent variable, thus potentially resulting in

technical efficiency estimates that are sensitive to outliers as well as increased inefficiency estimation (Thiam, Bravo-ureta and Rivas, 2001; Bravo-Ureta et al., 2007). This represents a fundamental flaw of deterministic frontiers.

The stochastic production frontier (SPF) model, independently proposed by Meeusen and van Den Broeck (1977) and Aigner, Lovell and Schmidt (1977), represents an attempt to resolve the extreme observation issue associated with previous models and to account for the presence of measurement errors and statistical noise. The model is inspired by the theoretical notion that no firm can surpass the ideal “frontier” and that deviations from the extreme are as a result of individual inefficiencies (Belotti et al., 2013:720). The overarching aim of the model is to infer about both technical efficiency and frontier parameters (Battese and Coelli, 1995; Kumbhakar and Lovell, 2000; Belotti *et al.*, 2013).

Stochastic frontier model is composed of a production function specified using a regression model with an error term which has two components. The first error component accounts for the presence of technical inefficiencies in production, and the second is the classical idiosyncratic disturbance component which accounts for measurement errors (in weather, output, unobserved inputs, etc.) and any other classical noise outside the control of the production unit. The stochastic frontier model also permits the estimation of standard errors and hypothesis testing unlike deterministic frontiers which violate some maximum likelihood (ML) regularity conditions necessary for such estimations (Thiam, Bravo-Ureta and Rivas, 2001).

The stochastic frontier production is specified as:

$$Y_i = f(X_i, \beta) + \varepsilon_i \quad i = 1, \dots, N \quad \text{Equation 6.3}$$

Where Y_i represents the output (or the logarithm of the output) of the i th firm;

X_i is a vector of (or transformations of the) inputs of the i th firm;

β is the vector of unknown technology parameters;

ε_i is the sum (or difference) of a normally distributed disturbance, composed of two components such that:

$$\varepsilon_i = v_i - u_i$$

Equation 6.4

The error term v_i represents measurement and specification error and a symmetric disturbance assumed to be $N(0, \sigma^2_v)$. The error term u_i is assumed to account for deviations from the frontier or technical efficiency in production and is assumed to be $|N(0, \sigma^2_u)|$. Furthermore, u_i and v_i are assumed to be independent of one another and are independently and identically distributed across observations, and the latter assumption about the distribution of the inefficiency term renders the model estimable (Battese, 1992; Belotti et al., 2013).

The initial specification of the error term distribution has been extended over the years. Although Aigner, Lovell and Schmidt (1977) assumed a half-normal distribution, which is $u_i \sim |N(0, \sigma^2_u)|$, and Meeusen and van Den Broeck (1977) specified an exponential distribution, $u_i \sim \mathcal{E}(\sigma_u)$, other generally specified distributions are the truncated normal and gamma distributions (Coelli, 1996; Kumbhakar and Lovell, 2000; Belotti *et al.*, 2013). However, the choice among distributional assumptions is not so important particularly if the focus is on the ranking of individual efficiencies of firms or the composition of the bottom and top efficiency score deciles (Kumbhakar and Lovell, 2000).

Although it is possible to utilise the modified ordinary least-squares or generalized method of moments to estimate the unknown parameters, this often yield inefficient results hence the wide usage of the method of maximum likelihood to estimate the inefficiency term (Coelli, 1995; Belotti *et al.*, 2013). Stochastic frontier analysis is generally based on two sequential steps. Firstly, the log likelihood function $\ell(\theta)$ is maximized in order to obtain the model parameters of θ , where $\theta = (\alpha, \beta', \sigma^2_u, \sigma^2_v)'$.¹ Secondly, inefficiency estimates are derived through the mean (or the mode) of the conditional distribution $f(u_i|\hat{\varepsilon}_i)$, where $\hat{\varepsilon}_i = y_i - \hat{\alpha} - x_i'\hat{\beta}$.

The assumption of independence between the two error terms allows for the derivation of the likelihood function, and the probability density function of the composite error term ε_i (where $\varepsilon_i = v_i - u_i$) is the convolution of the two densities of both error terms as;

¹ Model parameterizations for SF analysis are diverse in literature (Battese, 1992; Belotti *et al.*, 2013)

$$f_{\varepsilon}(\varepsilon_i) = \int_0^{+\infty} f_u(\mathbf{u}_i) f_v(\varepsilon_i + \mathbf{u}_i) d\mathbf{u}_i \quad \text{Equation 6.5}$$

Thus, for a sample of n productive units, the log likelihood function is given as

$$\ell(\theta) = \sum_{i=1}^n \log f_{\varepsilon}(\varepsilon_i | \theta) \quad \text{Equation 6.6}$$

Of paramount importance to stochastic frontier analysis is the choice of functional form for the production function. Literature is replete with the use of both the Cobb-Douglas and translog production functions. The Cobb-Douglas function is reported to be most suitable providing the main interest is not on efficiency estimates as against the evaluation of the overall structure of the production technology (Binam et al., 2004). However, the Cobb-Douglas is fitted and highly restrictive, hence lacks flexibility. It assumes constant returns to scale for every production unit, constant input elasticities as well as a substitution elasticity to be equal to one (Van Passel et al., 2009). On the other hand, the translog functional form has the advantage of flexibility but needs a lot of data to prevent estimation problems. Suffice to say however that efficiency estimates are not extensively affected by the choice of functional form. Indeed, there have been several allusions in literature of the discernible, but quite small impact of functional form on efficiency estimates (Thiam, Bravo-ureta and Rivas, 2001; Binam et al., 2004).

The estimation of firms' level of technical efficiency using SPF can be done as a one-stage or two-stage procedure. In the latter, the first step estimates firms' inefficiencies ignoring the effect of observable firm-specific characteristics on inefficiency, and in the second step, the predicted inefficiencies are regressed against the firm-specific variables. This procedure has however been criticized because of the inconsistency in its assumptions that inefficiency effects in the two-stage estimation are independent of each other (Coelli, 1996; Binam et al., 2004; Makombe et al., 2017). As Wang and Schmidt (2002) noted, the procedure results in biased estimates attributable to misspecification bias in the first step, and in the second step the spurious under-dispersion in the estimated firm-level efficiencies underestimates the effect of the firm-specific characteristics on efficiency levels.

The one-stage procedure on the other hand overcomes the bias evident in the two-stage procedure by specifying both the stochastic frontier and the manner in which technical efficiency depends on firm-specific characteristics, which is estimated as a single step (Wang and Schmidt, 2002). There exists variants of the one-stage procedure such as the one proposed by (Battese and Coelli, 1995) and (Wang and Schmidt, 2002). The Battese and Coelli (1995) variant has the advantage of being able to estimate efficiency scores for each firm and the factors responsible for the efficiency variance among firms in a single estimation procedure.

The Battese and Coelli (1995) model variant utilises the parameterization from Battese and Corra (1977), replacing σ^2_v and σ^2_u with $\sigma^2 = \sigma^2_v + \sigma^2_u$ and $\gamma = \sigma^2_u / (\sigma^2_v + \sigma^2_u)$. This is done in order to ensure that the parameter γ ranges between 0 and 1 such that a grid search can be conducted to obtain good starting values for the iterative maximization process used to obtain the maximum likelihood estimates.

Estimation of stochastic frontiers can also be categorized into cost and production functions, and according to the types of data, into cross-section or panel data studies. Panel data estimations contain more observations on a single unit, and thus may potentially yield more accurate estimates of efficiency (Thiam, Bravo-ureta and Rivas, 2001).

6.4 Data and Empirical Specification

6.4.1 Data

Data for the study was obtained from a survey of small-scale irrigation farmers in the Middle Rima Valley Irrigation Project (explicitly described in section 5.3.3.2), Sokoto State, Nigeria, and is based on cross sectional production information obtained during the 2015 production year in the irrigation project. The small farms are organized in farmer families who cultivate a variety of crops using the irrigation facilities provided by the Sokoto Rima River Basin Development Authority (SRRBDA). Information gathered from an inventory of farmers obtained from the SRRBDA indicates that there were about 10000 smallholders in the project. Systematic random sampling was used for the selection of smallholders for questionnaires administration. Based on a 5% margin of error and 95% confidence interval, 370 smallholders were sampled for the study. However, 306

questionnaires were successfully completed and returned representing an 83% response rate. Information collected using the questionnaire include the socio-economic characteristics of farmers, output – the values of crops harvested, inputs which include land area cultivated, values of fertilizer, pesticide and seeds, labour expressed in man days, and the value of farm tools used during cultivation.

6.4.2 Empirical Specification

Following Battese and Coelli (1995) specification, the model specified will have two parts; the stochastic production function (SPF) and the inefficiency model. The notion of frontier production in agriculture can be illustrated with a farm using n inputs (X_1, X_2, \dots, X_n) to produce output Y . Efficient transformation of inputs into output is illustrated by the production function $f(x)$, which indicates the maximum output obtainable from various input vectors. A typical smallholder agricultural production activity in developing countries, based on prior literature and economic theory, involves factor inputs of land, labour, modern inputs, specifically values of fertilizer, seed, pesticide and a sort of capital (farm implements to till and cultivate land). The production function estimated in this study is generally specified as follows

$$Y = (LAND, LABOUR, FERT, SEEDS, PEST, KPTL) \quad \text{Equation 6.7}$$

Where 'Y' is the gross value of all crops produced, measured in Naira²

'LAND' is the total area of land in hectares cultivated by the farm household for the given cropping season.

'LABOUR' represents the total labour days (either hired labour or family labour) spent on cleaning, ploughing, weeding and harvesting. It is measured in man days.

'FERT' is the amount of money spent (in naira) on fertilizer for a cropping season.

'SEEDS' is the amount of money spent (in naira) on yield enhancing technologies (including high quality seedlings and pesticides) for a cropping season.

'PEST' is the amount of money spent (in naira) on pesticide for a cropping season.

² Naira is Nigerian currency. 1 Naira equals 0.0051 Dollar as at 05/05/2016

'KPTL' is the value of all physical capital or farm tools (hoes and ploughs used for cultivation) for each household per cropping season. It is measured in naira.

The specific Cobb-Douglas stochastic production function is specified as follows:

$$\ln Y = \varphi_0 + \varphi_1 \ln(LAND_i) + \varphi_2 \ln(LABOUR_i) + \varphi_3 \ln(FERT_i) + \varphi_4 \ln(SEEDS_i) + \varphi_5 \ln(PEST_i) + \varphi_6 \ln(KPTL_i) + V_i - U_i \quad \text{Equation 6.8}$$

In the above equation the subscript, i , indicates the i^{th} farmer in the sample. \ln is natural logarithm and φ_s are coefficients to be estimated. Since the value of output is in natural logarithmic form, the coefficients $\varphi_2, \varphi_3, \varphi_4, \varphi_5$ measure percentage changes in output that result from a percentage change in the respective factors of production.

V_i s are assumed to be independent and identically distributed normal random errors, having zero mean and unknown variance, $\phi^2 v$; and U_i s represent the technical inefficiency effects, which are assumed to be independent of V_i s such that U_i s is the non-negative truncation (at zero) of the normal distribution with mean, μ_i , and variance, ϕ^2 , where μ_i s is defined by;

$$\mu_i = \delta_0 + \delta_1 z_{1i} + \delta_2 z_{2i} + \delta_3 z_{3i} + \delta_4 z_{4i} + \delta_5 z_{5i} + \delta_5 z_{5i} + \delta_6 z_{6i} \quad \text{Equation 6.9}$$

Where

z_1 = number of times a plot is cultivated in a year

z_2 = household size

z_3 = farming experience (in years)

z_4 = access to credit (1 – access to credit; 0 – no access to credit)

z_5 = off-farm income (1 – off-farm income; 0 – no off-farm income)

z_6 = educational status (1 – education; 0 – no education)

These variables are assumed to influence technical efficiency of farmers, and δ s are unknown scalar parameters to be estimated.

The maximum likelihood estimates (MLE) of the parameters in the Cobb-Douglas stochastic frontier production function model defined by Equation 6.8, given the specifications for the technical inefficiency effects defined in Equation 6.9 were obtained using FRONTIER 4.1 program (Coelli, 1996). The unknown parameters of the stochastic frontier production function and the inefficiency effects were concurrently estimated following the procedure laid out by Coelli (1996).

6.5 Results and Discussion

The results of the production frontier analysis is presented in this section. First, an attempt is made to present the descriptive statistics of important variables in the analysis and this is summarized in Table 6.1. The mean value of output of the smallholder farmers for the cropping year was N231 431. While the least a farmer realized as proceeds from his farm was N17 000, the highest revenue generated in the irrigation project was N510 000. The average size of the irrigation farms was 0.22ha, thus confirming the findings of Lowder, Skoet and Singh (2014) that majority of farms in sub-Saharan Africa is less than a hectare. Furthermore, Makombe et al. (2017) observed land to be a constrain to expanding production in Ethiopia. The implication of the estimated average farm size is that for every hectare of land on the irrigation project, the average revenue that can be generated is N1 051 959. The average number of manpower or labour used in production in man days was 51, resulting in a mean labour use of 231 per ha. The high labour use in the project is an indication that farming is far from being mechanized as majority of the smallholders rely on labour especially family labour for their farm operations. The average values of seeds, fertilizer, pesticides and farm tools are N17 033, N9 865, N2 201, N2 965 respectively. Cultivation of farm land during the cropping year was done either twice or thrice by the smallholders with majority cultivating their land twice. Furthermore, the average family size of the farmers was eight, and the high number may have influenced the reliance on family labour for farm operations. Evidently many of the smallholders have an appreciable level of experience of farming on irrigated lands as the average years of experience was 12.

Table 6.1: Summary statistics of farm inputs and output of irrigation smallholders

Variable	Mean	Std deviation	Minimum	Maximum
Total value of output (naira)	231 431	86 242	17 000	510 000
Farm size (ha)	0.22	0.1	0.06	0.6
Labour (man-days)	51	21	27	150
Value of seeds (naira)	17 033	6 439	1 500	36 000
Value of fertilizer (naira)	9 865	3 378	500	22 000
Value of pesticides (naira)	2 201	1 345	-	9 000
Value of farm tools (naira)	2 965	3 069	600	24 000
No of times land was cultivated	2.21	0.41	2	3
Household size	8	1.58	4	12
Years of experience	12	3.6	1	25

Source: Field Survey (2016)

A Cobb-Douglas stochastic production function was estimated for the smallholders in the irrigation project which is done based on the half normal distributional assumption of the inefficiency error term. The maximum likelihood estimates of the production function and the inefficiency effects are presented in Table 6.2. The lower section of the table presents the diagnostics statistics. The estimated variance (σ^2), was statistically significant at 5% level indicating goodness of fit and the appropriateness of the specified distribution assumption of the composite error terms. The gamma, $\gamma = \sigma^2_u / (\sigma^2_v + \sigma^2_u)$, which represents the variance ratio is close to 1 (0.945) in the model and is statistically different from zero. This thus establishes that inefficiencies exist among the smallholder farmers.

The maximum likelihood parameter estimates for the production function were all statistically significant at 5% level of significance with the exception of pesticides. Furthermore, the estimated coefficients, interpreted as output elasticities were all positive with the exception of pesticides and farm tools. The coefficient for land was highest indicating that land contribute the most to smallholder production in the irrigation project area. The output elasticity for land is 0.58, which suggests that a 10% increase in the land area cultivated would result in an output increase of 5.8% keeping other explanatory factors constant. The estimated output elasticities for labour, fertilizer and seeds are respectively 0.088, 0.137, and 0.169. This indicates that a 10% increase in the

number of labour employed in a farm holding would lead to a 0.8% increase in output, a 10% increase in fertilizer application on land would result in an output increase of 1.37%, and a 10% increase in the amount of seed used would increase output by 1.69%. On the other hand, the estimated output elasticity for pesticide is negative (-0.005), indicating that a 10% increase in pesticide use would decrease output by 0.05%. Also, the estimated output elasticity for farm tools is negative (-0.171), suggesting that a 10% increase in farm tools would decrease output by 1.71%. This result may be indicative of the primitive tools been employed by the smallholders for production. Literature has identified inadequate adoption of new and relevant technologies as a main constraint to increasing agricultural production (Collier and Dercon, 2014; Mockshell and Birner, 2016). Nevertheless, what is certain is that the increased utilization of these tools would not lead to an increase in the yield of smallholders.

Table 6.2: Maximum likelihood estimates of stochastic frontier production function

Independent variable	Parameter	Coefficient	T-ratio
<i>Production function</i>			
Intercept	β_0	11.493	23.105*
Ln (land)	β_1	0.580	13.965*
Ln (labour)	β_2	0.088	2.713*
Ln (fertilizer)	β_3	0.137	5.602*
Ln (seeds)	β_4	0.169	5.376*
Ln (pesticides)	β_5	-0.005	-0.999
Ln (farm tools)	β_6	-0.171	-7.158*
<i>Inefficiency function</i>			
Intercept	δ_0	-0.211	-0.243
No of times of cultivation	δ_1	1.300	2.670*
Household size	δ_2	-0.469	-1.502
Years of experience	δ_3	-0.343	-2.529*
Access to credit	δ_4	-2.107	-2.533*
Off-farm income	δ_5	-0.669	-3.104*
Education	δ_6	0.577	3.065*
<i>Variance parameters</i>			
Sigma-squared ($\sigma^2 = \sigma^2_v + \sigma^2_u$)		0.265	4.199*
Gamma ($\gamma = \sigma^2_u / (\sigma^2_v + \sigma^2_u)$)		0.945	59.352*
Log likelihood		86.572	
LR test		125.444	
Average TE		0.859	

*Significant at 5% level

Source: Output from Frontier 4.1 on Stochastic Frontier Analysis

The general results however indicate the importance of land, labour, fertilizer and seeds to output. The result of the effect of land in increasing output is consistent with evidence in literature (see for instance, Ajibefun, 2002; Binam et al., 2004; Tijani, 2006; Adeyemo et al., 2010), while that of the effect of labour agrees with the findings of Binam *et al.* (2004), Ogundari (2008), Solís, Bravo-Ureta and Quiroga (2009) and Reddy and Bantilan (2012). In conformity with the results obtained by Shehu et al. (2010) and Simonyan et al. (2012), the study observes that the enhancement of seeds application would have a positive effect on output. Furthermore, fertilizer application is positively influencing output which is consistent with other studies (Tijani, 2006; Ogundari, 2008; Al-hassan, 2012; Reddy and Bantilan, 2012; Simonyan *et al.*, 2012; Makombe et al., 2017). From the foregoing, it is evident that improvements in labour and land use as well as investment in high yielding variety seeds and fertilizers would have a positive impact on output production.

It is also noteworthy that smallholders are operating at decreasing returns to scale as the summation of the significant elasticities is 0.798. This further confirms the loss of efficiency in the production process as the result suggest that a unit increase in the quantities or values of the production resources would result in a less than proportionate increase in crop outputs. The observed decreasing returns to scale among the farmers concurs with similar findings in development agriculture literature (Binam et al., 2004; Tijani, 2006; Solís, Bravo-Ureta and Quiroga, 2009; Shehu et al., 2010; Reddy and Bantilan, 2012; Kuwornu, Amoah and Seini, 2013; Ogundari, 2013; Omondi and Shikuku, 2013).

The parameter estimates of the determinants of the inefficiency function which provide some explanations of the factors influencing technical inefficiency of the farmers are presented in the middle panel of Table 6.2. The parameters are interpreted taking into cognizance that their estimated coefficients are analysed as though they exhibit an inverse sign (Bravo-Ureta et al., 2007). In other words, a negative coefficient in the inefficiency function is interpreted to mean that the particular variable has a positive effect on technical efficiency, and vice versa (Tijani, 2006). The result indicates that number of times a plot is cultivated per growing year, farmers' year of experience, access to credit, off farm income and education have significant effects on technical inefficiency of smallholders while the effect of household size is not significant.

Surprisingly, the effect of the number of times a plot is cultivated on technical efficiency is negative, implying that technical inefficiency tend to increase the more plots are cultivated. This is indicative that the number of times plots are cultivated does not necessarily translate to improved efficiency.

Contrary to the findings of Solís et al. (2009) and Akanbi et al. (2011), education presents a negative effect on technical efficiency. In other words, increased in the level of education is associated with a reduction in efficiency levels. On the other hand, farmers' experience were found to significantly enhance efficiency which agrees with the findings of Osawe et al. (2007) and Omonona et al. (2010). In terms of human capital therefore, experience rather than schooling is positively associated with the adoption of improved technology and techniques for production as a unit increase in farmer's experience would lead to an increase in efficiency. Although Solís et al. (2009) emphasize the importance of improving human capital to enhance efficiency, their emphasis on the role of education in efficiency enhancement is not supported by this study. The foregoing is indicative of the type of education that must be emphasized to farmers. Undoubtedly, there is a clear distinction between classroom education and practical education garnered on the farms. The latter is directly linked to the years of experience of smallholders which has contributed positively to their efficiency levels in this study.

Furthermore, access to credit positively correlated with technical efficiency which is consistent with findings in literature (Binam et al., 2004; Ogundari, 2008; Akanbi et al., 2011). Credit availability is certainly important for boosting agricultural productivity in Nigeria. Credit access enables farmers to purchase improved inputs thus enhancing efficiency. As Ogundari (2008) aptly notes, availability of credit would potentially shift cash constraint outward, with farmers being able to secure agricultural inputs beyond their limited productive resources. Similarly, the generation of off-farm income led to increased efficiency levels. In a move to enhance productivity, off-farm income may indeed be diverted to provide farmers with resources to purchase inputs that were hitherto unaffordable from farm proceeds.

Generally, the positive influence of access to credit and off-farm income on efficiency amplifies the importance of financial capital in providing the resources needed to enhance agricultural

productivity. Khandker and Koolwal (2014) emphasize the role of financial capital in helping farmers to secure inputs and/or technology needed for improved agricultural productivity and food security but observe that this is problematic for African smallholders. This is consistent with the findings in this study as 86.9% and 46.4% of the sampled smallholders lacked access to credit and off-farm income respectively (Table 6.4).

Table 6.3: Frequency distribution of efficiency estimates.

Technical efficiency interval (%)	Number of farmers	percentage
≥ 40 < 50	2	0.7
≥ 50 < 60	0	0
≥ 60 < 70	11	3.6
≥ 70 < 80	55	18.0
≥ 80 < 90	83	27.1
≥ 90 < 100	155	50.7
Total	306	100

Mean = 85.9; Minimum = 42.1; Maximum = 97.0

Source: Output from Frontier 4.1 on Stochastic Frontier Analysis

The distribution of the predicted technical efficiencies of the sampled smallholders is presented in percentages in Table 6.3. Evidently, disparity exists in the technical efficiency levels of farmers which ranges between 42.1% and 97.0%. About half (50.7%) of the smallholders belong to the most efficient category, while other smallholders were spread across other categories. It is worth noting also that almost 96% have technical efficiency levels that are equal to or higher than 70%. The overall mean technical efficiency is 85.9% with a standard deviation of 9.3%, indicating substantial inefficiency levels among the smallholders. The implication of this is that on average, 14.1% of output is lost due to inefficiency and there is a possibility, in the short run, to increase crop outputs by the same percentage through the adoption of the technology used by the best performing smallholders. The mean technical efficiency is slightly higher than the mean efficiency estimates computed by Ogundari, Amos and Okoruwa (2012) in their review of 156 Nigerian agricultural efficiency studies (71%).

Table 6.4: Frequency distribution of efficiency estimates with some variables

Variable	N	percentage (%)	Mean TE
Farm Size (ha)			
< 0.20	133	43.5	0.86
≥ 0.20 < 0.40	153	50.0	0.86
≥ 0.40 < 0.60	16	5.2	0.86
≥ 0.60 < 0.80	4	1.3	0.87
Experience (years)			
≤ 5	3	1.0	0.90
> 5 ≤ 10	97	31.6	0.87
> 10 ≤ 15	165	53.9	0.86
> 15 ≤ 20	28	9.2	0.85
> 20 ≤ 25	13	4.3	0.87
No of times land was cultivated			
2	243	79.4	0.86
3	63	20.6	0.87
Household size			
≥ 3 < 5	6	2.0	0.92
≥ 5 < 7	34	11.1	0.87
≥ 7 < 9	150	49.0	0.85
≥ 9 < 11	89	29.1	0.87
≥ 11 < 13	27	8.8	0.87
Access to credit			
No (0)	266	86.9	0.85
Yes (1)	40	13.1	0.89
Off farm income			
No (0)	142	46.4	0.86
Yes (1)	164	53.6	0.86
Education			
No (0)	191	62.4	0.86
Yes (1)	115	37.6	0.87

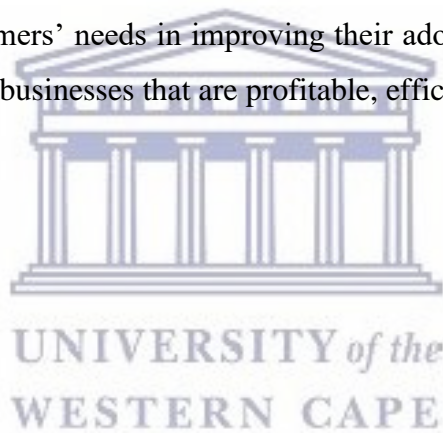
Source: Output from Excel Spreadsheet on Stochastic Frontier Analysis

6.6 Chapter Summary

The chapter analyses the productivity and technical efficiency of smallholder farmers in the Middle Rima Valley Irrigation Project, Sokoto State, Nigeria. Using data obtained from survey of 306 smallholders, and stochastic frontier production function, estimates of technical inefficiency among the smallholders were obtained. The average technical efficiency level among the

smallholders is 85.9%. Results suggest that improvements in technical efficiency is feasible given the adoption of best existing technology.

Empirically, results further suggests that smallholders with more years of experience, better access to credit, and those who generate off-farm income tend to be more efficient. Unexpectedly, efficiency levels is negatively and significantly correlated with the number of times plots are cultivated. It is apposite therefore to focus on policies that would increase human capital and ensure access to financial capital for smallholders involved in irrigation farming. The latter would no doubt require a substantial level of government commitment through financial and institutional frameworks that ensure easier access to loans and subsidies. To offset for lack of experience which helps in the build-up of farmers' skillsets among some farmers, extension services and capacity development needs to be strengthened among the smallholders. It is also important that such training are geared towards farmers' needs in improving their adoption of new technologies and transforming their farming into businesses that are profitable, efficient and sustainable.



CHAPTER SEVEN

FACTORS INFLUENCING HOUSEHOLD FOOD SECURITY AMONG IRRIGATION SMALLHOLDERS IN NORTH WEST NIGERIA

7.1 Introduction

Food insecurity remains a continuing global challenge in most parts of the developing world, including Nigeria. While considerable resources have been devoted to tackling the menace owing to its negative impacts on health and well-being, progress is rather slow and uneven across regions and countries. Indeed, much is yet to be explored on the conditions that result in food insecurity. The chapter investigates household food security and the socio-economic factors that determine it among smallholders in the Middle Rima Valley Irrigation Project, Sokoto State, Nigeria. The Household Dietary Diversity Score (HDDS) and Food Consumption Score (FCS) were used to assess household food security level, and multivariate regression was used to examine factors associated with food security.

7.2 Background

Approaches to measuring food insecurity are varied and contested such that there is no unanimity as to the best way to measure the phenomenon (Keenan *et al.*, 2001; Maxwell, Caldwell and Langworthy, 2008; Carletto, Zezza and Banerjee, 2013; Coates, 2013; Headey and Ecker, 2013). A wide range of indicators are presently used for assessing food security with diverse methodological considerations in terms of data collection, aggregation and analysis. This is an upshot of the multi-dimensionality of food security and the many interests or concerns encapsulated in the commonly accepted definition of the phenomenon. Food security is defined as a situation “when 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” (WFS, 1996 cited in FAO, 2006). The definition emphasizes the dimensions of food security; availability, access, utilization and stability. The latter stresses the notion of an uninterrupted and continuous availability, accessibility and utilization of food. Engaging with the different concerns underscored in the definition has led to diverse food security measurements delineated on the basis of certain characteristics. These characteristics include dimensions of food

security, unit of analysis ranging from individual to household to regional level, as well as whether the assessment is objective or subjective based on self-reported attitudes and perceptions (Carletto, Zezza and Banerjee, 2013; Jones *et al.*, 2013).

As such, national level measure of food security include the FAO's prevalence of undernourishment, IFPRI's global hunger index, the integrated food security phase classification (IPC) and WFP's comprehensive food security and vulnerability analyses (CFSVA) (Jones *et al.*, 2013). Measures of household food security include among others, household consumption and expenditure, dietary diversity, food consumption score, household food insecurity access scale, anthropometric measures, coping strategy index, and food adequacy question (Carletto, Zezza and Banerjee, 2013; Jones *et al.*, 2013).

The ambivalent nature of the diverse measurement metrics has increasingly become a cause for concern in food security research. In certain instances the diversity has muddied the waters with no clear convergence between and among the indicators. Consequently, Coates (2013) argues for a deconstruction of food security into its constituent parts with a view to ensuring systematic assessment, action and evaluation.

In another vein, measures of food security would be insufficient in themselves to drive policy and programme interventions without an adequate synthesis of the determinants of food insecurity. The literature is replete with accounts of the socio-economic determinants of food insecurity and their implication for food security research. Following Amartya Sen's notion of entitlement (Sen, 1990), food security has indeed been closely associated with household's resource endowment. Food security is intrinsically linked to market forces, the latter being also conditioned by the socio-economic and political conditions of a given society (Misselhorn, 2005). Although it is impossible to rule out the effect of factors such as diseases, epidemics, weather and political conditions as well as intra-household distribution on household food insecurity, food security must take into consideration resource characteristics of the household such as employment, income, education among others. The implication of the foregoing is that households with a poor range of resource endowments would be more susceptible to food insecurity, hence the need to incorporate other

interrelated factors into food security interventions (Babatunde, Omotesho and Sholotan, 2007; Mango *et al.*, 2014).

Despite the importance of measures of food security to public policy and programmes, there is presently a dearth of studies on the levels and determinants of food insecurity at the rural household level in Nigeria as more emphasis has over the years been laid on national food security statistics and narratives. This paucity is further pronounced among smallholders as little is known of the dynamics of food insecurity among them. This chapter attempts to contribute to the debate on rural food insecurity particularly among smallholders with a case study of smallholder households of the Middle Rima Valley Irrigation Project, Sokoto State, Northern Nigeria. The aim is primarily twofold: to empirically assess the levels of food security among the smallholder households; and to examine the socio-economic determinants of food security status of smallholder households.

The first is determined through an analysis of the food security status of smallholder households using the Household Dietary Diversity Score (HDDS) and Food Consumption Score (FCS). To deal with the second aim, multivariate linear regression analysis was conducted as certain independent variables were regressed with the HDDS and FCS which served as proxies for food security. The rest of the chapter proceeds as follows: section 2 discusses the methods employed in the research which includes the description of the study area, sampling and data collection as well as the analytical approaches utilized for the research. Section 3 presents the results of the research. In section 4, discussion of the presented results was attempted and relevant conclusion drawn from the research.

7.3 Analytical Approaches

Data collected were subjected to statistical analysis using Stata Version 14.0. It is established that household food security can be measured in diverse manners (Carletto, Zezza and Banerjee, 2013; Jones *et al.*, 2013). The study uses the Household Dietary Diversity (HDDS) and Food Consumption Score (FCS) to measure food security. Multivariate linear regression analysis was thereafter computed as HDDS and FCS (being the dependent variables) were regressed on certain independent variables that could affect food security. Both dependent variables are measured on a continuous scale hence the suitability of a linear regression model. Multivariate linear regression

is a variant of the multiple linear regression but with multiple dependent variables. Multiple linear regression is expressed as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \epsilon \quad \text{Equation 7.1}$$

Where

Y = dependent variable

$X_1 \dots X_k$ = independent variables

β = regression coefficients to be estimated

ϵ = error or residual term of the model.

Both the dependent and independent variables in the model are described below.

7.3.1 Dependent Variables

The dependent variables are the food security measures computed for the smallholder households in the study. These are the HDDS and FCS.

7.3.1.1 Household Dietary Diversity Score

Dietary diversity has in recent years emerged as one of the widespread and valid indicators of nutrient adequacy and energy intake (Hoddinott and Yohannes, 2002; Maxwell, Caldwell and Langworthy, 2008; Carletto, Zezza and Banerjee, 2013; Jones *et al.*, 2013). The indicator's appeal owed to some important factors. Apart from the fact that diversity of diet is an interesting and valid outcome in itself, a higher dietary diversity is associated with improvement in other relevant food security and health outcomes. Furthermore, it can accommodate the analysis of food security at the individual and/or household level and data collection and analysis is relatively not cumbersome (Hoddinott and Yohannes, 2002; Coates, 2013). It can also be used to capture a wide range of nutrients of concern, both macro and micronutrients and is reflective of how balanced a household or individual's diet is (Smith and Subandoro, 2007; Coates, 2013; Headey and Ecker, 2013).

Whereas the HDDS has been critiqued on the basis that it does not allow for the estimation of how much food is lacking since it lacks the ability to estimate the quantity or amount of food consumed,

it however reflects dietary quality and hence the likelihood of the score having an inverse relationship with malnutrition. A higher HDDS is indicative of a diversified household diet and higher prospects of balanced macronutrient intakes whereas a low HDDS is suggestive of a high consumption of starchy staples which are low in micronutrients, thus inadvertently leading to nutritional problems (Mango *et al.*, 2014).

The indicator is computed by adding up the total number of foods or food groups consumed over a certain reference period. Perhaps the most popular dietary diversity indicator is that developed in 2006 by the Food and Nutrition Technical Assistance (FANTA) Project of the United States Agency for International Development (USAID) which is referred to as the Household Dietary Diversity Score (HDDS). The HDDS calculates the number out of a total number of 12 food groups consumed by a household. Although different recall periods have been experimented in literature (Bilinsky and Swindale, 2006; Kennedy, Ballard and Dop, 2010; Carletto, Zezza and Banerjee, 2013), there has been no consensus about an optimal recall period (Carletto, Zezza and Banerjee, 2013). In another vein, Bilinsky and Swindale (2006) note that the inclusion of foods consumed by individual members when they are outside the household may lead to an overestimation of the HDDS.

The set of 12 food groups used in calculating HDDS are: A, cereals; B, root and tubers; C, vegetables; D, fruits; E, meat, poultry, offal; F, eggs; G, fish and seafood; H, pulses/legumes/nuts; I, milk and milk products; J, oil/fats; K, sugar/honey; L, miscellaneous. According to Bilinsky and Swindale (2006:5), the HDDS for each household is given as:

$$\text{HDDS (0 – 12)} = \text{Sum (A + B + C + D + E + F + G + H + I + J + K + L)}$$

7.3.1.2 Food Consumption Score

The food consumption score (FCS) developed in 1996 by the World Food Programme (WFP) is a frequency-weighted score derived by computing the frequency with which a household consumes eight food groups over a certain period. The FCS assesses the accessibility dimension of food security and is used for the identification of both the food insecure regions within and across countries and the food requirements of food-insecure populations (Jones *et al.*, 2013). The FCS is

a composite score based on food frequency, dietary diversity and comparative nutritional importance, hence its desirability (WFP, 2008). The food groups in the FCS analysis are staples, pulses, fruits, vegetables, meat/fish/egg, milk, sugar and oil. Each food group is weighted on the basis of the nutrient density derived from their consumption. The food groups and standard weights for the computation of the analysis is presented in Table 7.1.

Table 7.1: Food groups and weight in FCS computation

	Food Items (examples)	Food groups (definitive)	Weight (definitive)
1	Maize, maize porridge, rice, sorghum, millet pasta, bread and other cereals Cassava, potatoes and sweet potatoes, other tubers, plantains	Main staples	2
2	Beans, peas, groundnuts and cashew nuts	Pulses	3
3	Vegetables, leaves	Vegetables	1
4	Fruits	Fruit	1
5	Beef, goat, poultry, pork, eggs and fish	Meat and fish	4
6	Milk, yogurt and other diary	Milk	4
7	Sugar and sugar products	Sugar	0.5
8	Oil, fats and butter	Oil	0.5
9	Spices, tea, coffee, salt, fish powder	Condiments	0

Source: WFP (2008:8)

The number of times each food group is taken is multiplied by their respective weights and the results are thereafter summed up to give the overall FCS (Carletto, Zezza and Banerjee, 2013; Jones *et al.*, 2013). There are issues surrounding the cut-off points defining food insecurity based on FCS as there is no unanimity on the thresholds for FCS. Nevertheless, the frequently used thresholds based on the FCS score are: 0 – 21, Poor; 21.5 – 35, Borderline; and > 35, Acceptable. However, in situations or circumstances where the consumption of oil and sugar is high among a given population, it is advised that the cut-offs be reviewed upwards by adding 7 to each threshold (WFP, 2008). Hence the thresholds for such population is given as: 0 – 28, Poor; 28.5 – 42, Borderline; and > 42, Acceptable.

While the 24 hour recall is most prevalent for HDDS (Bilinsky and Swindale, 2006; Kennedy, Ballard and Dop, 2010; Carletto, Zezza and Banerjee, 2013) and 7 day recall for FCS (WFP, 2008; Carletto, Zezza and Banerjee, 2013), the study utilizes the 7 day recall in order to be able to use

the same data gathered over the same period as well as to avoid confusing respondents. This was also done since a 7 day recall period is also acceptable for HDDS data computation purposes. Recommending the use of the 7 day recall period, the WFP (2008) notes that a shorter recall period could result in the non-capture of foods served habitually but infrequently (being taken on specific days of the week which may be influenced by religious or market days considerations) and a longer recall period is problematic for respondents as they may fail to remember what was consumed over the extended period. Wiesmann *et al.* (2009) note that indicators based on a 7 day recall period which combines frequency (number of times food was consumed per week) and diversity were preferable to indicators that solely captures diversity.

In this research, households that were sampled were asked to recall foods taken over the past 7 days and the frequency with which they were taken. The foods mentioned were then classified into the standardized food groups (9 food groups for FCS and 12 food groups for HDDS). For HDDS, if a food group was consumed, it was coded as “1 = Yes”, and coded as “0 = No” if it was not consumed. The summation of the affirmative responses gives the HDDS score for each household.

7.3.2 Independent Variables

The independent variables that were considered and regressed against the dependent variables (the food security indicators), and the rationale for their selection are described below.

7.3.2.1 Household Size

Household size has a profound effect on food security as it shapes the consumption requirements of households. Larger households exert more pressure on per capita food availability, and such households are more likely to be food insecure (Babatunde, Omotesho and Sholotan, 2007; Omonona and Agoi, 2007; Bogale and Shimelis, 2009; Mannaf and Uddin, 2012; Mango *et al.*, 2014). It is thus hypothesized that a negative relationship exist between household size and food security.

7.3.2.2 Farm size

The food security status of households involved in agricultural production is often influenced by the size of their farms. Farm size is the total farm land measured in hectares that is cultivated by a farming household. Farm size is understood to affect productivity which in turn can affect food security. It is assumed that households with smaller farm size are more likely to be food insecure than those with larger farm size (Babatunde, Omotesho and Sholotan, 2007; Mannaf and Uddin, 2012). The relationship between farm size and food security is expected to be positive.

7.3.2.3 Household income

Income refers to the gross earnings of the household in a year from farm and non-farm activities. Income is a major determinant of food security as it influences the ability or otherwise to be able to procure food in the market. There is evidence in literature of the positive relationship between income and food security (Rose, 1999; Babatunde, Omotesho and Sholotan, 2007; Bogale and Shimelis, 2009; Carter *et al.*, 2010), as it is anticipated that income will improve household's access to food as well as their productivity.

7.3.2.4 Years of experience of the household head

Years of experience was used in lieu of age in the study as focus was on smallholder farmers. Years of experience of household heads in farming activities is important and could influence food security status of the household. It is assumed that the more experienced farmers are, the greater the likelihood of making better decisions that would boost production, thus consequently affecting positively their income and food security status. The relationship between years of experience and food security is therefore anticipated to be positive.

7.3.2.5 Education of the household head

Education has the inherent ability to enhance household food security status, and this is directly linked to its effect in the generation of higher incomes and improving the understanding of nutrition (De Cock *et al.*, 2013). Being a form of human capital, education is also anticipated to improve the production and nutritional decisions of households (Babatunde, Omotesho and Sholotan, 2007). Omonona and Agoi (2007) and Mango *et al.* (2014) observed in their empirical

studies that food security increases as educational level increases. The expected relationship between education and food security is therefore positive.

7.3.2.6 Training

The importance of smallholder training cannot be overstated as it helps in building the capacity of farmers to respond effectively to the ever changing production and agri-business environment. Improvement of competence through training in areas such as crop diversification, risk mitigation and mechanisms of markets would have positive implication on productivity of smallholder households, their incomes and food security status. Hence training, like education, is anticipated to have a positive effect on food security.

7.3.2.7 Livestock ownership

Ownership of livestock is an indication of the social and economic status of a farmer and represents a viable means of coping with stress and shocks and diversifying livelihoods. As Bogale and Shimelis (2009) rightly pointed out, livestock could provide draft power on farms and assists households to meet subsistence, income and nutritional requirement. Farmers with livestock can obtain compost manure, meat, milk and milk products from their livestock or exchange them for cash. From the foregoing, relationship between livestock ownership and food security is expected to be positive. For livestock ownership, total livestock units (LSU) were computed following Njuki *et al.* (2011) specification of a single figure to indicate the total number of livestock owned across species.

7.3.2.8 Non-farm activities

Engagement in non-farm activities is a means of diversifying smallholder household livelihoods. It assists the household to generate more income and enables the household to cope with unanticipated losses that may emanate from agricultural production. The effect non-farm activities have on food security is also explored in the study.

7.3.2.9 Remittance

Remittance is a means of household livelihood diversification and serves as an exit strategy out of poverty through the generation of more income from migrant household members. Mango *et al.* (2014) posit that the purchasing ability of households benefitting from remittances in terms of more healthy, balanced and nutritious diets is greater than those households who do not. Hence there is a greater likelihood that households with access to remittance would be more food insecure than households without access. The anticipated relationship between remittance access and food security is therefore positive.

7.4 Results

The results of the study are presented in this section. Firstly, the socio-demographic characteristics of respondents were presented. This is followed by the levels of food insecurity of sampled households using the HDDS and FCS. Lastly the section presents the determinants of food insecurity based on the HDDS and FCS.

7.4.1 Socio-demographic Characteristics of Smallholder Households

The socio-demographic characteristics of smallholder households are summarized in Tables 7.2 and 7.3. From Table 7.2, the distribution of household size ranges from 4 to 12 with an average household size of 8. A summary of the livestock units (LSU) which represents the aggregation of household's livestock from various species is also presented in the table. The mean LSU for the households was 2.2 although the distribution ranges from 0.02 to 10.5. Household heads had considerable farming experience as average years of farming experience was 12 years. No single smallholder operated a farm that is up to a hectare as farm size was between 0.06ha to 0.6 ha with mean farm size being 0.22ha. The annual income that accrue to the households ranged from N17 000 to N920 000, although the average household income for the sample was N241 953.

Majority of the household heads were not educated, with 62.4% having no formal education. However, many (55.2%) of the household heads have undergone one training or another in order to make better decisions that can improve production and enhance market access. Majority of the households have diversified livelihoods through involvement in non-farm activities as 53.6%

engaged in such activities. Finally, it is evident that remittance is not a very popular strategy for livelihoods diversification among the smallholder households as a meagre 11% received remittances from household members.

Table 7.2: Smallholder characteristics

Farm Household Characteristics	Mean	Standard deviation	Minimum	Maximum
Household size	8	1.58	4	12
Livestock units (LSU)	2.20	2.78	0.02	10.5
Years of experience	12	3.6	1	25
Farm size (ha)	0.22	0.1	0.06	0.6
Gross household income (Naira)	241 953	106 650	17 000	920 000

Source: Field Survey (2016)

Table 7.3: Smallholder characteristics

Farm Household Characteristics	Frequency	percentage
Education:		
<i>No Formal</i>	191	62.4
<i>Formal</i>	115	37.6
Training:		
<i>No</i>	137	44.8
<i>Yes</i>	169	55.2
Non-farm activities:		
<i>No</i>	142	46.4
<i>Yes</i>	164	53.6
Remittance:		
<i>No</i>	272	88.9
<i>Yes</i>	34	11.1

Source: Field Survey (2016)

7.4.2 Levels of Food Insecurity among Smallholder Households

Data for the food security indicators considered in the study are presented in Tables 7.4, 7.5 and 7.6. The HDDS for households ranges between 4 and 11. The mean HDDS was 6.83, which signifies a household consumption per week that is barely half of the different food groups available. The food groups were also divided into tertiles based on the responses generated from the households. The number of households in the lower tertile (food groups total between 4 and 6) was higher than the other two tertiles as nearly half (48.4%) of the households fall under the tertile. The proportion of households in the medium (food groups total of 7) and upper tertile (food groups

total between 8 and 11) were 25.2% and 26.4% respectively. Overall, 74.6% of households consume at most seven food groups in a week.

With regards to the FCS, 21.9% had poor FCS and 68% were within the borderline score. Of the total number of households, 10.1% had an FCS score that is acceptable. In other words, based on the FCS, a tenth of the households had adequate and diverse food consumption required for healthy living. The mean FCS for the smallholder households was 33.3. While the least FCS among the households was 19, the highest FCS recorded in the study area was 55.

However, it is imperative to identify the most vulnerable households in terms of food insecurity in the study area. To achieve this, an approach similar to that utilized by Kennedy, Ballard and Dop (2010) was used. Households with an FCS that falls within “poor and borderline” and an HDDS below the medium tertile (below 7) were considered to be markedly food insecure. Applying this threshold from a cross tabulation of HDDS and FCS (Table 7.4), it is evident that at least 139 (45.4%) households had pronounced food insecurity. In terms of the association between the FCS and HDDS presented in Table 7.7, there is a moderate positive relationship ($r = 0.48, p < 0.001$) between the two scores as further evident from the scatterplot diagram in Figure 7.1.

Table 7.4: Cross tabulation of HDDS and FCS

Household Dietary Diversity Score	Food Consumption Score			Total
	Poor	Borderline	Acceptable	
1st Tertile (Low, scores between 4-6)	48	91	9	148
2nd Tertile (Medium, scores of 7)	14	57	6	77
3rd Tertile (High, scores between 8-11)	5	60	16	81
Total	67	208	31	306

Pearson Correlation: 0.4817; Sig ($p < 0.0001$)

Source: Output from HDDS and FCS analysis

Table 7.5: Household dietary diversity grouping

Household Dietary Diversity Score	Frequency	percentage
Ist Tertile (Low, scores between 4-6)	148	48.4
2nd Tertile (Medium, scores of 7)	77	25.2
3rd Tertile (High, scores between 8-11)	81	26.4
Total	306	100

Mean = 6.83; SD = 1.43; Minimum = 4; Maximum = 11

Source: Output from HDDS analysis

Table 7.6: Food consumption score grouping

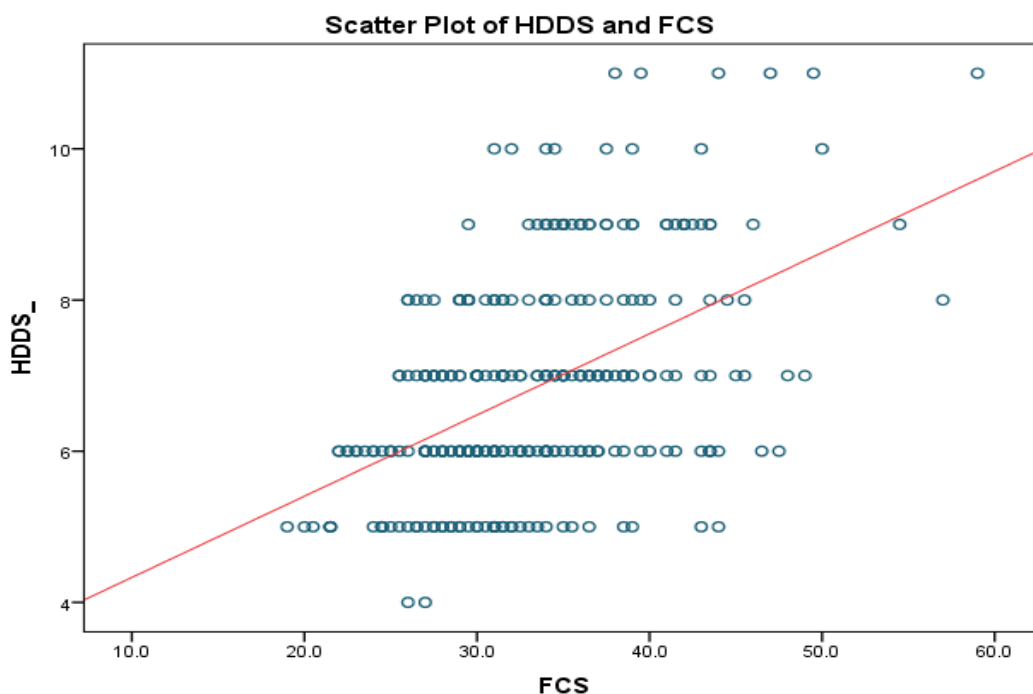
Food Consumption Score	Frequency	Percentage
0 – 28.0 (Poor)	67	21.9
28.5 – 42.0 (Borderline)	208	68.0
> 42.0 (Acceptable)	81	10.1
Total	306	100

Mean = 33.3; SD = 6.5; Minimum = 19; Maximum = 59

Note: Categorisation based on the premise that oil and sugar was eaten by households on a daily basis

Source: Output from FCS analysis

Figure 7.1: Scatter plot of HDDS and FCS.



Source: Output from HDDS and FCS analysis

Table 7.7: Pearson Correlation of FCS, HDDS and some Socio-economic characteristics

	HH Size	LSU	Years of experience	Farm size	Gross HH Income	HDDS	FCS
HH Size	1.0000						
LSU	0.1227*	1.0000					
Years of experience	0.1309*	0.0764	1.0000				
Farm size	0.5228*	0.2777*	0.1817*	1.0000			
Gross HH income	0.4112*	0.2715*	0.2104*	0.6290*	1.0000		
HDDS	0.2951*	0.0344	0.1261*	0.5280*	0.4122*	1.0000	
FCS	0.3341*	0.1988*	0.3393*	0.5556*	0.5208*	0.4817*	1.0000

Source: Output from pearson correlation analysis

7.4.3 Determinants of Food Insecurity among Smallholder Households

Variables that were assumed to be determinants of food insecurity were included as predictors of the outcome variables (HDDS and FCS), the indicators for food security in the study. The results of the regression model for HDDS are presented in Table 7.8. The F statistics test the overall significance of the regression model. In other words, it signifies whether the regression model provides a better fit to the model than a model with no independent variables. The table indicates that the model is a good fit for the data and the independent variables statistically significantly predict the dependent variable ($F = 16.39$, $p < 0.001$). The coefficient of determination, R^2 is an indication of the proportion of the variation in the dependent variable that can be explained by the independent variables. The R^2 is 0.333, implying that households' socio-economic characteristics explain 33.3% of the variability in the HDDS.

The t-statistics test the hypothesis that each coefficient is equal to zero. Using a significant level of 95%, the hypothesis for each coefficient is rejected if the p-value is lower than 0.05. If so, then it is concluded that the variable has a significant influence on the dependent variable. From the table, five out of the nine independent variables were significant predictors of HDDS. These are livestock unit, farm size, household income, education, and training. However, while farm size, household income, education, and training positively influenced household dietary diversity, livestock unit had a negative influence on dietary diversity. From all the socio-economic characteristics considered, farm size was the most significant predictor of HDDS with a coefficient of 0.23, implying that a 10% increase in farm size will lead to a 2.3% increase in HDDS with all

other explanatory factors constant. This is followed by income as a 10% increase in household income will increase HDDS by 0.8%. Both education and training had similar positive effect on HDDS; those who had formal education and training respectively had 4.2% higher HDDS than those who do not. On the other hand, a 10% increase in livestock units (LSU) owned by household would decrease HDDS by 0.4% holding all other independent variables constant.

Table 7.8: Parameter estimates of determinants of household dietary diversity among smallholders

Variables	Coefficient	Standard error	t-statistics	P-value
Constant	1.04911	0.44956	2.33	0.020*
Household size	0.05374	0.06072	0.89	0.377
Total livestock unit	-0.04147	0.01432	-2.90	0.004*
Years of experience	0.02321	0.03211	0.72	0.470
Farm size	0.23484	0.03279	7.16	0.000*
Gross household income	0.08478	0.03313	2.56	0.011*
Remittance	-0.03894	0.03246	-1.20	0.231
Education	0.04211	0.02098	2.01	0.046*
Training	0.04245	0.01975	2.15	0.003*
Non-farm activities	-0.03498	0.02148	-1.63	0.104
<i>Model Parameters</i>				
R ²	0.333			
F Statistic	16.39			
Sig.	0.0000			

*Significant at 5% level

Source: Output from linear regression analysis

Table 7.9 presents the result of the regression model for FCS. The F Statistics indicate that the independent variables statistically significantly predict the dependent variable ($F = 22.59$, $p < 0.001$). The coefficient of determination R^2 which measures the strength of the relationship between the dependent variable and the independent variables is 0.407, signifying that 40.7% of the variation in FCS is explained by the combined influence of households' socio-economic characteristics. A cursory look at the t-statistics shows that three out of the nine independent variables were significant predictors of FCS and these are farmer's years of experience, farm size and household income. These variables, based on their respective beta coefficients, all had positive influences on FCS. However, farm size was the most significant predictor of FCS with a coefficient of 1.16, which suggests that a 10% increase in farm size will increase FCS by 11.6% keeping all

other explanatory factors constant. Furthermore a 10% increase in the years of farm experience of the household head will increase FCS by 1.2%, and a 10% increase in household income will increase FCS by 1.1% keeping all other independent variables constant.

Table 7.9: Parameter estimates of determinants of food consumption among smallholders

Variables	Coefficient	Standard error	T-Statistics	P-value
Constant	2.00027	0.39776	5.03	0.000*
Household size	0.00281	0.05372	0.05	0.958
Total livestock unit	-0.00708	0.01267	0.56	0.577
Years of experience	0.12328	0.02841	4.67	0.000*
Farm size	1.15534	0.02901	5.35	0.000*
Gross household income	0.11313	0.02932	3.86	0.000*
Remittance	0.00758	0.02872	0.26	0.792
Education	-0.01105	0.01856	-0.60	0.552
Training	0.00616	0.01747	0.35	0.725
Non-farm activities	0.01781	0.01900	0.94	0.349
<i>Model Parameters</i>				
R²	0.407			
F Statistic	22.59			
Sig.	0.0000			

*Significant at 5% level

Source: Output from linear regression analysis

7.5 Discussion

The chapter assessed the levels and determinants of food insecurity among smallholder households. Contrary to the expectation of a strong correlation between HDDS and FCS as noted by Maxwell, Vaitla and Coates (2014), the association between FCS and HDDS of the households was moderate, but positive and statistically significant. As FCS does not only measure diversity but also incorporates frequency of consumption, it is probable that although smallholder households consume a food over the recall period, such households do not consume such food on a consistent basis hence the moderate association between the two score. While both indicators purport to measure the quantity and quality of food access (Leroy *et al.*, 2015), they both do well in the measurement of the quantity dimension. However, FCS may be a better measurement of quality between the two owing to the inclusion of weights in its computation.

Combining evidence from both indicators, the study indicates that at least 45.4% of smallholder households were food insecure. The proportion of food insecure households is lower than 58.8% reported by (Akerlele *et al.*, 2013) in South West Nigeria and 62.8% reported by (Babatunde, Omotesho and Sholotan, 2007) among farming households in North Central Nigeria. On the other hand, the food insecurity condition among the smallholders is worse than the 39% reported by (Omonona and Agoi, 2007) in their study of households in Lagos State, Nigeria. However, their study was carried out among the urban population in Lagos State, a leading commercial city in Africa with higher income earners, thus plausibly explaining the disparity in food security levels between the two studies. Furthermore, compared to other studies in some parts of the world, the proportion of food insecure household seems higher (see for instance, Carter *et al.*, 2010; Asghar and Muhammad, 2013).

From the multivariate model, farm size emerged as the most significant factor influencing food security among smallholder households as the likelihood of being food secure increases with increase in land cultivated by the farmers. This underlines the important role farm size plays in ensuring food security among households involved in agricultural production. A possible explanation for the finding is that there is a greater likelihood that households with larger land size will engage in increased cultivation, better crop diversification and have higher quantity of crop produce which could be consumed directly or used to raise income that can be utilised to purchase other food items. The relevance of farm size to food security highlighted in the study is in line with other empirical findings in Ethiopia (Bogale and Shimelis, 2009) and Kenya (Kassie, Ndiritu and Stage, 2014) where it was observed that the probability of being food secure increases with farm size. Douxchamps *et al.* (2016) also identified land area per capita as a key driver of food security in West Africa, and further proposed intensification as a major adaptation strategy in view of the growing constraints surrounding expansion of land area for agricultural purposes.

Result also shows that higher rates of food security are associated with increased household income. This suggests, in line with a priori expectation, that households with lower income has a higher risk of being food insecure. The result is in consonance with the findings of Omonona and Agoi (2007), Babatunde, Omotesho and Sholotan (2007), Bogale and Shimelis (2009), Akerlele *et al.* (2013), De Cock *et al.* (2013) and Motbainor, Worku and Kumie (2016) who all observed an

inverse relationship between household income and food insecurity. The result further confirms, and is indicative of the critical role income plays in accessing food, and in the overall achievement of food security.

Furthermore, education was observed to positively influence households' dietary diversity. In other words, educated farmers are less likely to be food insecure compared to uneducated farmers. This chimes in with similar studies in Nigeria (Omonona and Agoi, 2007; Babatunde, Omotesho and Sholotan, 2007; Akerele *et al.*, 2013) and in other parts of the world (De Cock *et al.*, 2013; Mango *et al.*, 2014; Motbainor, Worku and Kumie, 2016). The foregoing is probably due to the fact that educated farmers can transfer the knowledge acquired to better manage their farms. As Akerele *et al.* (2013) rightly asserts, education increases the stock of human capital, thus consequently leading to improved labour productivity and income earnings (Akerele *et al.*, 2013). Furthermore, educated heads have greater odds of making better diet and nutritional decisions for the benefit of the households than their uneducated counterparts. In a similar vein, training received by farmers was positively associated with dietary diversity of households. In other words, those who have not had any training under the scheme were more likely to be food insecure than those who have benefitted from training. This is explicable as such training are bound to help farmers adopt better farming practices and acquire skills that they hitherto lacked. The foregoing would no doubt impact positively on total yield, which in turn could improve household food security.

Farming experience also had a positive relationship with the FCS, suggesting that household food insecurity declines with increase in years of experience of smallholders. In other words, the higher the experience, the lower the risk of food insecurity. The importance of experience in improving farmers' stock of farming knowledge cannot be understated. Mkwambisi, Fraser and Dougill (2011) report that in the absence of adequate agricultural extension officers, farmers in Malawi relied on the experiences garnered over the years to make agricultural decisions. More experienced farmers, through leveraging on years of "learning by doing", are more likely to possess better knowledge of farming and management practices that could help improve yield and income earnings, thus affecting household food security positively.

Surprisingly, total livestock units owned by households had a negative effect on FCS, thus indicating that food insecurity increases with increase in TLU of households. This is inconsistent with the findings of Bogale and Shimelis (2009) and Motbainor, Worku and Kumie (2016) who both observed a positive association between livestock owned and food security of the households, and concluded that livestock ownership serves as wealth accumulation and a coping strategy against shocks and food insecurity. Nevertheless, a plausible explanation for the result obtained in this study with regards to livestock ownership could be that investing in livestock takes away resources that could be used to provide food for household consumption.

7.6 Chapter Summary

Knowledge about the extent and determinant of food insecurity is important in order to assess progress and deliver appropriate interventions. The chapter emphasizes the significance of adapting objective indicators for the measurement of food security. Both HDDS and FCS were used to assess the levels of food insecurity among smallholder households in Sokoto State, Nigeria. Further, socio-economic characteristics of households that could serve as determinants of food security were examined.

The chapter established a significant level of association between the HDDS and FCS, hence validating the food insecurity phenomenon in the study area. At least, nearly half (about 45%) of households were food insecure, thus underlining the dire food security situation among the smallholder households. The anticipated influence of income on food security status of household is derived, a clear reaffirmation of the importance of this factor to food security. A low income household relatively stands a greater risk of being food insecure as they may lack the resources to purchase healthy and nutritious foods. Although reliance on own food production may assist to some degree, this however cannot mask issues of dietary diversity. It is therefore apposite that agricultural and related activities that would lead to the generation of more income be encouraged. Undoubtedly this would require institutional and socio-economic investment through improving infrastructure to enhance access to market and providing access to credit facilities for increased cultivation.

Farm size appear to be the most significant contributor to food security in the study area, as food insecurity declines with increase in farm size. Expanding farm size would depend on a number of factors, chief among them being land availability and the motivation of the smallholders. In most parts of the world, there is an increasing limitation on the expansion of land for farming owing to the emergence of competing uses. If such is the case, then sustainable intensification which entails agricultural production growth or intensification without expanding to non-agricultural land may be the solution in order to increase yields. More importantly however is the incentive, on the part of the smallholders, to increase production in an era of inadequate access to market. Needless to say, that if smallholders are not guaranteed that their produce would be sold, motivation for expansion would inevitably be lacking.

The chapter also highlights the positive influence of education, training and farming experience on food security. This demonstrates the importance of human capital to the achievement of food security. Indeed, smallholder households with these human capital stock are likely to earn more income, make better nutrition decisions, and consequently be food secure. To offset for a shortfall of experience and education among smallholders, trainings that are geared towards improving the competence of the smallholders in the adaptation of modern farming techniques and technologies, the application of appropriate inputs and the adoption of good marketing practices are needed.

Finally, sufficient knowledge of the conditions peculiar to specific communities is also important for policy making. Agricultural programmes and food security interventions should be tailored to take advantage of community's strengths, whilst alleviating their weaknesses. Such programmes could include social protection in form of cash transfers and agricultural input subsidies for farmers.

CHAPTER EIGHT

ASSESSING PROJECT OUTCOMES THROUGH THE SUSTAINABLE LIVELIHOODS APPROACH (SLA) LENS: A CASE STUDY OF THE MIDDLE RIMA VALLEY IRRIGATION PROJECT, NORTH WEST NIGERIA

8.1 Introduction

Nigeria, like many African countries is caught up in the uncertainty of the effectiveness of agricultural intervention in achieving poverty reduction and improved quality of life. This ambiguity is more pronounced especially in rural areas where majority of the poor and those involved in agriculture reside. The constant review of agricultural projects vis-à-vis their outcomes is therefore apposite. This chapter assesses the livelihood profiles, strategies and outcomes of smallholders in the Middle Rima Valley Irrigation Project, Sokoto State, Nigeria. Drawing on quantitative data and the sustainable livelihoods framework, the study explores a wide range of assets and capabilities that the farmers may potentially command as a result of their involvement in the project and how that influences their overall perception of their quality of life. This was done by exploring variables that capture human, physical, natural, social and financial capitals the smallholders possess.

8.2 Analytical Approaches

Both descriptive and inferential statistics were utilised in this chapter. The descriptive statistics were presented using tables and cross tabulations and frequency distributions. Inferential statistics focused on hypothesis testing and the statistical tools utilised are Logistic Regression and Canonical Correlation. A significance level of 0.05 (5%) is used for the test. As a rule, the acceptance of the null hypothesis is premised on the significance value being greater than the given level of significance. Otherwise, the null hypothesis is rejected in favour of the alternative hypothesis if the significance value is less than or equal to the given level of significance.

The sustainable livelihoods approach (SLA) represents a framework that can be used to assess livelihood outcomes and livelihood strategies. With regards to the latter, a household's range of entitlement in terms of assets is assumed to determine the choice of a particular livelihood strategy

that will be adopted. The range of assets are also assumed to affect households' livelihood outcomes. As a result, variables that make up the different capitals that households possess were assessed vis-à-vis their relationship with livelihood outcomes and strategies.

Table 8.1: Variables for livelihoods analysis and their coding scheme

Variable	Coding scheme
Dependent variable (Livelihood outcome)	
Perception of improvement in quality of life	1 = Yes, 0 = No
Dependent variables (Livelihood strategies)	
Remittance receipt	1 = Yes, 0 = No
Non-farm activities	1 = Yes, 0 = No
Livestock ownership	1 = Yes, 0 = No
Independent variables	
<i>Human capital</i>	
Education	1 = Formal education, 0= No formal education
Number of households in farms	Continuous
Number of employed workers	Continuous
Training	1 = Yes, 0 = No
<i>Financial capital</i>	
Involvement in active savings	1 = Yes, 0 = No
Credit access	1 = Yes, 0 = No
<i>Social capital</i>	
Group influencing project	1 = Yes, 0 = No
<i>Physical capital</i>	
Market enhancement due to better infrastructure	1 = Yes, 0 = No
Physical Capital Index (pci)	Continuous
<i>Natural capital</i>	
Farm size	Continuous
Water availability all year round	1 = Yes, 0 = No
No of times land was cultivated	Continuous

Variables that can significantly influence livelihoods outcomes and strategies of smallholders in the irrigation project are presented in Table 8.1. Physical capital was measured by respondents' perception of enhancement of market access due to better infrastructure as well as a physical capital index (pci) score. The pci variable was derived from the principal component analysis (PCA) of some physical capital variables. The PCA is a multivariate statistical technique used for reducing many variables into a smaller number of dimensions. Presently, there is an increasing

application of PCA using asset data to construct socio-economic indices. This is understandable as complications may arise on data analysis of asset ownership due to the fact that a large number of variables may be involved. To resolve this, approaches such as PCA is used for the organization of data to reduce dimensionality while also limiting information loss in the total variation explained by the variable (Vyas and Kumaranayake, 2006). A major consideration in PCA analysis is the selection of components where the associated eigen value is greater than one. For the physical capital variables, only the first component provided an eigen value greater than one, which also explains 92.5% of the total variance.

For social capital, it was evident that all of the farmers were members of the Water Users Association (WUA). This limited its relevance in the analysis, hence its non-inclusion. However, respondents' opinion on whether or not the WUA group was influencing project decisions was included in the analysis. Financial capital was measured by farmers' involvement in active savings and their ability to access credit facilities. Four variables were used to measure human capital assets. These include the educational level of farmers, number of household working on farmland, number of employed workers. Lastly, respondents' involvement in any training programme through the irrigation scheme was also considered part of the human capital measures. Finally, the size of land cultivated by farmers, availability of water all year round from the irrigation facilities and the number of times land was cultivated during the cropping season constitute the natural capital asset base.

In the analysis of factors that determines the perception of the quality of life of farmers, the dependent variable could be ordinal or categorical, with the latter referred to as binary variables when such variables only take up two values. For this study, smallholders were asked to assess whether or not the irrigation project has led to improved quality of life for them and their households. This implies that the variable is a binary variable, where one signifies that the project has led to improved quality of life and zero signifies it has not. The foregoing justifies the adoption of binomial logistic regression for the study.

Logistic regressions are particularly useful for analysis when the dependent variable is categorical which may either be ordered or unordered (Elliott and Woodward, 2007; Menard, 2010; Salkind,

2010). In other words, logistic regression is relevant when the outcome to be predicted is dichotomous or categorical in nature (Osborne, 2015). The independent variables could either be interval, ratio, or dummy variables which are variables whose categories are less than those at the interval or ratio levels of measurement (Menard, 2010). Binomial logistic regression is thus a statistical technique that analyses the relationship between a dichotomous outcome or dependent variable and one or more predictors or independent variables which may be either interval, ratio, ordinal or categorical in nature.

The equation for binomial logistic regression model is given as:

$$\text{logit}(Y) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k \quad \text{Equation 8.1}$$

where Y is the binary outcome; $\text{logit}(Y)$ represents the natural logarithm of the odds of Y

X_1, \dots, X_k are predictors with associated coefficients B_1, \dots, B_k , and

α is the constant term which corresponds to the value of $\text{logit}(Y)$ when all of the X_k are equal to zero.

As noted by Salkind (2010), if the two values in the outcome variable are coded 1 and 0 respectively, and P_1 and P_0 is the probability of being in the category coded as 1 and 0 respectively, then the odds of being in category 1 are:

$$P_1/P_2 = P_1/(1 - P_1) \quad \text{Equation 8.2}$$

$\text{Logit}(Y)$ which is the natural logarithm of the odds is

$$\ln[P_1/(1 - P_1)] \quad \text{Equation 8.3}$$

Where \ln is the natural logarithm transformation (Salkind, 2010:731).

Canonical correlation analysis (CCA) was used to examine the relationship between livelihood strategies and livelihood assets of smallholders. The CCA is a multivariate statistical technique which examines the interrelationship among sets of multiple dependent variables and independent variables (Hair et al., 1998). The technique is used to measure the association and strength among

sets of variables. Given sets of independent variables, $CV_{X1} = a_1X_1 + a_2X_2 + \dots + a_nX_n$ and dependent variables, $CV_{Y1} = b_1Y_1 + b_2Y_2 + \dots + b_nY_n$, CCA is expressed as;

$$CV_{Y1} = CV_{X1} \quad \text{Equation 8.4}$$

where CV_{Y1} and CV_{X1} are the first canonical variates u and v respectively. The u and v canonical variates are synthetic variables which are also referred to as synthetic criterion variable and synthetic predictor variable respectively. Each pair of canonical variates comprises a canonical function and the maximum number of functions in the model would equal the number of variables in the smaller variable sets of the two. Essentially, CCA represents the bivariate correlation between two synthetic variables (canonical variates) in a canonical function.

An advantage of the model is that it can accommodate any metric variable and transformed non metric data (dummy variables) without the strict assumption of normality (Hair et al., 1998). Although for the purpose, it is necessary to categorise sets of variables into dependent and independents variables, the categorization is rather inconsequential as CCA only examines correlation between canonical variates. Hence it is inappropriate to expect or assume predicted causality among the variables (Hair et al., 1998; Sherry and Henson, 2005). The use of CCA is appropriate for this study as it assists in measuring the overall relationship between the livelihood strategies variables and livelihood capital assets.

8.3 Results and Discussion

The research findings are discussed under the various headings below. Except otherwise stated, all the tables through which information are summarized below emanated from the authors' field survey of 2016.

8.3.1 Socio-Economic Characteristics

Socio-economic status has been identified as a key driver of agricultural output whose measurement is important in order to measure and effect change. Socio-economic and

demographic characteristics considered to have very strong contributions to the central theme of the study are therefore examined.

The result from the sample survey also demonstrates that the majority of the respondents were within the age range of 36 to 65 years, as this accounted for 85.2% of the total respondents. Table 8.2 further indicates that 11.5% of the total were aged 35 years and below, and 3.3% were aged over 65 years. It is thus clearly evident from the table that most respondents were within the employable age range. The marital status of the respondents is also presented in Table 8.2 and it is evident from that the majority of the respondents were married. A total of 280 farmers, accounting for 91.5% of respondents, were married while 23 farmers, representing 7.5% of the respondents were single.

Education goes a long way in influencing farmers' participation in a scheme (Vanslebrouck *et al.*, 2002) and agricultural productivity, while it also has the inherent ability to influence the financial status of respondents. Also presented in Table 8.2 is the educational and income status of respondents. It is evident from the table that majority (62.4%) had no formal education, whereas 98 (32.0%), 15 (4.9%), and 2 (0.7%) respondents respectively had primary education, secondary education and tertiary education. With respect to monthly income, the table indicates that 41 (13.4%) respondents earned between R5001 and R10000, 131 (42.8%) respondents earned between R10 001 and R15 000, 86 (28.1%) respondents earned between R15 001 and R20 000, 27 (8.8%) respondents earned between R20 001 and R25 000, 12 (3.9%) respondents earned between R25 001 and R30 000 and 9 (2.9%) respondents earned over R30 000 as a monthly income. It is also conclusive from the table that the majority of the respondents earned a monthly income that is not more than R20 000, as this accounted for 84.3% of the total respondents.

Table 8.2: Distribution of smallholder farmers in Middle Rima Irrigation Project by socio-economic characteristics

Socio-economic characteristics			
Gender		Frequency	percentage
	Male	291	95.1
	Female	15	4.9
	Total	306	100.0
Age		Frequency	percentage
	25 years and below	33	10.8
	26-35 years	2	.7
	36-45 years	70	22.9
	46-55 years	137	44.8
	56-65 years	54	17.6
	Above 65 years	10	3.3
	Total	306	100.0
Marital status		Frequency	percentage
	Single	23	7.5
	Married	280	91.5
	Divorced	1	.3
	Widowed	2	.7
	Total	306	100.0
Education		Frequency	percentage
	No formal education	191	62.4
	Primary school education	98	32.0
	Secondary school education	15	4.9
	Tertiary education	2	.7
	Total	306	100.0
Average monthly income of household head(₺)		Frequency	%
	0-5000	0	0
	5001-10000	41	13.4
	10001-15000	131	42.8
	15001-20000	86	28.1
	20001-25000	27	8.8
	25001-30000	12	3.9
	Above 30000	9	3.9
	Mean = 16,715 SD = 6,993		
	Total	306	100.0

Source: Field Survey 2016

8.3.2 Assessment of Changes in Livelihoods

Sustainable livelihoods framework can be used to measure changes in social, physical, human and financial capital, and project outcomes through the exploration of the livelihoods characteristics of the respondents and their households. The sustainable livelihoods approach was utilised through an assessment of the different capitals the beneficiaries possess.

8.3.2.1 Social Capital

Social Capital represents people's ability to secure benefits due to their membership in social networks or other structures. All the farmers interviewed indicated the Water Users Association as the only group they belong to. The association comprises individual water users who come together to derive mutual benefits by engaging in water and agriculture related activities. Presented in Table 8.3 are two of the important indicators to examine changes in farmers' social capital in the project. These were the benefits beneficiaries derived from being members of farmer group as well as the group's ability to influence project.

Table 8.3: Social capital measures

Social capital measures	Yes	No	Total
Group influencing project decisions	175 (58.7%)	123 (41.3%)	298 (100%)
Group beneficial to individual farmers	166 (81.4%)	38 (18.6%)	204 (100%)

Source: Field Survey 2016

A majority of respondents perceived that farmer group or associations were influencing project decisions and that their membership of farmer groups had been beneficial to them with both accounting for 66.7% and 85.9% of the total responses. The above findings are indication of the ability of the smallholders to harness social capital for their own good/benefits.

8.3.2.2 Financial Capital

Financial capital refers to cash as well as other resources such as savings, credit, pensions, and remittances among others.

Table 8.4: Financial capital measures

Financial capital measures	Yes	No	Total
Involvement in active savings	73 (23.9%)	233 (66.1%)	306 (100%)
Access to credit facilities	40 (13.1%)	266 (86.9%)	306 (100%)
Indebtedness	52 (17.0%)	254 (83.0%)	306 (100%)

Source: Field Survey 2016

Furthermore, Table 8.4 presents information on beneficiaries' involvement in active savings as well as their ability to access credit facilities. The table indicates that 66.1% of the beneficiaries sampled were not involved in active savings and 86.9% lacked access to credit facilities. Several findings have indicated that non-involvement in active savings may deny access to credit facilities (See for example, Carter and May, 1999; Lawal *et al.*, 2009; Motsoari *et al.*, 2015). However, in order to conclude that there is any association between involvement in active savings and access to credit facilities, it is apposite to employ statistical testing. The Pearson's chi-square test is the appropriate statistical tool as both variables are nominally scaled and the independent samples were randomly derived. The following hypotheses are thus tested at 5% level of significance;

$H_0 =$ There is no significant relationship between involvement in active savings and access to credit facilities.

$H_1 =$ There is a significant relationship between involvement in active savings and access to credit facilities.

Table 8.5: Chi-square tests for active savings and access to credit facilities

	Value	Df	Assymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	78.849 ^a	1	.000		
Likelihood Ratio	67.549	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	79.588	1	.000		
N of Valid Cases	306				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.54

Source: Output from chi-square analysis

The rule and decision criteria are as explained in preceding section. The results of the test, as shown in Table 8.5, indicates that the chi-square test conducted is valid. This is due to the fact that zero cells have an expected count of less than five, with the minimum expected count being 9.54. The result of the test reports a Pearson's chi-square value of (79.849) at 1 degree of freedom and a significance value of (0.000). In line with the decision rule, since the P value is less than the level of significance, the null hypothesis is rejected in favour of the alternative hypothesis. There is thus a statistically significant relationship between beneficiaries involvement in active savings and access to credit ($X^2 = 79.849$, $df = 1$, $P < 0.0001$).

From the above analysis, it can be concluded that many farmers were not involved in active savings which further contributed to their lack of access to credit facilities.

8.3.2.3 Physical Capital

As part of the capital that make up the livelihoods framework, physical capital includes among others, basic infrastructure such as water, shelter, transport, and communications (Frankenberger, Drinkwater and Maxwell, 2000). Analysis of beneficiaries' physical capital asset presented mixed results. Table 8.6 presents an examination of the physical capital assets smallholders had acquired since joining the irrigation scheme. The analysis established that 53.6% and 93.1% had acquired new electronic appliances and new farming equipment respectively, while 21.2% had experienced an increase in livestock ownership. Whereas 41.2% of the smallholders surveyed had been able to purchase either a bicycle or motorcycle, vehicle ownership was almost non-existent with 98% of the sample surveyed stating that they had not been able to purchase a vehicle despite their participation in the irrigation scheme. However, participation in the irrigation project had translated into home ownership for many of the respondents as 63% indicated that they had been able to build their own house.

Table 8.6: Physical capital measures

Physical capital measures	Yes	No	Total
Build a house	193 (63.1%)	113 (36.9%)	306 (100%)
Purchase bicycle, motorcycle or cart	126 (41.2%)	180 (58.8%)	306 (100%)
Purchase vehicle	6 (2.0%)	300 (98.0%)	306 (100%)
Purchase electronic appliances/gadgets	164 (53.6%)	142 (46.4%)	306 (100%)
Purchase new farming equipments	285 (93.1%)	21 (6.9%)	306 (100%)
Increase livestock ownership	65 (21.2%)	241 (78.8%)	306 (100%)

Source: Field Survey 2016

From the foregoing, it can be concluded that participation in the irrigation scheme has led to increased farming equipment, electrical appliances and home ownership but has not translated to an appreciable increase in vehicle ownership.

8.3.2.4 Human Capital

Human capital comprises the “skills, knowledge, ability to labor and good health, which are important to the pursuit of livelihood strategies” (Frankenberger, Drinkwater and Maxwell, 2000:8). Three important indicators were used to assess beneficiaries’ human capital and these are the number of employment (excluding household members) on individual farm sites, whether smallholders had been part of any training programme organised on the project and whether beneficiaries had acquired new knowledge, practices, technologies and skills owing to their involvement.

Table 8.7 indicates that 90.2% of the beneficiaries reported nil employment on their farm sites, 4.3% employed one person and two persons respectively on their farms, while only a meagre 1.2% employed more than two persons on the farm sites.

Table 8.7: Employment on farm site

Number employed on farm site	Frequency	percentage
None	276	90.2
1	13	4.3
2	13	4.3
3	2	0.6
4 and above	2	0.6
Total	306	100

Source: Field Survey 2016

Table 8.8: Acquisition of new knowledge, practices, technologies and skills

Recipient of Training through the Irrigation Scheme	Frequency	percentage
Yes	169	55.2
No	137	44.8
Total	306	100

Source: Field Survey (2016)

Table 8.9: Acquisition of new knowledge, practices, technologies and skills

Acquisition of more skills and better farming techniques skills as a result of involvement in the Project	Frequency	percentage
Yes	258	84.6
No	47	15.4
Total	305	100

Source: Field Survey (2016)

Table 8.8 also indicates that more than half (55%) the total number of smallholders have benefitted from training schemes organised by the irrigation agency. With regards to the acquisition of skills highlighted in Table 8.9, majority of the respondents (84.6%) reported that they have adopted and adapted new knowledge, practices, technologies and skills as a result of their involvement in the project. Evidently, majority is harnessing human capital available to them although most smallholders relied on family labour rather than employing workers on farms. Majority benefitted

from training programmes emanating from the project and had experienced an appreciable improvement in their farming skills.

8.3.2.5 Natural Capital

Natural capital refers to the natural resource stocks which are vital inputs contributing to the generation of livelihoods (Duncombe, 2006). These include land, water, and air among others.

Table 8.10: Farm size owned in hectares

Farm size (hectares)	Frequency	percentage
0.01 - 0.20	172	56.2
0.21 - 0.40	116	37.9
0.41 - 0.60	16	5.2
0.61 - 0.80	2	0.7
Total	306	100

Mean farm size = 0.22 hectares

Source: Field Survey (2016)

Table 8.11: Availability of water all year round

Is water available all year round?	Frequency	%
No	51	16.8
Yes	252	83.2
Total	303	100

Source: Field Survey (2016)

Table 8.12: Number of times land was cultivated

Number of times land was cultivated in the past cropping year	Frequency	%
Twice	243	79.4
Three times	63	20.6
Total	306	100

Source: Field Survey (2016)

Three important indicators were used to assess smallholders' natural capital and these are the size of farmland, availability of water all year round, and the number of times farmers cultivate their land during the year. From the analysis, all of the smallholder had less than a hectare of farmland. Specifically, 94.1% farmers had farmland that is not above 0.40ha while the average land size was

0.22ha. Also, majority (83.2%) had access to water for irrigation all year round. With respect to the number of times land was cultivated during the cropping season under review, 79.4% and 20.6% cultivated their land twice and three times respectively. The foregoing is an indication that most smallholders utilised to a larger extent the natural capital available to them.

8.3.2.6 Livelihood Strategies and Outcomes

To assess livelihood outcomes of smallholders, the study considered overall improvement in the livelihoods of smallholders by asking them if they have experienced improvement in their livelihoods and those of their households. It is evident from the analysis presented in Table 8.13 that 231 smallholders (representing 75.5% of the total beneficiaries) were of the opinion that their involvement in the irrigation project had improved their livelihoods while 75 (24.5%) stated that their involvement in the project had not improved their livelihoods. The foregoing is indicative that majority perceived their livelihoods to have improved. Further examination revealed households' diversification of livelihood strategies. As a means of supporting or enhancing their livelihoods, 53.6% of households participate in non-farm activities such as petty or small business trading, handicraft, and transportation. Furthermore, 26.8% own livestock and 11.1% receive remittance to support their livelihoods.

Table 8.13: Perception of overall improvement in livelihoods

Improved Livelihoods	Frequency	percentage
Yes	231	75.5
No	75	24.5
Total	306	100

Source: Field Survey (2016)

Table 8.14: Livelihood strategies

Physical Capital Measures	Yes	No	Total
Remittance receipt	35 (11.1%)	272 (88.9%)	306 (100%)
Non-farm activities	164 (53.6%)	142 (46.4%)	306 (100%)
Livestock ownership	82 (26.8%)	224 (73.2%)	306 (100%)

Source: Field Survey (2016)

8.3.2.7 Multivariate Analysis

Logistic regression models, like other regression models are also susceptible to the issue of multicollinearity, a situation where two or more predictor variables are highly correlated. To test for multicollinearity, the **-collin-** command was used in STATA 14 software programme. Common indicators for collinearity include variance inflation factor (VIF) and tolerance and these were interpreted for the analysis. Large individual and average VIF values (values greater than 6) and small tolerance values (tolerance values close to zero or less than .1) are symptomatic of collinearity issues. Based on the foregoing assumption, the result (Table 8.15) indicates that there is no multicollinearity issue with the predictor variables used in the analysis.

Table 8.15: Collinearity diagnostics test result for variables used for livelihoods analysis

Variable	VIF	SQRT VIF	Tolerance	R-Squared
Education	1.11	1.05	0.9046	0.0954
Number of households in farms	1.29	1.13	0.7771	0.2229
Number of employed workers	1.15	1.07	0.8720	0.1280
Training	1.16	1.08	0.8618	0.1382
Involvement in active savings	1.42	1.19	0.7054	0.2946
Credit access	1.88	1.37	0.5307	0.4693
Group influencing project	1.27	1.13	0.7869	0.2131
Market enhancement due to better infrastructure	1.33	1.15	0.7506	0.2494
Physical capital index (pci)	1.09	1.05	0.9146	0.0854
Farm size	1.25	1.12	0.7973	0.2027
Water availability all year round	1.19	1.09	0.8410	0.1590
No of times land was cultivated	1.79	1.34	0.5573	0.4427

Mean VIF = 1.33

Source: Output from collinearity diagnostic analysis

Table 8.16: Parameter estimates of determinants of the perception of the quality of life of farmers

Variables	Odds Ratio	Standard error	Z-Statistics	Probability
Constant	0.23804	0.29758	-1.15	0.251
Education	0.99349	0.32953	-0.02	0.984
Number of households in farms	1.42886	0.26017	1.96	0.050*
Number of employed workers	1.07663	0.33429	0.24	0.812
Training	2.41871	0.81538	2.62	0.009*
Involvement in active savings	0.61364	0.27598	-1.09	0.278
Credit access	0.91497	0.62586	-0.13	0.897
Group influencing project	3.47795	1.17583	3.69	0.000*
Market enhancement due to better infrastructure	5.62695	2.10582	4.62	0.000*
Physical Capital Index (pci)	1.23647	0.14833	1.77	0.077
Farm size	1.00071	0.00028	2.56	0.010*
Water availability all year round	1.70377	0.70312	1.29	0.197
No of times land was cultivated	0.39908	0.20667	-1.77	0.076
<i>Model Parameters</i>				
Log likelihood	-97.9360			
Wald statistic	52.6			
Sig.	0.0000			

*Significant at 5% level

Source: Output from logistic regression analysis

The results of the regression model are as presented in Table 8.16. Logit coefficients cannot be read as regular OLS as they are in log-odds units, hence the proportional odds ratio was used. The Wald chi-square statistics (52.6) tests that at least one of the predictors' regression coefficient is not equal to zero in the model. The null hypothesis is that all of the regression coefficients in the model are equal to zero. In other words, it is the probability of obtaining the chi-square statistic (in this case, 52.6), if there is no effect on the predictor variables. The small p-value for the Wald statistics ($p < 0.001$) leads to the conclusion that at least one of the regression coefficients is not equal to zero. Hence the model is statistically significant.

The Z statistics test the hypothesis that each coefficient is equal to zero. Using a significant level of 95%, the hypothesis for each coefficient is rejected if the p-value is lower than 0.05. If this is the case, then it is concluded that the variable has a significant influence on the dependent variable.

From the model, five out of the 13 explanatory variables have significant association with the odds of improved quality of life as their p-values were lower than 0.05. In other words, five out of the 13 explanatory variables are likely to influence the chances of households perceiving their quality of life to have improved as a result of the irrigation project. Variables that were insignificant were education, number of employed workers on farmlands, involvement in active savings, credit access, physical capital index, all year round water availability, and number of times land was cultivated.

The number of household members engaged in farming activities was found to have significant effect on households' perception of quality of life. For every unit increase in the number of family members involved in the farms, the odds of perceiving their quality of life to be better increases by 1.4. Human capacity development in terms of training also had significant effect on quality of life perception. Results indicated that those that benefitted from training organized by the irrigation agency were 2.4 times more likely to perceive their quality of life to have improved compared to those that did not benefit from training. Furthermore, perception of the influence of WUA on project decisions has significant effect on households' perception of quality of life. Those who perceive WUA as influencing project decisions taken on the project were 3.5 times more likely to indicate agreement that their quality of life has improved than those who do not.

Results also establish that enhancement of market access due to better infrastructure had significant effect on households' quality of life. Households that indicated that improved infrastructure has enhanced market access were 5.6 times more likely to perceive their quality of life to have improved than those who do not. Lastly, farm size was found to significantly influence households' perception of their quality of life. Specifically, a unit increase in the size of farms would increase the odds of households perceiving their quality of life to have improved by 1. Hence it can be said that the probability of households having a positive perception about their quality of life increases as farm size increases.

Canonical correlation analysis was conducted to study the multivariate relationships between the livelihood assets variables and livelihood strategies variables, with the former being the predictors of the latter. Results indicate that the overall model was statistically significant using Wilk's

multivariate test criterion (as presented in Table 8.17); Wilk's lambda (λ) = 0.574, $F(36, 860.52) = 4.937, p < 0.001$. As Wilk's λ accounts for the unexplained variance of the model, $1 - \lambda$ produces the variance accounted for by the model, which is an r^2 type effect found in OLS regression. Therefore, the overall model r^2 type effect size was 0.426, an indication that the overall model explains a substantial proportion, about 43% of the variance shared between the two variable sets. The dimension reduction analysis presented in Table 8.19, allows for the testing for statistical significance of the hierarchical arrangement of functions. From the table, two functions were statistically significant. Functions 1 to 3 and 2 to 3 were statistically significant, $F(36, 860.52) = 4.936, p < 0.001$, and $F(20, 584.0) = 3.120, p < 0.001$ respectively. On the other hand, Function 3 did not explain a statistically significant proportion of shared variance between the two variable sets, $F(10, 293.0) = 1.382, p = 0.188$. More so, it only explained a meagre 4% of the variance within its function (R_c^2). Hence it was not considered further in the analysis.

Table 8.17: Effect ... within cells regression multivariate tests of significance (S = 3, M = 31/2, N = 145)

Test Name	Value	Approximate F	Hypothesis DF	Error DF	Significance of F
Pillais's	0.48940	4.75957	36.00	879.00	0.00
Hotellings's	0.63416	5.1027	36.00	869.00	0.00
Wilks's	0.57425	4.93646	36.00	860.52	0.00
Roy's	0.28281				

Source: Output from canonical correlation analysis

Table 8.18: Eigen values and canonical correlations

Function	Eigenvalue	%	Cumulative %	Canonical Correlation	Squared Correlation
1	0.39433	62.182	62.182	0.53180	0.28281
2	0.19265	30.379	92.560	0.40191	0.16153
3	0.04718	7.439	100.00	0.21226	0.04505

Source: Output from canonical correlation analysis

Table 8.19: Dimension reduction analysis

Function	Wilks λ	F	Hypothesis DF	Error DF	Significance of F
1 to 3	0.57425	4.93646	36.00	860.52	0.000
2 to 3	0.80069	3.12041	20.00	584.00	0.000
3 to 3	0.95495	1.38235	10.00	293.00	0.188

Source: Output from canonical correlation analysis

In canonical correlation, two types of synthetic (latent) variables are created. These are synthetic criterion variable and synthetic predictor variable which are weighted on the basis of the relationships between variables within the sets, and a major aim of canonical correlation is to examine the relationship between these two variables (Sherry and Henson, 2005). The squared canonical correlation (R_c^2) indicates the proportion of the shared variance between the two composites derived from the two variable sets and this was computed for each function (See Table 8.20). Functions 1 and 2 explained 28% and 16% of the variance within their functions respectively (See Tables 8.18 and 8.20).

Having discovered that there is a notable relationship between the variable sets as evidenced by the statistical significance and effect sizes captured by the first two functions, the next step is to find out what variables are contributing to the relationship in the variable sets across the two functions. Table 8.20 presents for Functions 1 and 2, the standardised canonical function coefficients (Coef) which, according to Sherry and Henson (2005), are used for the combination of the observed predictor and criterion variables into two respective criterion variables and are equivalents of and interpreted similarly to the beta weights in regression. The table also presents the structure coefficients (r_s) which are correlations between observed variables and the synthetic variables generated from the observed variable sets (canonical variate), as well as squared canonical structure coefficients (r_s^2) which are the square of the structure coefficients and reflects the proportion of the variance an observed variable in a set linearly shares with its canonical variate. Lastly, the canonical communality coefficient (h^2) is presented and this is derived through the addition of the r_s across all interpreted functions for each variable. It is analogous to factor analysis' communality coefficient and is suggestive of the usefulness of the variable in the complete canonical solution as it indicates the proportion of variance in each variable that is explained by the solution (Sherry and Henson, 2005).

Following the threshold adopted in some studies for considering a loading in factor analysis as practically significant, and that adopted by Coetzee and Stoltz (2015) in a study that utilized CCA to explore the role of career adaptability among employees, only the variables with an r_s of at least 0.3 were considered in the interpretation and these were emboldened in the table. Similarly, communality coefficients of at least 30% were emboldened to indicate the variables' significant contribution to the entire analysis.

Table 8.20: Canonical solution for livelihood assets predicting livelihood strategies for Functions 1 and 2

Variables	Function 1			Function 2			h^2 (%)
	Coef	r_s	r_s^2 (%)	Coef	r_s	r_s^2 (%)	
<i>Livelihood strategies canonical variate variables</i>							
Remittance receipt	0.500	0.620	38.44	-0.264	-0.043	0.18	38.62
Non-farm activities	0.603	0.629	39.56	-0.616	-0.563	31.70	71.26
Livestock ownership	0.481	0.650	42.25	-0.855	-0.750	56.25	98.50
<i>Livelihood assets canonical variate variables</i>			28.28			16.15	
Education	-0.003	-0.152	2.31	-0.367	-0.268	7.18	9.49
Number of households in farm	0.687	0.746	55.65	-0.199	0.037	0.14	55.79
Number of employed workers	0.202	0.252	6.36	0.312	0.178	3.17	9.53
Training	-0.130	-0.135	1.82	0.070	-0.078	0.61	2.43
Involvement in active savings	0.109	0.323	10.43	0.112	-0.064	0.41	10.84
Credit access	-0.057	0.407	16.56	-0.041	-0.206	4.24	20.81
Group influencing project	-0.092	0.063	0.40	-0.161	-0.370	13.69	14.09
Market enhancement due to better infrastructure	-0.182	-0.053	0.28	-0.704	-0.725	52.56	52.84
Physical capital index (pci)	-0.067	0.235	5.52	0.172	0.152	2.31	7.83
Farm size	0.516	0.669	44.76	-0.031	-0.298	8.88	53.64
Water availability all year round	0.148	0.197	3.88	0.298	0.106	1.12	5.00
Number of times land was cultivated	0.187	0.233	5.43	-0.437	-0.505	25.50	30.93
R_c^2			28.28			16.15	

Note: Coef = standardized canonical function coefficient; r_s = structure coefficient; r_s^2 = squared structure coefficient; h^2 = communality coefficient. Structure coefficients (r_s) of at least 0.30 are emboldened. Communality coefficients (h^2) of 30% or more are emboldened.

Source: Output from canonical correlation analysis

From Function 1, all three livelihood strategies variables which are the criterion variables were all relevant contributors to the livelihood strategies canonical construct (the synthetic criterion variable). This is evidenced by the relatively high squared structure coefficients (r_s^2) and canonical function coefficients (coef). The squared structure coefficients (r_s^2), which indicates the proportion of the variance an observed variable in a set linearly shares with its canonical variate were for remittance receipt, 38.4%; non-farm activities, 39.6%; and livestock ownership, 42.3%. The canonical function coefficients (coef) also reveals that the livelihood strategies had larger coefficients (remittance receipt = 0.50; non-farm activities = 0.60; livestock ownership = 0.481) relative to most variables in the function. Furthermore, a cursory look at the structure coefficients of the three variables reveals that they all had the same sign, suggesting that the variables were all positively related.

The predictor variables whose r_s exceeded 0.30 were number of households in farm, involvement in active savings, credit access and farm size. These variables had positive r_s signs indicating they were all positively related and that they positively contributed to the livelihood assets canonical construct. However, number of households working on farm and farm size were primary contributors to the construct with r_s^2 of 55.7% and 44.8% respectively, with secondary contributions to the construct by credit access (16.6%) and involvement in active savings (10.4%). Furthermore, the relevant predictor variables were positively related to livelihood strategies since they share similar positive r_s signs with the livelihood strategies variables.

For Function 2, Table 8.20 suggests that criterion variables of relevance were non-farm activities and livestock ownership as both were primary contributors to the synthetic criterion variable. Livestock ownership however contributed highest to the livelihood strategies canonical construct with an r_s^2 of 56.3% and a canonical function coefficients of -0.86. The r_s^2 and canonical function coefficients for non-farm activities were 31.7% and -0.62 respectively. Both variables had negative r_s signs, indicating they were positively related to each other.

Also in Function 2, predictor variables of relevance were group influencing project, market enhancement due to better infrastructure and number of times land was cultivated. Market enhancement due to improved infrastructure was indicated as the strongest predictor of the

livelihoods assets canonical construct ($r_s = -0.73$; $r_s^2 = 52.6\%$), followed by number of times land was cultivated ($r_s = -0.51$; $r_s^2 = 25.5\%$), and group influencing project ($r_s = -0.37$; $r_s^2 = 13.7\%$). The variables were all positively related since they all had the same negative signs. It is also evident that these predictor variables were positively related with the relevant livelihood strategies variables, having shared similar negative r_s signs.

Finally, Table 8.20 presents the canonical communality coefficient (h^2), an indication of the proportion of variance in each variable that is explained by the canonical solution. The result indicates that all the criterion variables were useful in the model. It is however evident that livestock ownership and non-farm activities were the most useful criterion variables in the canonical solution with h^2 of 98.5% and 71.3% respectively, thus outlining their importance as significant livelihood strategies adopted by the smallholders. Predictor variables with important contributions to the entire canonical solution were number of household members in farm ($h^2 = 55.8\%$), farm size ($h^2 = 53.6\%$), market enhancement due to better infrastructure ($h^2 = 52.8\%$), and number of times land was cultivated ($h^2 = 30.9\%$). The foregoing is suggestive that compared to other livelihood asset variables, these four variables were strongly related to livelihood strategies adopted by the farmers.

8.4 Discussion

The role of capital assets in improving households' livelihood cannot be overstated. There are indications that smallholders are harnessing social capital for their own good/benefits as majority perceived that the farmer association (WUA) was influencing project decisions and that being a member had been of benefit to them. Furthermore, there is a likelihood that those who perceived WUA as influencing project decisions perceived their quality of life to have improved than those who do not. Affiliations with relevant groups can go a long way in assisting members to harness resources and organise themselves in such a way that they can establish agency and act to address institutional factors inhibiting potential benefits that may accrue from agricultural interventions. As Allison and Ellis (2001) rightly asserts, homogenous groups have the potential to advance collaborative solutions, decrease hierarchical and divergent interactions, while also fostering better management of resources. The latter is indeed veracious when such resource is a shared and limited resource.

Contrary to the findings of Soltani *et al.* (2012) who found a positive relationship between financial capital and livelihoods diversification, there was no substantial relationship between financial capital and livelihood strategies. Although this study found insignificant relationship between financial capital and livelihood outcomes, the farmers suffer from shortage of financial capital as many were not involved in active savings which further contributed to their lack of access to credit facilities. Indeed, little or no form of savings has been identified as a major issue characterising smallholders in Nigeria (Okuneye, 2010). An implication of this is that drawing down on savings as a coping strategy by the farmers cannot be adapted since savings is low. Diversification of livelihoods, that is the increase in livelihood strategies, hinges on an improvement of financial inflows as households may be constrained in expanding their strategies in the absence of financial resources. Improvement of financial capital is therefore imperative and this may be facilitated through the improvement of other assets. For instance, social groups may be organised such that they provide savings mechanisms thereby fostering savings culture and credit access, natural assets improvement can improve financial flows and financial training can facilitate better management of financial resources (Allison and Horemans, 2006).

Respondents had experienced increase in farming equipment, electrical appliances and home ownership but there was no appreciable increase in vehicle ownership. Those who indicated that improved infrastructure in form of transportation and telecommunication facilities had enhanced market access had higher probability of indicating that their quality of life had improved. Furthermore, perception on infrastructure provision was strongly associated with livelihood strategies adopted by the farmer households. Provision of relevant infrastructure precipitates easier access to market which according to Soltani *et al.* (2012), facilitates increased and diversified cultivation of crops and promotes the expansion of non-farm activities which could lead to increased income and better livelihoods. Despite the general impression that access to physical assets would influence diversification of livelihood strategies (Ansoms and McKay, 2010), all other physical capital assets do not show a significant relationship with households' perceived quality of life and livelihood strategies. However, there is an indication that those who had positive perception of infrastructure provision in their rural community are those who had diversified their livelihood strategies or whose probability of doing so looks greater. While it is impossible to rule out the likelihood of inequalities of affordability and access to infrastructure, it is suffice to note

that there is a tendency for livelihood strategies to be influenced by infrastructure provision in a community. In other words, presence or otherwise of an infrastructure may be seen by households as a constraint or enabler of livelihood diversification.

Evidently, majority is harnessing human capital available to them although most smallholders relied on family labour rather than employing workers on farms. Most farms in the study area could be termed “family farms”, a farm typology which is dominant in developing countries (Wiggins, Kirsten and Llambí, 2010; Graeb *et al.*, 2015), and even more prevalent in West Africa than in other regions of Africa (Moyo, 2016). Many smallholders benefitted from training programmes emanating from the project and had experienced an appreciable improvement in their farming skills. The probability of households perceiving improved quality of life rises with increased number of household members involved in the farm and involvement in training programmes. Poverty has been strongly linked with low levels of education and skills (Ellis, 1998; Loison, 2015). Indeed smallholder irrigation farmers have been found in different parts of the world to often lack the requisite training and knowledge of farm and modern irrigation management technique (Fanadzo *et al.*, 2010; Kulshrestha *et al.*, 2010; van Averbek, Denison and Mkeni, 2011; M. Fanadzo, 2012; Colenbrander and van Koppen, 2013; Levidow *et al.*, 2014). That those who had benefitted from training schemes had positive perception of their quality of life is profound as they would be more informed about potential benefits they may accrue from better irrigation farming techniques as a result of their training.

There exist two conflicting views of the role of household size in livelihoods or poverty status of households. On the one hand, it is noted that the higher the household size, the higher their consumption needs which may inadvertently increase the incidence of poverty. On the other hand, it is possible for larger household sizes to experience improved livelihoods if many of the household members are working thus generating income. Although literature is replete with evidence associating higher farm households with increased poverty in Nigeria (see for example, Olorunsanya *et al.*, 2012; Amao, Ayantoye and Fadahunsi, 2013; Idowu, 2013; Igbalajobi *et al.*, 2013; Adekoya, 2014), they do not necessarily explore the relationship between number of household members working on farms and households’ welfare or wellbeing status. Indeed, household size may have impacted positively on farm productivity in the study area with a

consequent positive effect on well-being. As Bacha *et al.* (2011) assert, increasing the labour supply within a household on irrigated farms is not a liability but rather has the potential of enhancing agricultural intensification. Given that larger household sizes could increase the total labour supply of farming families thereby expanding their potential to generate income from farms (Ogwumike and Akinnibosun, 2013), this may offset the greater consumption needs and counteract the expected poverty effects of such households.

Farm size for most smallholders is small – less than a hectare. This is not unforeseen as 72% of global farms are less than one hectare in size (Lowder, Scoet and Raney, 2016) and the size of majority of farms in sub-Saharan Africa is smaller than one hectare (Lowder, Scoet and Singh, 2014; Lowder, Scoet and Raney, 2016). In another vein, there is an increasing evidence of stagnation or a decreasing state of average sizes of farms in developing economies (Hazell *et al.*, 2010; Loison, 2015), which has been attributed to the unconvincing results of economies of scale in farming which negates the a priori expectation that economies of scale in farming would lead to a corresponding increase in farm sizes in these countries (Hazell *et al.*, 2010; Wiggins, Kirsten and Llambí, 2010). Most smallholders however utilised to a larger extent the natural capital available to them. The probability of households having a positive perception about their quality of life increases as farm size increases. In other words, the higher the size of land cultivated by the household, the higher the chances of the household to experience improved well-being. This position is consistent with those of Bacha *et al.* (2011), Idowu (2013), Adekoya (2014) and Hichaambwa and Jayne (2014) that poverty decreases with increase in farm size cultivated by households. Farm size is also strongly associated with livelihood strategies of households. In reality, incentives to diversify livelihood strategies could be amplified by the smaller farm sizes in the irrigation scheme. This aligns with what Gecho *et al.* (2014) observe in their study of farmers in Southern Ethiopia that farm sizes influences whether or not households would pursue other livelihood strategies. Also, Bezu and Holden (2014) posit that farm sizes in rural Ethiopia are too small to be the sole source of livelihood, hence the motivation for diversification. Unsurprisingly, exploring other source of livelihoods also had strong association with number of times land was cultivated during the cropping season. In another vein, there is evidence of beneficial land management practices among smallholders especially in form of intercropping and manuring which were prevalent practices among the smallholders.

Diversification of livelihoods has been recognized as an exit strategy out of poverty (Murphy, 2010). Many smallholder households in rural areas of sub-Saharan Africa have increasingly diversified their livelihoods (Gollin, 2014; Loison, 2015), which is often facilitated through infrastructural development, advent of rural towns and enhanced accessibility to urban areas (Loison, 2015). Although agriculture is the main source of livelihoods in Nigeria, many rural households are gradually diversifying their livelihoods to improve their well-being (Oyinbo and Olaleye, 2016). Households' prominent livelihood strategies for diversification in the study area is involvement in non-farm activities such as petty or small business trading, handicraft, and transportation. This is followed by livestock ownership, while some households received remittances from family members. Engagement in non-farm activities could serve as a coping strategy and help in the alleviation of poverty as more income is generated for the farming household. Igbalajobi *et al.* (2013) and Oyinbo and Olaleye (2016) in their empirical work observe that involvement in non-farm activities have poverty reducing effects in farm households in Nigeria. Ellis, Kutengule and Nyasulu (2003) similarly identified participation in non-farm activities as a vital component of improving the well-being of rural Malawi.

Livestock ownership was also an important livelihood strategy among the smallholders. In similar findings, Mortimore and Adams (2001), Soltani *et al.* (2012), and Ulrich *et al.* (2012) identified livestock production as a major livelihoods strategy in north east Nigeria, rural Iran, and rural Kenya respectively. Motivation for owning livestock in Nigeria include the fact that they are source of insurance and collateral, they are self-producing and they can assist with farm activities (Mortimore and Adams, 2001). Suffice to note that ownership of livestock reduces the risk of poverty and evidence have shown that better-off households are those with substantial accumulation holdings including livestock (Bezemer and Lerman, 2004; Ellis and Freeman, 2004; Ansoms and Mckay, 2010).

Finally, although some households received remittance, its importance as a livelihoods strategy among the smallholder households was minimal. This is suggestive of the limited importance of migration in the study area and the main thrust relates to opportunities. As Gollin (2014) points out, if there are many opportunities in the urban areas and barriers to mobility falls, then

outmigration from rural areas will increase. But this raises the question of whether there are no poverty in urban areas also and whether there are genuine opportunities in those areas which rural dwellers are aware of. Arguably, people would rather stay where they can meet basic needs rather than leave for uncertainties.

8.5 Chapter Summary

The chapter investigated the livelihood profiles of smallholder households of the Middle Rima Valley Irrigation Project, North West Nigeria. Different capitals that make up the livelihoods framework and their link to the quality of life of households were explored. The study finds evidence of substantial social, physical, human and natural capitals held by households, but financial capital was limited. Smallholders are harnessing social capital as the farmer group is influencing project decisions and farmers are benefitting from being a member of WUA. While majority of the farmers have experienced increase in financial returns through their participation in the project, majority of the beneficiaries are not involved in active savings, hence lacked access to credit facilities. Also, majority of the smallholders have witnessed an increase in their physical capital assets but participation in the project has not translated to vehicle and or home ownership for many of them. Most smallholders do not employ people on their farm sites but rely on family labour and majority have received training through the scheme. They have also have adopted and adapted new knowledge, practices, technologies and skills to their work as a result of their participation in the project. There is evidence of beneficial land management practices among smallholders given that majority engaged in intercropping and manuring.

Beneficiaries' perception of the overall improvement of their livelihoods presented a divided front, although majority noted improvement in their livelihoods. Farmer group's influence, farmer training, household size working on farms, infrastructure provision and farm size were variables with positive effects on livelihoods of smallholder households, thus underlining the relevance of these social, human, physical and natural capital assets. Compared to other livelihood asset variables, the four variables that were strongly related to livelihood strategies adopted by the farmers are farm size and number of times land was cultivated – natural capital; infrastructure provision which facilitates better access to market – physical capital; and number

of household members on farm – human capital.

Consistent with evidence in literature, the study finds that farming households have diversified livelihoods in a bid to improve their well-being. Besides involvement in crop production, income from non-farm activities such as petty or small business trading, handicraft, and transportation is a major source of livelihood support for households. Livestock ownership is also an important livelihood strategy providing insurance, collateral and income for households while also contributing to land cultivation. Remittance from migrant households is minimal, an indication that migration as a livelihoods strategy is not so popular among the households.

In view of the foregoing, many implications come to light. There is the need for better empowerment of smallholders through more training schemes in order to improve their livelihoods. The chapter has stressed the importance of farm size in livelihoods improvement, hence opportunities for farmer households to expand land being cultivated should be considered and explored. Where this is not feasible, sustainable intensification may be the solution. Infrastructure provision is important for farmers and this should not only be restricted to on-farm infrastructure but more importantly off-farm infrastructure which has the potential to enhance input and output markets access. The importance of infrastructure is also accentuated in its indirect influence in facilitating off-farm activities which is prominent among the smallholder households.

It is evident that the lack of savings culture and orientation among the farmers inhibits their future access to credit facilities. Access to credit facilities would serve as a readily available and accessible financial capital which beneficiaries can fall on in terms of shocks. This will not only serve as buffer for volatile yield periods but help in ensuring the sustainability of the project. The motivation to migrate is not so great among the smallholder, and this can be maintained if the enablers of better livelihoods highlighted are enhanced among the smallholders. Finally, adequate assessment as to habits and needs deficiency that may impede the sustainability of positive outcomes from projects of this nature should be factored into the designing process of such interventions. The accommodation of such analysis into the design of such interventions provides ample opportunity to implement effective measures to mitigate against the deficiencies.

CHAPTER NINE

DIFFERENTIATION IN SMALL-SCALE IRRIGATION AGRICULTURE IN NORTH WEST NIGERIA

9.1 Introduction

Despite studies on food security at the household level in Nigeria, Akerele *et al.* (2013) advocated for more in-depth assessment of household food security to inform policy and programme decisions. However, this would be incomplete without due consideration of the income and/or poverty status as well as economic activities of households. It is indeed expedient to lay emphasis on a holistic approach that enhances the productive and economic capacities of smallholders; towards ways of collectively improving their productivity, income and food security status. For smallholder households therefore, an examination of the interplay between agricultural production, food security and poverty is imperative for more robust interventions. The chapter attempts a taxonomy of smallholder households of Middle Rima Valley Irrigation Project, Nigeria based on their productivity, income and food security status using cluster analysis. The classifications/categories were thereafter assessed vis-à-vis other socio-economic characteristics.

9.2 Data Analysis

As a major objective of the chapter is to classify smallholder households into categories based on their productivity, income and food security status, a number of statistical procedures were carried out in the chapter using different statistical software packages.

First is the assessment of the productivity of smallholders which was done by examining their efficiency using the Stochastic Production Frontier Function. This is explicitly undertaken in Chapter 6. Productivity measures in agriculture refers to the association between the production of an agricultural commodity and the inputs used to produce the commodity. Whereas least-squares econometric production models and total factor productivity are more suitable and often applied to aggregate time series data and provide measures of technical change, data envelopment analysis and stochastic frontier are most often adopted on a sample of firms, for cross sectional data and provide measures of relative efficiency among firms (Coelli *et al.*, 2005).

Arguably, enhancing productivity is attainable either through technological change or improved use of existing technology. In resource constrained environments however, improving efficiency may be more feasible given limitations to developing the technology base (Tijani, 2006; FAO, 2017b). According to FAO (2017b), the types of inputs and resources available characterizes production technology and the production frontier represents the combination of inputs which yields the output that is maximally obtainable. As such, the production frontier is the “ideal frontier” which no firm can exceed, and divergences from the frontier are reflections of individual inefficiencies (Belotti *et al.*, 2013:720). Nevertheless, one of the fundamental objectives of producers include the avoidance of waste by obtaining maximum outputs from given inputs which corresponds to the attainment of a high level of technical efficiency (Kumbhakar and Lovell, 2000).

Stochastic frontier model, which aims at inferring about technical efficiency and frontier parameters (Kumbhakar and Lovell, 2000; Belotti *et al.*, 2013), comprises a production function which is specified using a regression model with an error term that has two components. Specifically, the Cobb-Douglas stochastic production function was used in the study. It is specified as follows:

$$\ln Y = \beta_0 + \beta_1 \ln(LAND_i) + \beta_2 \ln(LABOUR_i) + \beta_3 \ln(FERT_i) + \beta_4 \ln(SEEDS_i) + \beta_5 \ln(PEST_i) + \beta_6 \ln(KPTL_i) + V_i - U_i \quad \text{Equation 9.1}$$

In the above equation the subscript, i , indicates the i^{th} farmer in the sample. \ln is natural logarithm and β_s are coefficients to be estimated. Given that the value of output is in natural logarithmic form, the coefficients $\beta_2, \beta_3, \beta_4, \beta_5$ measure percentage changes in output that result from a percentage change in the respective factors of production.

V_i s and U_i s are components of the error term. V_i s are assumed to be independent and identically distributed normal random errors, having zero mean and unknown variance, $\phi^2 v$; and U_i s represent the technical inefficiency effects, which are assumed to be independent of V_i s such that U_i s is the non-negative truncation (at zero) of the normal distribution with mean, μ_i , and variance, ϕ^2 , where μ_i s is defined by;

$$\mu_i = \delta_0 + \delta_1 m_{1i} + \delta_2 m_{2i} + \delta_3 m_{3i} + \delta_4 m_{4i} + \delta_5 m_{5i} + \delta_5 m_{5i} + \delta_6 m_{6i} \quad \text{Equation 9.2}$$

Where

m_1 = number of times a plot is cultivated in a year

m_2 = household size

m_3 = farming experience (in years)

m_4 = access to credit (0 – no access to credit; 1 – access to credit)

m_5 = off-farm income (0 – no off-farm income; 1 – off-farm income)

m_6 = educational status (0 – no education; 1 – education)

These variables are assumed to influence technical efficiency of farmers, and δ s are unknown scalar parameters to be estimated. The maximum likelihood estimates (MLE) of the parameters in the Cobb-Douglas stochastic frontier production function model as well as the inefficiency estimates of each smallholders was derived using FRONTIER 4.1 program (Coelli, 1996). The inefficiency estimates constitute one of the variables used in the smallholder typology, illustrating the productivity of each smallholder.

Food security status of smallholder households was computed using the food consumption score (FCS) developed by United Nation's World Food Programme (WFP). The FCS was expounded upon and its analysis carried out in Chapter 7. The FCS signifies household's dietary diversity, nutrient intake and frequency of consumption. It is derived by aggregating data on the diversity and frequency of food consumed by a household over the previous seven days, and applying weight on the respective food groups based their relative nutritional value (WFP, 2008). The food groups and their respective weights are; staples – 2, pulses – 3, vegetables – 1, fruit – 1, meat and fish – 4, milk – 4, sugar – 0.5, oil – 0.5, and condiments – 0. The overall FCS for each smallholder household which addresses the accessibility dimension of food insecurity was derived by multiplying the frequency with which each food group is consumed by their respective weights, and thereafter summing the scores together (Jones *et al.*, 2013). Households' income status used in the analysis was the gross annual earnings of the household for the production year.

Cluster analysis was used to classify smallholders into categories based on the aforementioned variables. Cluster analysis is a technique that is primarily concerned with the classification of observations, individuals or objects into groups or categories based on shared similarities (Blaikie, 2003; Babu and Sanyal, 2009; Hair Jr *et al.*, 2014). In other words, cluster analysis is fundamentally concerned with putting the most similar observations together in groups with an overarching aim of maximizing the homogeneity within clusters and the heterogeneity between clusters. The classification, rather than being an end in itself, is often a means to an end which could either be data reduction or hypothesis generation.

The clustering process started with the assessment of the variables for any multicollinearity issue. This was achieved by examining their Pearson correlation coefficients. Because clustering variables were in differing scales, they were standardized using Z scores in a bid to avoid cases of variables having more than the anticipated influence on the cluster solution as well as for easier comparison between variables. Suffice to note that a fundamental issue for any clustering analysis is the specification of clustering seeds or number of clusters to be included in the analysis. To arrive at the most fitting cluster solution, a combination of both the hierarchical and nonhierarchical methods was used in the study. Firstly, a hierarchical procedure was used to generate a complete set of cluster solutions and to identify suitable number of clusters. It was also used to identify and eliminate outliers from the data. Once the number of clusters is derived, the nonhierarchical procedure using K-means was used for the final cluster of observations.

Hierarchical method combines the repetitive clustering process with a clustering algorithm to establish the similarity between clusters with multiple clusters. The procedure produces differing cluster solutions ranging between one-cluster solution to single-member clusters, thus providing a basis for assessing which cluster solution (or number of clusters) would be a good fit for the analysis (Hair Jr *et al.*, 2014). The Ward's method of clustering algorithm was used as it relatively generates homogenous clusters and the squared Euclidean (straight-line) distance was used as the distance measure. Another consideration in the hierarchical approach is the use of the "stopping rule" to specify the number of clusters most representative of the structure of the data. The stopping rule adopted is based on the rate of change in the total heterogeneity measure as the number of clusters decreases or increases. A large increase in heterogeneity from one stage to another would

be an indication that the prior cluster solution should be selected as the new combination is merging substantially different clusters. Hair Jr *et al.* (2014) notes that the agglomeration coefficients is a useful tool in selecting final cluster solution, as small coefficients signify the merging of fairly homogenous groups and vice versa.

After the selection of the final cluster solution (number of clusters), K-means method of cluster analysis which specifies the number of clusters was applied to the data. Clustering algorithm used is the optimization procedure which allows for the reassigning of observations to another cluster other than the one it was initially assigned. An important advantage of the K-means clustering over the hierarchical procedure is the involvement of an iterative reassignment of observations to clusters until some user-specified numerical criterion is arrived at (Babu and Sanyal, 2009; Hair Jr *et al.*, 2014). In essence, K-means was used to develop optimal cluster solutions.

The overall fit of the final cluster solution was assessed using ANOVA which represents the difference in the variable means across the clusters. The clusters established were also characterized using some socio-economic variables of the smallholder households and these were used in profiling the final cluster solution. These variables are; household size, farm size, household head's educational status, farming experience, total livestock unit, participation in training schemes, participation in non-farm activities, and receipt of remittance. The research thereafter proceeds to establish some predictive validity by applying multinomial logit regression to test whether the socio-economic variables are significant predictors of clustered smallholder households. The cluster analyses were carried out using SPSS Version 24.

9.3 Results

The summary statistics of the clustering variables is presented in Table 9.1. The mean technical efficiency of the smallholders was 85% with a standard deviation of 9%. Average food consumption score for the sampled households 33.2 with a standard deviation of 6.3. Given that FCS score that ranges between 0 – 21 and 21.5 – 35 are categorised as poor and borderline respectively and a score greater than 35 is classified as acceptable food security levels (WFP, 2008), it is thus evident that majority of the households had unacceptable food security levels. The

mean annual income of the households was 237,995 naira with a standard deviation of 90,823 naira.

Table 9.1: Summary statistics of clustering variables

Variable	Mean	Standard deviation	Minimum	Maximum
Efficiency	0.85	0.09	0.42	0.97
FCS	33.2	6.3	19.0	57.0
Household income (naira)	237, 995	90, 823	122, 000	570, 000

Source: Output from frequency distribution analysis of clustering variables

Table 9.2: Pearson correlation of clustering variables

	Efficiency	FCS	Household Income
Efficiency	1	0.225**	0.538**
FCS	0.225**	1	0.539**
Household Income	0.538**	0.539**	1

** Correlation is significant at the 1% level (2-tailed)

Source: Output from pearson correlation analysis

Subsequently, the selected variables for the cluster analysis were scrutinized for any multicollinearity issue. The Pearson correlation analysis presented in Table 9.2 indicates that there were statistically significant associations between the variables, albeit the three variables were moderately correlated with each other. Hence there was no issue of multicollinearity which can affect the computation of the cluster analysis. Hierarchical cluster analysis was performed using the Ward's linkage with squared Euclidean distance. The initial results revealed that two observations were outliers and were thus removed from the analysis. The analysis was performed again with the remaining 304 observations. Evidence from literature suggest that the smaller the number of clusters, the bigger the agglomeration coefficients (Hair Jr *et al.*, 2014). More importantly, more clusters renders the process of managing them problematic while they also become trickier to communicate. As such, no more than six clusters were desired and the focus was thus on the last 10 stages of the agglomeration schedule which is presented in Table 9.3.

Table 9.3: Agglomeration schedule for initial cluster analysis

Stage	Cluster Combined		Coefficients	Number of clusters after combining	Differences in agglomeration coefficients between stages	Proportionate increase in heterogeneity to the next stage	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2					Cluster 1	Cluster 2	
294	6	31	156.04	10	16.38	10.5%	292	285	297
295	1	2	172.42	9	17.42	10.1%	269	293	301
296	4	9	189.84	8	18.40	9.7%	289	288	298
297	6	67	208.24	7	23.66	11.4%	294	191	300
298	3	4	231.90	6	31.74	13.7%	286	296	302
299	11	18	263.64	5	49.20	18.7%	291	287	301
300	6	10	312.83	4	76.31	24.4%	297	290	302
301	1	11	389.14	3	150.07	38.6%	295	299	303
302	3	6	539.21	2	369.79	68.6%	298	300	303
303	1	3	909	1			301	302	0

Source: Output from cluster analysis

The differences in the agglomeration coefficients between stages indicate the extent of increase in heterogeneity from one stage to the next, and the application of the stopping rule is aided by examining the percentage change in clustering coefficients from one stage to the next (Hair et al. 2014). Since no more than 6 clusters are desired, a cursory look at the table indicates the agglomeration coefficient shows relatively large increases going from stage 300 to 301 (24.4%), 301 to 302 (38.6%), and stage 302 to 303 (68.6%), hence relatively large increases in heterogeneity. However, relatively smaller coefficients were derived moving from stages 298 to 299 (13.7%) and 299 to 300 (18.7%). Hence it was decided that the appropriate cluster solution for the research would be either a five-cluster solution or a six-cluster solution. Preliminary analysis of both cluster solutions was performed using the K-means method. The ANOVA result generated for both solutions (presented in Table 9.4) indicate that the five-cluster solution showed relatively bigger F Values compared to the six-cluster solution. As a result of the foregoing, and also for easier analysis and comparison among clusters, the cluster solution with five clusters was selected as the final cluster solution for the analysis.

The non-hierarchical cluster analysis done using the K-means method grouped households into five clusters and an optimization algorithm that maximizes within-cluster variance and maximizes between-cluster variance was chosen. Table 9.4 presents the ANOVA results of the five cluster solutions. The results indicate that there are statistically significant differences between the cluster households on each of the three clustering variables (as p-values < 0.0001). Interpretation and profiling of clusters were done by examining the mean cluster centres (presented in Table 9.5 and Figure 9.1) as well as the pairwise comparisons between the clusters and some socio-economic characteristics of households within each clusters (Table 9.6).

Table 9.4: Anova for final cluster solution

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Zscore (Efficiency)	57.750	4	0.241	299	239.828	0.000
Zscore (FCS)	51.936	4	0.319	299	163.026	0.000
Zscore (HHIncome)	53.898	4	0.292	299	184.375	0.000

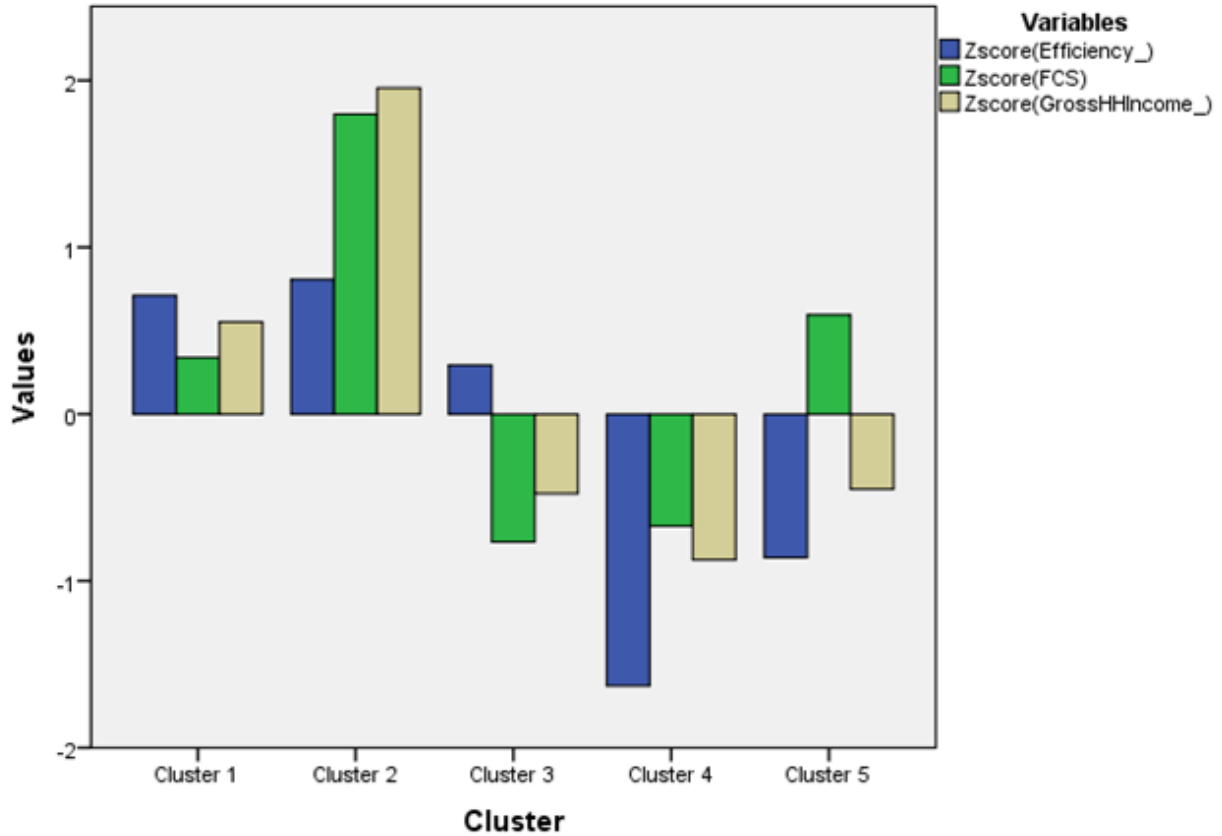
Source: Anova output from cluster analysis

Table 9.5: Final cluster centers

	Cluster				
	1	2	3	4	5
Zscore (Efficiency)	0.71078	0.80756	0.29379	-1.62852	-0.86046
Zscore (FCS)	0.33839	1.79724	-0.76570	-0.67073	0.59594
Zscore (HHIncome)	0.55203	1.95439	-0.47587	-0.87268	-0.45027

Source: Output from cluster analysis

Figure 9.1: Final cluster centers



Source: Output from cluster analysis

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Cluster 1, termed *households with average food security and income but high efficiency levels*, comprises 27.3% of the total households. Compared to the means for the entire sample, the cluster has higher mean household size, farm size and years of farming experience but lower total livestock units. The households farm on an average land size of 0.25 hectares. About 26.5% of households within the cluster have formal education (lower than the sample means) and 62.7% have received at least a form of training via the irrigation scheme (higher than the total sample average). Remittance receipts is low among the households (9.6%) but majority (65.1%) engage in non-farm activities.

Cluster 2, termed *households with high food security, income and efficiency levels*, represents the best-off households among the cluster groups but constitutes 10.5% of sampled households. Compared to the average levels in the total sample, these households has higher mean household

size (9.56), farm size (0.39 ha), years of farming experience (15.28) and total livestock units (2.46). Furthermore, a higher proportion of the households compared to other clusters engaged in non-farm activities (75%) and received remittance (43.8%). However, the proportion with formal education was lower than the entire sample. Also, majority have received training but the proportion was lower than cluster 1.

Table 9.6: Household characteristics by clusters

Socio-economic characteristics	Cluster					Sample means (n = 304)
	1 (n = 83)	2 (n = 32)	3 (n = 100)	4 (n = 49)	5 (n = 40)	
Household size (mean)	8.76	9.56	7.43	7.53	8.03	8.11
Farm size (mean ha)	0.25	0.39	0.17	0.18	0.21	0.22
Farming experience (mean years)	12.31	15.28	11.50	10.80	12.95	12.20
Total livestock unit (mean)	0.24	2.46	0.26	0.28	1.06	0.59
Households with formal education (%)	26.5	25.0	44.0	51.0	35.0	37.2
Households that have received training (%)	62.7	59.4	54.0	44.9	50.0	54.9
Households engaging in non-farm activities (%)	65.1	75.0	50.0	28.6	50.0	53.3
Households with remittance receipts (%)	9.6	43.8	7.0	4.1	7.5	11.2
Smallholder typology	Households with average food security and income but high efficiency levels	Households with high food security, income and efficiency levels	Households with average efficiency levels but food insecure and income poor	Households with low efficiency levels, food insecure and income poor	Households with low efficiency levels, income poor but food secure	Entire sample

Source: Author's computation from cluster analysis

Cluster 3, referred to as *households with average efficiency levels but food insecure and income poor*, comprises the largest proportion (32.9%) of the total households. It has the lowest mean values for household size and farm size among the clusters, and the second lowest average in terms

of farming experience and total livestock units. However, the cluster had the second highest proportion of households with formal education which was also higher than the total sample average. At least half of the households in the category has received training from the irrigation scheme and engaged in non-farm activities.

Cluster 4, termed *households with low efficiency levels, food insecure and income poor*, represents perhaps the most deprived of all clusters. About 16.1% of the total households fall into this category, and are characterized by lower levels of farm size, household size, farming experience and total livestock units compared to the entire sample average. Surprisingly, the cluster has more households with formal education than other clusters. However it has the least proportion of households with training under the scheme. Furthermore, it has the least proportion engaging in non-farm activities and receiving remittance among the clusters.

Cluster 5, referred to as *households with low efficiency levels, income poor but food secure*, comprises 13.1% of smallholder households surveyed. This group has relatively higher mean household size, farming experience and total livestock units (only lower than cluster 2). Mean farm size was lower than the sample average and so are the proportion of households with formal education, households with training, households who engaged in non-farm activities and households who received remittances.

A multinomial logistic regression was performed to model the relationship between membership in cluster groups and the predictor variables (household characteristics). Results presented in Table 9.7 adding the predictor variables into the model that contained only the intercept fits the data significantly better than the null model, X^2 (df = 32; N = 304) = 237.11, $p < 0.0001$. From the goodness-of-fit result, a statistically significant result ($p < 0.05$) is suggestive that the model is a poor fit for the data. The model however is a good fit for the data since the p-value for the Pearson chi-square is 0.590.

For the parameter estimates, cluster 3 was used as the reference category as it was the most dominant group in terms of the number of households in the group. The odds ratios, which are the

exponentiation of the coefficients of the predictors were interpreted using significant levels ranging from 1% to 10%. These are presented in Table 9.7.

Table 9.7: Determinants of smallholder typology (multinomial logit regression)

Explanatory variables	Cluster 1		Cluster 2		Cluster 4		Cluster 5	
	Odds Ratio	SE	Odds Ratio	SE	Odds Ratio	SE	Odds Ratio	SE
HH Size	1.560***	0.143	1.323	0.261	1.190	0.153	1.249	0.167
Farm size	1.002***	0.000	1.003***	0.000	1.001**	0.000	1.001***	0.000
Farm Experience	1.085	0.056	1.401***	0.089	0.922	0.060	1.147**	0.058
TSU	0.829	0.205	1.285	0.190	0.915	0.185	1.269*	0.141
Education	1.394	0.383	0.960	0.712	0.708	0.377	0.991	0.427
Training	0.703	0.371	0.514	0.670	2.014*	0.385	1.142	0.413
Nonfarm activities	1.267	0.398	0.883	0.744	4.336***	0.440	1.648	0.452
Remittance	0.766	0.644	0.147**	0.940	2.031	0.893	1.066	0.791

Reference cluster: Cluster 3

Model Fitting Information: Log Likelihood = 645.87; chi-square = 237.11; df = 32; p-value < 0.0001

Goodness of fit: Pearson's chi-square = 826.07; df = 836; p-value = 0.590

Deviance chi-square = 608.65; df = 836; p-value = 1.000

Pseudo R-Square: McFadden = 0.257; Nagelkerke = 0.569; Cox and Snell = 0.542

*, **, *** mean statistically significant at 10%, 5%, and 1% respectively

Source: Output from multinomial logit regression analysis

Given a unit increase in household size, the relative chance of being in cluster 1 as against cluster 3 increases by a factor of 1.560. Also a unit increase in farming experience increases the odds of being in cluster 2 relative to cluster 3 by a factor of 1.401. Given that remittance is a dummy variable, with "0" signifying non-receipt of remittance and "1" indicating receipt of remittance. The probability of not receiving remittance decreases by 0.147 times in cluster 2 relative to cluster 3. In other words, the probability of receiving remittance increases by 0.147 times in cluster 2 relative to cluster 3. More precisely, households in cluster 2 are more likely to receive remittance than households in cluster 3. Following the same method of interpretation, it is evident that households in cluster 4 are 2.014 times less likely to have been trained compared to those in cluster 3. They are also 4.336 times less likely to engage in non-farm activities relative to households in cluster 3. This is a further confirmation of the deprivation or low levels of welfare of households

in cluster 4. For these households, it is evident that livelihoods diversification is limited among them.

Regarding farm size, results indicate that given a unit increase in farm size, the relative chance of being in cluster 1, cluster 2, cluster 4 or cluster 5 as against the referent cluster (cluster 3) increase by factors of 1.002, 1.003, 1.001 and 1.001 respectively. A cursory consideration of these odd ratio values for farm size across all clusters is indicative that increase in farm size increases the probability of being in cluster 2 (the best-off cluster) relative to other clusters as it has a higher odds ratio value. The foregoing emphasizes the importance of farm size in improving the livelihoods of smallholders as it can contribute to moving households to a higher return livelihood.

9.4 Discussion

Evidence from the analysis indicates that there is a significant positive relationship between efficiency, income and food security. This is not unexpected as it has been established that agriculture leads to income generation which consequently provides the means for food access (Smith, 1998; Negin *et al.*, 2009; Dioula *et al.*, 2013). However, the association between income on the one hand, and efficiency and food security status on the other was stronger than the association between efficiency and food security. This thus underlines the importance of income to smallholder production and household food security. The study attempted to identify and group households into categories based on their efficiency in agricultural production, food security and income status.

Households with the highest efficiency was characterized with high food consumption scores and income levels, further corroborating the relationship between the three phenomena. Very few households however fall into this category, an indication that households with greater inefficiency would probably also face income and food security challenges. Besides, households with average levels of efficiency were associated with food insecurity and low income. This is the dominant household typology in the study area but not the most deprived as there was a greater likelihood that a typical household in the category had been trained or diversified its livelihoods through engagement in farming activities.

The most deprived households had low efficiency levels, were income poor as well as food insecure. The reason for this may not be far-fetched as the households had lower farming and socio-economic status, with the exception of formal education. The proportion of households in this category with formal education was indeed higher than well-off households, but fewer had training compared to other clusters. More profoundly, the study established that training, rather than education has more effect on efficiency, food security and income.

Farm experience tends to be positively associated with food security, income and efficiency levels. It is expected that as farmers become more experienced, their ability to make better choices and better utilize resources improves, which consequently enhances their productivity. With productivity improvement comes improved income and food security status. The foregoing is reflective of the fact that practical training and experience are more fundamental to raising productivity and incomes of farmers than formal education in the study area. The importance of experience further begs the question of how to offset for experience in the light of the fact that it cannot be substantially increased without due consideration of time. Arguably, the solution could be in the training and retraining of farmers as well as opportunities and spaces for knowledge transfer between and among them. The significance of training is exemplified in the observation of Wordofa and Sassi (2018) who noted that farmer training leads to income gains for farmers. With the shrinking of government extension outreaches however, a way to go may be to follow the suggestion of Jansen *et al.* (2006) who advocated for the adoption of farmer-to-farmer extension model which is being promoted in some NGO led initiatives.

Importance of land to income, food security and agricultural productivity is exemplified in its significance to all clustered households. Evidently, larger land sizes increases the probability of being in the best-off smallholder clusters. In other words, the higher the farm size, the greater the chance of increased earnings and household food security. While Place (2009) alluded to the several evidence in literature of the positive association between farm size and households, accounts of the effect of farm size on food security has been mixed. For instance, Muraoka, Jin and Jayne (2018) noted that farm size leads to increased food security in rural Kenya. Abay, Hirvonen and Minten (2017) however observed that the difference in food security indicators was not so large between households with large farms and small farms in Ethiopia, as farmers in the

latter category cultivated intensively and diversified their livelihoods in a bid to enhance the food security status.

Livelihoods diversification is very limited among the most deprived households, but was undertaken by many of the best-off households. Regression results also indicates livelihoods diversification increases the probability of being in a better-off household typology. Indeed, there is a likelihood that income and livelihood strategies can have a mutual effect on each other. Income secured from non-farm activities or remittance, for instance, can be used to increase yield while increased incomes from improved yields can be utilized to diversify livelihoods. For some households, it appears their ability to diversify is associated with their financial liquidity, which is facilitated by their relatively higher income earnings. This chimes in with the views advanced in literature on the significance of finance in agricultural and livelihoods improvement (Brown *et al.*, 2006; Fayet and Vermeulen, 2014; Rahn *et al.*, 2014).

9.5 Chapter Summary

The use of both the cluster and multinomial regression analyses for the research represents an innovative way of exploring smallholder households' differentials. The partitioning allows for the testing of hypothesis that farming and socio-economic characteristics of households affects smallholder typologies based on efficiency, food security and income status of the households. The study found that household clusters are not only differentiated by their efficiency, food security and income status but also by some other household characteristics with an overarching effect on the former variables. In other words, household characteristics differentials determines variation in the efficiency, food security and income status of smallholder households. This procedure has generated results that may assist in better targeting of interventions based on the particular characteristics explored in the analysis. Also, the chapter highlighted the important role land size and farmer training plays in improving farmers' livelihoods. As increasing farm size is not feasible into the future, sustainable intensification should be promoted among smallholders. A multi-pronged approach to the provision of extension services and training of farmers would assist in bridging the gap that may exist in technical and management knowledge among the farmers. The study also found that although livelihood diversification is not very common among the farmers, it is an important strategy that can assist smallholders to improve their productivity and

livelihood status. For this reason, opportunities for diversifying livelihoods should be promoted among the smallholders.



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CHAPTER TEN

ENABLERS OF AND CONSTRAINTS TO PRODUCTIVITY AMONG IRRIGATION SMALLHOLDERS: A QUALITATIVE ANALYSIS

10.1 Introduction

Given the importance of assessing the performance of projects vis-à-vis its effects on participants' livelihoods, the chapter provides the qualitative assessment of the constraints and enablers of agricultural production in the study area. The challenges militating against the project objectives, the factors influencing project success, as well as the successes or benefits of the project as perceived or experienced by the smallholders and irrigation officials are analysed and discussed. The findings are presented under four themes with associated sub-themes and categories which all emerged from the analysed interview data.

10.2 Qualitative Methodology

The methodology for the qualitative research which highlights the type of research design, data collection as well as data analysis procedures is as explained in the research methods chapter. It is however important to reiterate the profile of the participants selected for the interviews. This is presented in Table 10.1.

Table 10.1: Profile of Interviewed Participants

Participants	Position	Gender	Marital Status
Participants 1 (P1)	Project Manager (MRVIS ¹)	Male	Married
Participants 2 (P2)	Assistant Project Manager, Civil Engineering (MRVIS)	Male	Married
Participants 3 (P3)	Chief Irrigation Officer (MRVIS)	Male	Married
Participants 4 (P4)	Irrigation Officer (MRVIS)	Male	Married
Participants 5 (P5)	Smallholder	Male	Married
Participants 6 (P6)	Smallholder and Secretary, WUA ² (MRVIS)	Male	Married
Participants 7 (P7)	Smallholder and Leader, WUA (MRVIS)	Male	Married
Participants 8 (P8)	Smallholder (MRVIS)	Male	Married

¹ Middle Rima Valley Irrigation Scheme; ² Water Users Association

10.3 Results and Discussion

The analysis and discussion of the case data collected through in-depth interviews are presented in this section. Four officials of the Sokoto Rima River Basin Development Authority (SRRBDA) and four smallholders were interviewed and constituted the participants of the qualitative aspects of the study. The analysis revealed four major themes with a variety of categories. These are summarised in Table 10.2 and thereafter extensively discussed.

Table 10.2: Themes, Sub-themes and Categories

Theme	Sub-themes	Categories
Project and Farming Characteristics	Project Characteristics	Project Characteristics
	Farming Characteristics	Farming Characteristics
Enablers of Productivity	Capital Stock (Financial, Natural and Social)	Innovations for financial access
		Social capital
		Smallholders are land owners
	Market access	Natural capital
		Millers as offtakers
Constraints to Productivity	Conflict	Strategy for input provision
	Conflict	Farmers-Herders conflict
	Environmental Issues	Environmental Issues
	Deficient livelihood capital stock	Lack of Financial capital
		Human capital
		Lack of physical capital (storage facilities)
	Market constraints	(Undiversified) livelihood strategy
		Access to input market
	Deficient governmental and programmatic support	Access to output market
		Inadequate governmental support
Other issues	M&E	
	Culture	
	Productivity	
	Personal outcomes	

Theme	Sub-themes	Categories
Contributions of the Project	Increase in physical capital	Increase in physical capital
	Food security	Food security
	Other project benefits	Other project benefits

Source: Author's analysis

10.3.1 Project and Farming Characteristics

The theme captures the aim and objectives of the irrigation project as explained by participants. It also includes the farming approaches and practices of smallholders involved in the irrigation project. This can help to unpack how farms are managed by smallholders and their relationship to the broad economic structures and agri-food systems.

10.3.1.1 Project Characteristics

Central to the aim of the project is to ensure all year round farming in the project locale. This is made possible through the provision of water for irrigation throughout the year. This was the view of nearly every participant interviewed in the study. A participant stated:

The goal is just to make the farmers available, that is, make them work all year round, to carry out irrigation activities during the dry season and also during the wet season (P2: SRRBDA staff).

Another participant noted:

The goals and objectives of this project is to provide all year round cropping, that is during the raining season and the dry season, to minimize the rural urban migration, to make the farmers stay and cultivate food for themselves, their community and the country at large (P4: SRRBDA staff)

Evidently, the project is aimed at ensuring that farmers are available to work all year round by making irrigation infrastructure available and offsetting for the lack of rain during the dry season. As Takeshima (2018) points out, irrigation mitigates against weather-related risks particularly those associated with rainfall uncertainty. There is also a tendency during the dry season for farmers to be out of work and move out of farms to seek livelihoods elsewhere, especially prior to the development of the irrigation infrastructure. Through the irrigation project therefore, farmers

are encouraged to irrigate during the dry season rather than migrate to other communities and regions. Coffey, Papp and Spears (2015) found in India that households with irrigation access were less likely to send out migrants during periods of low or no rainfall than households with no access to irrigation. Irrigation agriculture is thus serving as a strategy for rural development geared towards increasing production, ensuring food security and livelihoods as well as minimizing rural-urban migration in the study area.

The strategy for the implementation of the project entails the placement of SRRBDA staff to the location of the infrastructure project to provide administrative, maintenance and managerial expertise on the project. A participant stated:

... Federal government has deployed staffs to be providing service to the people. Provide engineering services as well as to make the goals and objectives of the project to be realized, these are the strategies put in place to achieve the project (P2: SRRBDA staff).

The river basin (SRRBDA) has an office situated around the project location with resident staffs, while some other officials of the basin shuttles between the basin headquarters in Sokoto and the project location. The organizational structure of the irrigation project which comprises all resident officials in the project was also described by a participant:

The organizational structure of the project , we have the project manager, we have the admin department, apart from the project manager who is head of all, we have the admin department responsible for the administration and the finances of the project. We also have the maintenance department who is responsible for all the maintenance work and operation of all the infrastructures. Then we have the service department which is responsible for the coordination of farmer's activity, provision of water services (P2: SRRBDA staff).

Also, the examination of the roles of irrigation officials would further assist in unpacking the implementation strategy for the project. Participants were thus asked what their roles entailed which generated diverse responses. The Assistant Project Manager (Civil Engineering) explains

that his department is in charge of civil works particularly the maintenance of infrastructure, road, dam embankment and main canal. He added:

...Also we are responsible for the distribution of water to farmers, we operate the canal to make sure the farmers have the necessary water both at the raining season and dry season, during the dry season we have to supplement the water so that the farmers will wet their crops. We are responsible for the release, distribution and control of the water (P2: SRRBDA staff).

The Project Manager is responsible for the general planning and execution of the project. He describes further what his role entails:

My role is... to see that the farmers are educated in the modern farming. The way they irrigate during dry season, the distribution of water to farmers, economic maintenance of their canals, to find ways of making sure they get farm inputs such as fertilizers through NGO or through our authority. (P1: SRRBDA staff).

Another official attached to the irrigation project stated:

My role in this project is to help farmers, to show them how to cultivate or to operate waters to the farmers and making schedule, giving them advice on how to go with their production (P3: SRRBDA staff).

From the foregoing, it is evident that not only does the work of the officials include ensuring the provision of water for smallholders, but their responsibility also extends to intervening in the provision of other essential inputs for farmers as well as the training of farmers in modern irrigation farming technique.

10.3.1.2 Farming Characteristics

Farming characteristics is indeed a key driver of agricultural output whose examination is important in order to assess the sustainability and/or future prospects of such farms. The leading crop grown by smallholders is rice, and other crops include wheat, melon, okro and cassava. Farmers, rather than government, are responsible for their own land preparation. Land clearing

and harrowing are the responsibility of the farmers themselves although often supported by NGOs while many employed labour as a participant stated:

It is the people that prepare their land, not the government. Like this we are approaching dry farming now, a farmer will come, invite labourers, do land clearing then water his plots, then harrow. In that (the latter), private does that because we don't have. We have NGOs that use to come and do that (P1: SRRBDA staff).

The implication of the above-mentioned is that farmers may need funds to prepare land which goes into paying labour and hiring tractors, and this may take a huge chunk of the total cost of input. Awotide *et al.* (2015), for instance, note that the cost for land preparation was the highest among the cost incurred by smallholders in cassava production in Nigeria. Also, mixed cropping and crop rotation which entails the sequencing of the cultivation of different kinds of crops in the same area to maintain soil nutrients are being practiced by the farmers, although the adoption of the latter is low among the farmers. This very much was obtained from an excerpt from a participant:

(Continuous application of fertilizer) reduce the soil content because they don't normally practice what we call crop rotation, we just want to introduce that to them now (P3: SRRBDA staff).

Farmers have been trained and encouraged to engage in mixed-cropping. Quite a number of them have done this which have resulted in positive outcomes. Indeed, mixed cropping has been reported to be a common farming practice in Nigeria (Ajetomobi and Abiodun, 2010; Oseni, 2010; Apata, 2011; Tambo and Abdoulaye, 2013; Onubuogu *et al.*, 2014). Moreover, it serves as an adaptation measure to climate change among farmers (Ajetomobi and Abiodun, 2010; Tambo and Abdoulaye, 2013), and adopted to contribute to all year round food availability for farmers' household (Oseni, 2010; Onubuogu *et al.*, 2014).

Furthermore, some smallholders, in a bid to ensure soil fertility, practice shifting cultivation as a farmer describes his technique thus:

I will cut a new portion of land because if I work on the old one the grass will be too much (P6: Smallholder).

The nature of farming as practiced by the farmers is commercial in scope. In other words, they do not only farm to meet subsistence needs but more importantly to generate output that can be sold for income in the market. Farmers' commercialization efforts, according to a participant, is also increasingly evident in farmer's ability to improve their stock of capital:

After feeding their families they still have a lot of produce to sell, so they are practicing both subsistence and commercial farming system... because at the end of the year most of them use to buy motorcycle, some use to diversify their money to other Agricultural sector in terms of poultry and animal husbandry, when they gather money they use to buy cows and keep it with the cattle rearers (P4: SRRBDA staff).

Although most of the smallholders engaged in what is called family farming which entails the management and organization of agricultural production by a family and aligns with evidence in literature (Wada, 2012), a key feature of the farming practices of irrigation agriculture as observed in the study area is the gendered nature of agriculture as farming is male dominated. This observation was supported by the views of the smallholders when asked about gender participation in agriculture:

How can I go to farm with my wife? It's a man that is known to work, he can go and be under the sun, use his energy to work, a woman is to rest and have her needs met. Actually it's the grown up boys that sometimes do the less strenuous job on the farm but the females don't go to farm. We employ laborers that are looking for job to do, to come and work on the farm (P6: Smallholder).

Another smallholder stated:

Ah women, women don't do irrigation farming, its only men. You know our women don't go anywhere, we do (P8: Smallholder).

Further, another noted:

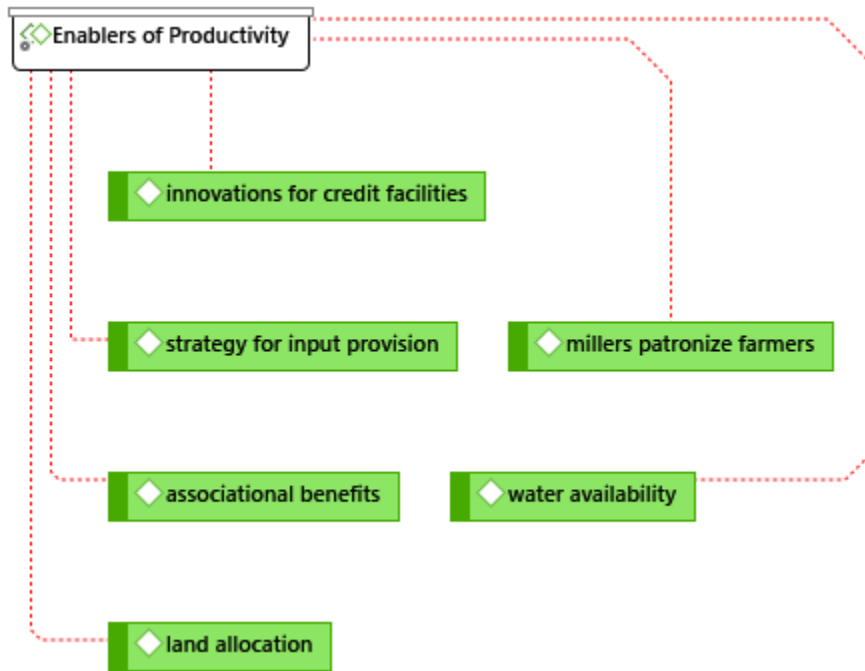
No the women stay at home, I do it (farming) along with my children (P7: Smallholder).

Evidently, irrigation farming in the study area is male dominated as women either stay at home or engage in other form of activities such as handicraft, small business or petty trading. The finding is contrary to what Palacios-Lopez, Christiaensen and Kilic (2017) observes in Nigeria. They reported that 37% of labour in Nigerian agriculture is provided by women while this reduces to 32% in Northern Nigeria, although these were significantly lower than what was obtained in many sub-Saharan countries (Palacios-Lopez, Christiaensen and Kilic, 2017: 56).

10.3.2 Enablers of Production

The section considers factors or strategies that aim at, or contribute to improving the productive capacities of smallholders as identified by the interviewees. Enablers is used to mean those things or factors that positively affect smallholders' productive capabilities. A number of factors were identified by the participants as contributing to the potential of the smallholders to increase production and consequently generate better income. The factors are also placed in categories as presented in Figure 10.1. While innovations for credit facilities, associational benefits, water availability and land allocation fall under the different capital stocks smallholders possess, strategy for input provision and “millers patronize farmers” deals with the issue of market access and measures to ease these access for smallholders. The enabling factors are discussed extensively under the sub-themes identified.

Figure 10.1: Categories generated for enablers of productivity



10.3.2.1 Capital Stock (Financial, Natural, Social and Human Capitals)

Development of important capitals are necessary in the quest for positive livelihood outcomes. This is also applicable to smallholders whose range of capital assets that can be commanded has overarching implications on their productive capabilities and household sustenance. One of the most important resources to any farmer is land and issues relating to its ownership and control are fundamental to efforts geared towards productivity increase. Land ownership in the study area is hereditary, hence farmers are the owners of their land. However due to the fact that government contributed in the development of the irrigation infrastructure and the irrigated lands, government appropriates two percent to itself for future development and to be able to allocate to other interested investors. Suffice to point out also at this juncture, that by virtue of Decree No 6 of 1978 (Land Use Decree) which embodies the existing Land Tenure system, all lands in each State in Nigeria are under the control of the State Governor who administers such lands for the use and common benefits of the citizenry. A SSRBDA staff, referring to land allocation, stated:

The system is that government will come and measure your land, you know land tenure. The farmers prepare their lands themselves. What the government does is to take some percentage, then they call back the farmers, those that were given a

hectare they usually remove just 2 percentages from it and give them back their lands. That two percent is the one that the government has (P1: SRRBDA staff).

Also another staff added:

The farmers own the land, government only helps them to develop the land (P2: SRRBDA staff).

Evidently, smallholders are land owners which implies that farmers are in control of cultivation and management of their lands. Deininger, Savastano and Xia (2017) asserts that traditionally through customary institutions, there is a level of tenure security that is high enough to encourage investment compared to other world's regions. Given that smallholders in the scheme are land owners, this ensures a level of tenure security which, according to Tessema, Aweke and Endris (2013) and Deininger, Savastano and Xia (2017), is imperative for productivity enhancing ventures and sustainable land management practices as farmers who are land owners would be more inclined to take decisions to preserve the fertility of their own lands.

Another natural capital stock which smallholders have access to in abundance is water. As it is the aim of the project to provide all year round water supply for agricultural purposes, evidence suggest that the authority in charge has not defaulted in this as indicated by the farmers. One of them stated:

There is no problem of water, there is enough water (P7: Smallholder)

Another smallholder noted:

Yes, presently we get enough water (P8: Smallholder).

The provision of water throughout the year would no doubt enable farmers to engage in all year round cultivation, and hence contribute to raising the level of their output. Water has been recognized as an important driver of agricultural production, which is particularly illustrated in the fact that 40% of world's food production is cultivated on irrigated land which constitutes 19% of world's agricultural land (Hanjra and Qureshi, 2010). It is thus satisfying that despite increasing

global pressure on available water resources (de Fraiture and Wichelns, 2010; Hanjra and Qureshi, 2010), water is available all year round for smallholder use.

An important enabler of production for the smallholders is the strategy for the provision of credit facilities for the farmers. This has been in form of providing necessary inputs for the farmers on credit while farmers are expected to pay back after harvest:

But like last year we have one tax integrated company that gave them a lot of fertilizers. After the harvest, you pay with rice. If you get three bags of NPK, one bag of urea, you will pay at the cost of like NPK 1000 per annum. They you add small interest. Then when you finish your harvesting you pay them with rice. That's the only company that comes and do that (P1: SRRBDA staff).

The ability to access credit facilities is also facilitated by the organization of smallholder into smaller units or groups in order to manage or share risk and to be in a better position to be granted these facilities by financial institutions. A staff of SRRBDA stated:

We are grouping them in FCs and DCs, this FCs and DCs, we have sectors, sectors, fcs are in 40s to 150s, we register them as one corporate affairs. The government will not give the farmers money individually or else a group, that is why we are trying to register them as a corporate affair so that we can get credit for them (P3: SRRBDA staff).

The organization of the smallholders into smaller groups in order to access credit facilities involves their division along or using distribution channels (DCs) and field canals (FCs). As the several definition of social capital revolves around productive benefits emanating from social relations, there is evidently social capital benefits smallholders derive from being a member of the Water Users Association (WUA), their organization into groups and their relations to each other regarding farm work. Explaining the relations between banks that give credit facilities and smallholders, a participant noted:

It's the banks (that give loan), one of the requirements is to register with the water users association. It is easier for the banks to give them, because the banks will not deal with individuals but with corporate association. In the users association, we

have unit, we have block level consisting of at least 5 to 6 channels making a block, we have apex that is the overall, each of this leader in the blocks reports to the apex (P2: SRRBDA staff).

The above quote justifies the importance of associational membership to loan access for the smallholders. In another vein, smallholders derive benefits by learning from each other as a participant when asked if farmers make suggestions to each other or learn from each other regarding farm work stated:

Yes we do. You know everything has to do with suggestions. For instance some farmlands are bad so we talk about how we can better that. Because if they are joined together and said all are good, some will not get so much. As such, considerations are made to see what can be done (P8: Smallholder).

Literature on social capital has underscored the importance of social networks as an effective means of accessing credit (Asante, Afari-Sefa and Sarpong, 2011; Wydick, Hayes and Kempf, 2011). Farmer groups enhance the prospect of formal acceptance of smallholders by financial institutions, thus improving farmers' capability to access credit. This buttresses findings in the quantitative analysis of smallholders' livelihoods which noted the harnessing of social capital by farmers for their own benefits owing to the perception by majority that the farmer association was influencing project decisions.

Also evident in the scheme are efforts and activities geared towards improving the human capital of the smallholders. These have included training schemes on modern irrigation farming technique.

A participant stated:

Presently we have erm ADP coming in now. The very last year they came and gather around 1000 farmers and we gave them land for a trial and they teach them how to transplant rice and they showed them recent planting fertilizer. And we were trying to show the farmers that if they did that one they would get more output than before... That is why NGOs are coming to teach them, you need modern way of farming. (P1: SRRBDA staff).

Also another participant noted:

There is something we call transformation irrigation management in Nigeria (TRIMING) that is, training, under this concept, the farmers have to participate in whatever we are doing (P2: SRRBDA staff).

The above quotes are suggestive that the Agricultural Development Projects (ADP) and Transforming Irrigation Management in Nigeria (TRIMING) programme have elements of training which smallholders have benefitted from. Also, the scheme has received support from non-governmental organisations in the training of smallholders. Such trainings on modern farming techniques from these entities and programmes have included methods for transplanting and application of new fertilizers.

The foregoing aligns with evidence from the quantitative analysis, of the harnessing of human capital by smallholders. Although human capital benefits from the project mostly takes the shape of family labour, smallholders benefitted from training programmes emanating from the project which principally contributed towards enhancing their farming skills. Farmer training is indeed important in the desire to achieve productivity increase. Such training include training in farm management, sustainable agricultural practices, finance at both farm and enterprise levels, accessing credit among others. In terms of farm management for instance, training is important because investment in inputs without sufficient training of their use would result in a negative and undesired impact on yield (Sustainable Food Lab, 2017).

10.3.2.2 Market Access

Market access, as construed here, refers to the ability to sell or procure goods or services. For smallholders, two markets are important; input and output markets. Access to input market for smallholders refers to the ability to procure necessary inputs for agricultural production, and output market access describes the ability of smallholders to sell their agricultural produce. Important in the study is the exploration of those factors or strategies that facilitates access to these markets as these would undoubtedly contribute to the improvement of the productive capacities of smallholders.

An important enabler of production for the smallholders is the strategy for the provision of credit facilities for the farmers. This has been in form of providing necessary inputs for the farmers on credit while farmers are expected to pay back after harvest. Farmers are able to access input from a private company who gives fertilizers and chemicals to farmers on credit. Acknowledging the assistance received from this company, a farmer noted:

The customers whom we buy chemicals from help us too (P6: Smallholder).

Another strategy for input provision mentioned by a farmer is the sale of livestock to raise fund for input:

I sometimes will sell maybe a cow to buy fertilizer and herbicides (P6: Smallholder).

The latter quote highlights a reasonable strategy used by smallholders since some of them keep livestock. Indeed, investment in other capitals may serve as conversion factors or be converted to cash to buy inputs. In other words, other capitals may serve as buffer or provide the necessary financial ability to provide inputs as the need arises.

In terms of the output market, the extent to which smallholders are able to sell their produce would unquestionably go a long way in improving production and productive capacities of smallholders. Access to output market is being enabled by linking smallholders to millers who purchase the major crop produce (rice). The process through which this is facilitated is described thus:

So under the concept of transformation irrigation program the farmers are made to realize that they have to register, all the unit have to register, all the apex have to register, if they register they are going to be linked to the bridge value chain system and the inputs providers, there is synergy between the farmers, the water user association and the bank... The up takers, like the millers come from neighbouring states like Kaduna, Kebbi, Kano, they come directly to buy rice. Some of them are even planning to establish their own milling company here, so that they can buy, produce it and even sell it here (P2: SRRBDA staff).

Smallholders are linked to millers who are the offtakers through the Transforming Irrigation Management in Nigeria (TRIMING) programme launched. The TRIMING programme, which is under the auspices of the Federal Ministry of Water Resources and focuses on selected large scale public irrigation schemes in Nigeria, is aimed at improving irrigation access and strengthening institutional arrangements for integrated water resources management and agriculture service delivery. One of the components of the broad aim is to improve agricultural productivity and value chain development within the selected schemes. The Middle Rima Valley Irrigation Scheme is one of the selected scheme of the TRIMING programme. Through the programme also, smallholders are being linked to input markets where they engage with input providers. In other words, for assistance with inputs, there seems to be a kind of relationship between WUA, input providers, offtakers and banks. The extent to which smallholders benefit from this relationship, and largely from the TRIM programme is however questionable as would be seen later.

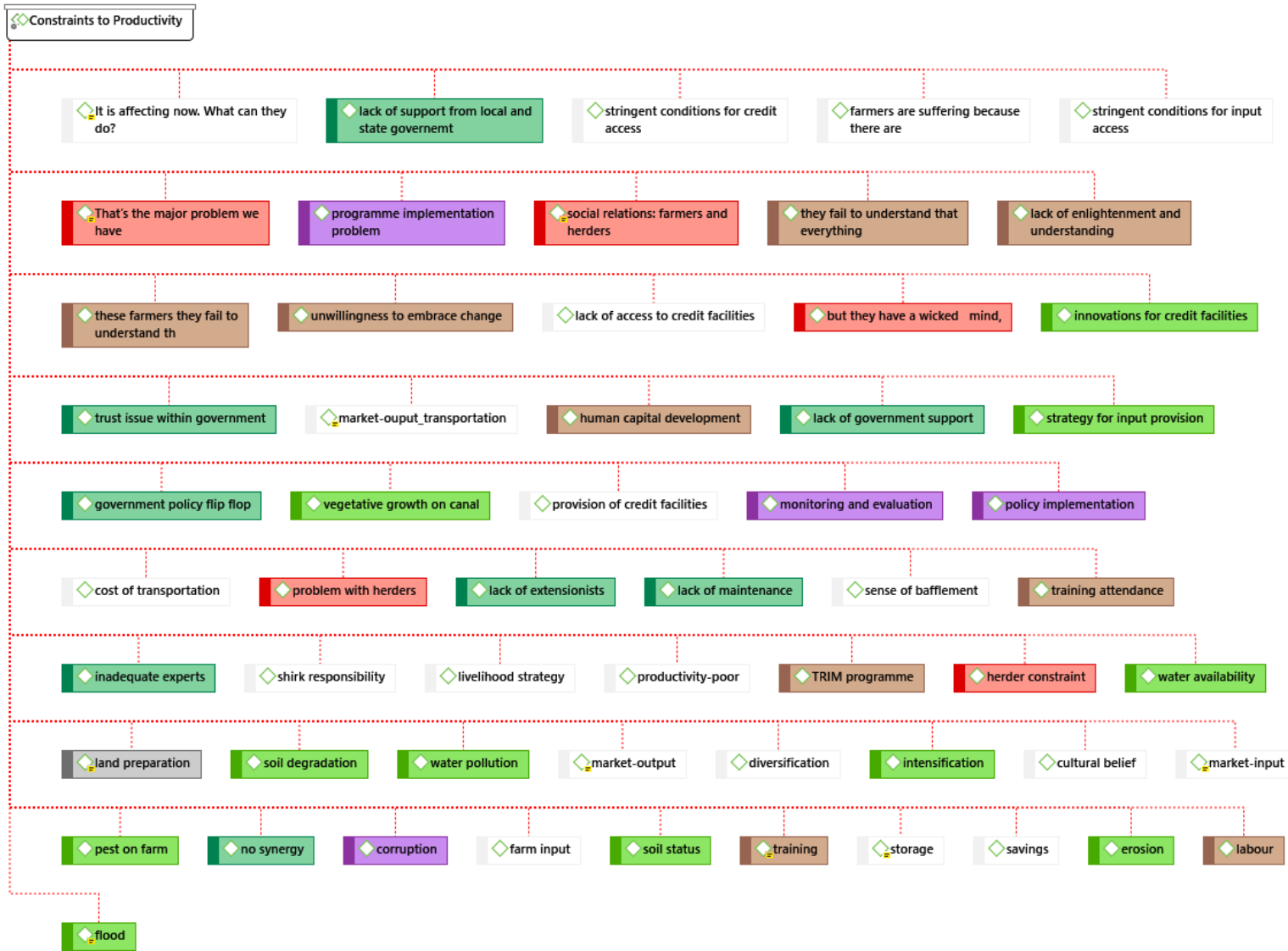
10.3.3 Constraints to Productivity

The study also explored factors limiting production or productive capacities of smallholders and this is the focus of this section. Diverse factors were identified as inhibiting the ability of smallholders to increase production and these were expounded under the various sub-themes.

10.3.3.1 Conflict

Continuing conflict between farmers and herders has been a bane of agricultural production over the years. In recent years however, the conflict has taken on increased proportions and regularity (Moritz, 2010; Baca, 2015), with grave consequences for agriculture in Nigeria. Indeed, it can be asserted that the incessant conflict is presently threatening the peace, security and development of the Nigerian state. As would be seen in this section, the nature of the conflict shapes and is shaped by diverse historical, environmental, political and economic elements.

Figure 10.2: Codes Generated for Constraints to Productivity.



Source: Output from qualitative analysis using Atlas Ti.

In the irrigation scheme under study, progress in agricultural production is being hindered by the persistent clashes between herdsmen and farmers. Virtually every participant interviewed touched on the challenges posed by the ongoing conflict, especially the destructive tendencies of the herders. A participant described the situation:

The cattle rearers are causing a lot of destruction in the irrigation scheme. Instead of them to understand that this scheme is good for them because during the dry season, they have where animals come to eat, but they have a wicked mind, when they are supposed to enter and work out, they enter the structure (canal) anyhow, instead of them to follow a protected area, they keep up entering the canals, matching and jumping the canals and breaking the canal deliberately (P2: SRRBDA staff).

Another participant explained:

The Fulani cattle they normally destroy the irrigation structures and it affect the farmers, the canal is a structure being constructed by the Engineers that takes water from one place to another; so the cattle rearers normally take their cattle to pass through this main canal and this is affecting the soil... The cattle rearers normally destroy the facilities put in place by the government. This is another major problem and it is affecting the beneficiaries which are the farmers too... Yes they break the conveyance structure that is taking the water from one place to another and these breakage is caused by cattle (P4: SRRBDA staff).

Referring to the destruction of crops, a smallholder noted:

I told you they disturb us, you see they come and destroy our crops, so we have been struggling with them and there is nothing we can do. We need the government to help us with that too (P6: Smallholder).

Furthermore, another smallholder specifically mentioned the damage done by the herdsmen's cattle on his farm:

Cattle finished the crops I planted completely on my farm, you too (referring to a SRRBDA staff) are aware of that, so we are back this time to try and see what God will do (P7: Smallholder).

Evidently, the menace of the cattle herder is a major concern of the project. There is overwhelming proof of the interference of herdsmen in the achievement of the project's objective as irrigation infrastructure and agricultural or cultivated land are increasingly being destroyed through the activities of the herders. In their quest for grazing for their cattle, the herders lead their cattle to the irrigated land, thus tampering with and destroying canals that convey water to farmlands, soils and crops.

The Fulani is an ethnic group of the West African Savannah. While some of them are involved in farming, trading and other tertiary activities, majority are cattle herders. In other words, a large proportion of them are pastoralists who are always on the move in search of grazing land for their cattle (Okeke, 2014). A significant number of them are based in the Sahel but there is a trending shift Southward in search of pastureland (Dimelu, Salifu and Igbokwe, 2016). This phenomenon, often referred to as the north-south migration pattern of cattle herders, dates back to the pre-colonial and colonial era. During the course of the Fulani jihads that took place between 1804 and 1810, the Fulani who were majorly pastoralists conquered a significant part of what is presently referred to as Northern Nigeria, dominating especially North-East and North-West Nigeria, but had little impact in North Central Nigeria (Okeke, 2014). The Fulani conquest, which showed a southward territorial pattern, was incontrovertibly accompanied with the Fulani's dominant occupation – cattle herding. The herders' migration pattern also continued to the colonial era where prevailing pacification (albeit subtly enforced) of the rural areas by colonial agents ensured that herders gained access to large expanse of previously insecure territory, thus finding abundant pasturelands for their livestock (Baca, 2015).

The study also inquired about the antecedents of the conflict in the project area by asking when the challenge with the herders started. A respondent answered:

It's all the time sometimes we spend the night on the farm because even today I went to farm in the morning and met the cows (P3: Smallholder).

Another smallholder stated that the issue has been ongoing for years:

You mean the destruction and others, well like the Fulani man he will always go to where he knows crops are cultivated, so it's been long though we have been trying but till this moment there is no solution (P6: Smallholder).

The foregoing is a pointer to the fact that farmers-herders conflict has been an age-long issue which is affecting the productive capabilities of smallholders in the project. Another interesting insight which could be gleaned from the latter quote is the tendency of herders to go to where the grass is greener, and/or where land is being cultivated. Given that there will always be reduction in vegetation cover during dry seasons, herders find the irrigated land pretty appealing and useful owing to the presence of, or the obvious increase in vegetation cover in the irrigation scheme. Climate change has been variously implicated in literature as one of the major underlying factors responsible for farmer-herder conflict (see for instance, Odoh and Chilaka, 2012; Baca, 2015; Dimelu, Salifu and Igbokwe, 2016; Adeoye, 2017). Climate change has resulted in issues such as changes in temperature and rainfall, drought and flooding, with overarching implications for the natural environment (Dimelu, Salifu and Igbokwe, 2016).

The ongoing conflict is also a reflection and/or an outcome of the tussle for natural resources especially land. In other words, the right to and control over land have been at the centre of the crisis between the two parties. This was gleaned from interviews as a participant noted:

It (the conflict) started... because immediately they finish constructing, the cattle rearers don't have access to it (the land) (P4: SRRBDA staff).

Also, another participant stated

The two, they normally blame one another. The farmers blame the cattle rearers that they destroy their farms while the cattle rearers blame the farmers that before irrigation program their cows have access to large land to feed (P2: SRRBDA staff)

The foregoing is indicative of how conflict emanates from natural resource endowment as both parties believe they have right of access to the land. For the herders, the belief is that the irrigation project (human's intervention) has come to reshape how livelihoods are derived and constructed

in the community, consequently denying them access to their means of livelihood construction. Generally, herders are wary of the continued encroachment of grazing fields and routes by farmers. Farmers, on the other hand, see herders as group of people who through their search for pastures cause a lot of crop damage and evades justice by escaping before they are caught. As Moritz (2010) noted, farmers and herders make their livelihood within the same political, geographical and socio-cultural conditions, often characterized by resource scarcity or political inequality. At the heart of the conflict between the two groups is thus competition over a diminishing resource pool as literature has identified a causal link between resources scarcity and violent conflicts (Turner, 2004; Schubert, 2005; Moritz, 2010; Adeoye, 2017). Turner (2004), for instance, points out that these two groups are engaged in land uses that are obviously constantly in competition over a dwindling resource base thus leading to violence.

It is however important to note the contradictions of the effect of the irrigation project on the two groups. While the scheme serves to improve farmers' well-being, the area occupied by the project serves as spaces of enclosure for herders, thus impinging on their means of livelihoods. This is very much related to political ecologists' proposition put forward as the environmental conflict thesis. Summing up the argument, Robbins (2012) points out that "increasing scarcities produced through resource enclosure or appropriation by state authorities, private firms, or social elites accelerate conflict between groups (gender, class, or ethnicity). Similarly, environmental problems become "politicized" when local groups (gender, class, or ethnicity) secure control of collective resources at the expense of others by leveraging management interventions by development authorities, state agents, or private firms" (Robbins, 2012:200). Dimelu, Salifu and Igbokwe (2016) points out that government-backed irrigation projects in Nigeria engenders competition among natural resource users. The foregoing contradictions and clash of interests as a result of the development initiative in favour of farmers is likely to lead to increased conflicts between the two groups.

Despite the growing tensions between farmers and herders in the irrigation scheme, efforts have been geared towards improving their relations and mapping out an approach whereby both can coexist and even benefit from each other in the community. Indeed, over the years the relations between farmers and herders have not always been negative but they also have a symbiotic

relationship as they mutually benefit from each other. Referring to the potential to mutually benefit from each other, a participant stated:

It is actually a dual benefit for the farmers and the rearers. For the farmers they cultivate the cow feed, they gain 50-70 thousand after selling the feeds to the rearers and the rearers have the advantage of having fresh cow feed directly, and this helps the animals... Most time we call meetings, there is a reasonable percentage of farmers that use to cultivate animal feeds during the dry season, the cattle rearers buy from them. Harvesting starts around November to December ending, then by January we call meetings and instruct all the rearers around to stop going to the irrigation areas (P2: SRRBDA staff).

The above quote is suggestive of the opportunities for mutual co-existence and benefits between herders and farmers. Herdsmen patronize farmers as they buy cattle feeds from them, while there is a possibility to use compost cow manure as fertilizer by the farmers. Furthermore, SRRBDA's strategy of resolving crisis as well as ensuring peace and unity among the herders and farmers is the organisation of meeting where issues are deliberated and constant communication between the agency and both parties. Another participant added:

We use to hold a meeting, almost three months two months. Before starting up irrigation we have to hold meeting with their leaders. We have Water Users Association, we have Cattle Rearers Association. We use to hold meeting with them, so that we have a cordial relationship between the farmers and the cattle rearers... Now we have reached an agreement that if we want start we call them that we are starting our work from this month up to April, so we are looking for their cooperation that they should not come into that area. So through that their leaders they would inform their people. We are building cordial relationship with them in short (P1: SRRBDA staff).

Evidently, there are efforts being put in place by SRRBDA to ensure cordial relations between and among both farmers and herders on the one hand, and the implementing agency on the other hand. Regular meetings and communication are being used as strategies to improve social relations

between farmers and herders. There is however a clarion call for government intervention on the farmers-herders conflict by the smallholders. A smallholder stated:

Well, I am calling on the government to map a way out of all these destruction caused by the Fulani, the government should help find a place for them, so that we won't continue having problems with them (P6: Smallholder).

The solution suggested by the smallholder lies in the government isolating specific areas for grazing purposes, a term referred to as ranching. However, this may pose a cultural challenge as herders tend to be nomads moving from one place to another, rather than living a sedentary lifestyle.

10.3.3.2 Environmental Issues

The environment plays an important role in providing natural resources needed by humans for healthy and secure living. Human-environment relations explains how man's decision making and processes shapes and alters the environment and how the environment in return responds to such interactions. Under the irrigation scheme, diverse environmental constraints were brought to the fore, many of which were as a result of humans' intervention.

The importance of soil in plant growth cannot be overstated. However participants noted there are challenges around soil status. This is specifically related to soil degradation owing to poor management. This was captured by a participant thus:

There are challenges in irrigation farming because first of all you will get a farm work, spend money or even borrow and then realize the soil is not good enough, the harvest is poor (P8: Smallholder).

Another smallholder also stated:

Actually the soil is not fertile without fertilizer, you need to apply fertilizer to make it fertile... We do that (to increase production) by applying fertilizer then when the crops starts growing we now raise the soil higher so that the crops comes up (P5: Smallholder).

The above quotes is a reflection of the status of the soil which participants noted is not in the best possible condition. Farmers till the land more and add more fertilizer in an effort to boost production. In other words, they intensify the use of the land, albeit not in a sustainable way because of the overreliance on fertilizer use. The indiscreet application of fertilizers and other inputs by farmers is thus contributing to the decline in soil condition and/or quality. This was explained by a participant:

Actually the inputs that they are using is affecting the soil activities. It's making the soil to lose its nutrient, you know they do apply fertilizers and other chemicals, certain amount of fertilizer is left inside the soil and therefore has negative impact on the people... Why I said it is has negative impact on the soil is because it reduces the soil content because they don't normally practice what we call crop rotation, we just want to introduce that to them now (P4: SRRBDA staff).

It is apparent that inadequate appreciation and application of sustainable agricultural practices is taking its toll on soil quality in the irrigation scheme. For instance, practices such as crop rotation which helps in maintaining soil nutrients is insufficiently carried out by farmers. In another vein, challenges around the fertility of the soil is further compounded by incidents of flooding and erosion in the irrigation scheme. Highlighting the problem of erosion, a participant indicated:

That one (erosion) is natural disaster being caused by the rainfall. If the run up is too much it will definitely wash away the embankment of the canal (P4: SRRBDA staff).

Further, a smallholder noted:

Sometimes if the rain is heavy it destroys the crops (P5: Smallholder).

Evidently, erosion is an environmental challenge destroying soils and crops in the irrigation scheme. Erosion is asserted to be a natural process, albeit often accelerated by human activities and interventions. It may also be a consequence of the incidence of flood in the irrigation scheme. The problem of flood in the scheme is extensively described by the Project Manager:

Like in the wet season we usually experience flood. So that is a negative issue with the project. The flood normally comes in August which causes a lot of damages as

it affects the harvesting of rice... When we get too much inflow into the dam, the more inflow we get the more we cannot use it in the dam. In 2010 we had major breakage which resulted in a lot of damage up to Kebbi State. So now that is why we have to control the dam, we don't want the dam to pass 2.8... at maximum, that's the safer area. So in that instance, we do normally open our radial gate up to 350. That means we are discharging up to 350 million cubic metres per second during wet season which is the maximum. So that is the cause of flood to some part of the irrigation areas. That's why hopefully World Bank is coming to make a dyke protecting that irrigation area (P1: SRRBDA staff).

A major environmental issue the project is grappling with is the occurrence of flood which has had devastating effect on irrigation infrastructure, agricultural production and the environment. This is as a result of too much inflow into the dam during the wet season. This caused major breakage to the dam infrastructure in 2010 which led to flooding of agricultural farms. In order to avert further occurrences, the dam's radial gate is occasionally opened to release water when water levels are high as a result of torrential downpour. However, the frequent release of water from the dam may also lead to greater than usual down river flows, as well as flooding and erosion of farmlands. The foregoing may adversely affect the motivation of smallholders to cultivate farmlands. Adeniyi and Dinbabo (2016) also reported on the flooding challenge in the Tada Shonga Irrigation Project in Northern Nigeria which has had negative effect on rice production. To them, the fear of flooding may be the beginning of skepticism in cultivation for irrigation farmers and this may be true for the farmers in the study area.

Furthermore, pest has had damaging effect on cultivation in the irrigation scheme. This was mentioned by a participant who stated:

I told you earlier, when we plant the crops insects disturb them and there is a disease that causes them to fold as such we have to buy pesticides that are very expensive in order to enhance the crop's well being (P6: Smallholder).

From the above quote, the challenge of pest is apparent in the project and this can limit agricultural production. Moreover, pests can also constrict market access for smallholders as they may find it

difficult to sell damaged crops. As such, smallholders apply pesticides in order to prevent crops damage. However, indiscriminate application of pesticides and other chemicals on farmlands is also leading to water pollution as some of these get eroded into water channels. This was touched on by a participant:

The chemicals they use in spraying the plants at times if they don't wash the container very well it affects the water system along the canal, because some of them use to wash the container they used in spraying that contains chemical along the main canal and it affects the water system negatively (P4: SRRBDA staff).

The above quote typifies the way human activities result in the contamination of water bodies. Water quality is impacted through the leaching of pesticides and other unwanted chemicals into both surface and ground water. It is widely asserted that excessive application of fertilizer and pesticides are major contributors to non-point source of pollution of both surface and ground water (Zalidis *et al.*, 2002; Gordon, Finlayson and Falkenmark, 2010; Power, 2010). Power (2010), for instance, identifies nitrogen and phosphorus as commonly applied nutrients needed for agricultural, but whose heavy application in order to replenish lost ones and improve productivity has resulted in complex, and sometimes, damaging effects on the ecosystem.

Apparently, human interaction with the environment in the study area, in this instance irrigation agriculture, has had some negative effects on the environment including soil degradation. Indeed, literature is replete with evidence of dwindling soil fertility as one of the barriers to agricultural production in Nigeria (Olaleye *et al.*, 2010; Akpan, Nkanta and Essien, 2012; Olaniyan, 2015), although Maconachie (2012) observed discrepancies in farmers' perception of soil fertility and actual soil nutrients' examination in Kano State, Nigeria. Nevertheless, soil fertility decline is undoubtedly an issue in Nigeria, which could be likened to what Marx refers at as "metabolic rift" in which case due to the expansionist tendencies of the capitalist modes of production, there is a creation of a rift in the ecosystems leading to environmental degradation (Carolan, 2012b). This consequently has created a vicious cycle of fertilizer application to achieve productivity. The foregoing is a validation of the degradation and marginalization thesis which notes that the pattern and processes of appropriation, accumulation and consequently economic exploitation has gained momentum especially within marginalized communities such that natural resources are

overexploited, and consequently leading to degradation. In another vein, in line with Blaikie and Brookfield (1987) and Forsyth (2003) assertion that land degradation is not merely a consequence of population pressure but also of affluence and technology, this is true of the scheme as the irrigation technology is implicated in the incidence of flooding and erosion which affects soil quality.

10.3.3.3 Deficient Livelihood Capital Stock

The notion that livelihood capitals relates to the quality of lives of households and their productive capabilities is indisputable. Livelihood refers to the combination of resources, capabilities and activities necessary for sustenance (Su, Saikia and Hay, 2018), and the stock of livelihood capitals a household can command is a reflection of the welfare status of such household and how well such households will be able to have its needs met. Households with inadequate livelihood capital stock may find it difficult to meet basic needs, expand productive capabilities and are potentially vulnerable to shocks and stress. Evidence suggest that for smallholders under the irrigation scheme, livelihood capitals needed for production expansion are insufficient.

Access to financial capital that is essential for expansion of production is lacking for most smallholders under the irrigation scheme. This undoubtedly poses a constraint to the achievement of project objectives. The problem was described by a participant thus:

If a farmer has no money, he cannot cultivate more, without money you can't cultivate, you can't buy farm input... There are mechanized infrastructures, but if you don't have money the tractors will not work for you, because the tractor man is private, we don't have any government tractors (P3: SRRBDA staff).

Also, another participant stated:

The land is available now, some of them have labour, they have human capacity, but financial capacity to support the human capacity is what they don't have, and this is what is affecting them... They need it (finance) for seedling and farm inputs generally, for fertilizers, chemicals. These farm inputs are very very costly, most of them cannot afford to buy (P4: SRRBDA staff).

The above quotes are indicative that smallholders lack access to financial capital which resultantly affects the ability of smallholders to increase production. This corroborates evidence in literature which implicates lack of financial access as a bane of agricultural production expansion in sub-Saharan Africa (Hazell *et al.*, 2010; Jayne, Anriquez and Collier, 2013; Thorbecke, 2013; Loison, 2015). The lack of financial access and the possible reasons behind such lack was further interrogated in the study. Since savings is a fundamental element of financial access and often acts as a facilitator of financial access, smallholders were asked about their savings habit. This generated mixed responses from the farmers. A participant noted:

*No, because I put all my money into this farm work. Presently I don't have money.
I am rather thinking of taking care of my farm (P6: Smallholder).*

In the same vein, another participant who was asked whether he saves and how easy it was for him to save stated:

You know money is a difficult thing because instead of doing this work and investing the money somewhere, you rather make the money here and spend it here, so at the end of it when you are through, you are left with no money and the output is not good, so you see (P8: Smallholder).

On the contrary, a respondent noted he saves for the coming year in order to be able to purchase inputs. It could be deduced that although some were accustomed to saving, many did not engage in significant savings to meet future expenses on farm inputs. This aligns with the results of the quantitative section of the research which noted the shortage of financial capital is affected by and affecting their non-involvement in active savings. This further affected their ability to diversify their livelihoods. The foregoing observations chime in with evidence in literature of the low levels of savings among rural farmers in Nigeria (Bolarinwa and Fakoya, 2011; Ibrahim and Aliero, 2012; Akpan *et al.*, 2013), and its positive relationship to lack of access to credit facilities (Akpan *et al.*, 2013). The importance of savings is however underscored in its effect on the extent and sustainability of capital accumulation and economic growth (Obayelu, 2012).

Given the importance of finance in agricultural development, the Federal Government has over the years prioritized the improvement of financial access in agriculture. For instance, FMARD

(2016) reports that the rate of commercial lending to the agricultural sector was raised from 1% in 2011 to 5% in 2016 and proposed that by 2017/2018, 10% of all formal credits should go to agriculture. Government provisions for agricultural financing in Nigeria have included the Agricultural Credit Guarantee Scheme Fund (ACGSF) and the Anchor Borrower Programme (ABP) of the Central Bank of Nigeria.

The ACGSF has been in existence since 1977 and was established to provide assurance to banks lending money to farmers, providing a guarantee of up to 75% of the amount in default net of security obtained (Adetiloye, 2012). The ABP was established in 2015 to provide a bridge between anchor companies involved in agricultural processing and smallholders. The programme focuses on both the provision of farm inputs (on credit or otherwise) to farmers in order to boost agricultural production and secure or constant provision of inputs for agro-processors, thus ensuring a ready market for smallholders' output. When smallholders were asked if they had benefitted from such efforts, they repudiated that they had received any government loans. A participant stated

Honestly, I don't borrow money from the government. I just manage what I get, nobody gives me money... I don't know how to get money from the government (P8: Smallholder).

Another smallholder stated:

I have never actually borrowed from the government (P6: Smallholder).

Furthermore, a smallholder noted:

No, we have not gotten (any financial assistance) (P5: Smallholder).

It is evident that smallholders are financially constrained and funding needed to acquire necessary inputs is lacking for the farmers. Majority of the smallholders in the irrigation scheme have not been able to secure financial assistance either from the government or banks or any other entity. This calls into question the effectiveness of government's several schemes for agricultural financing particularly for smallholders.

A major reason for the anaemic effectiveness of government's policy for agricultural financing especially for smallholders may be the stringent provisions attached to credit access. For instance, the conditions under the ABP that must be satisfied before farmers can be guaranteed access to credit are quite daunting for many smallholders. This was extensively described by the Project Manager:

Like this programme of ANCO borrowers through the Central Bank, presently, they introduced it this year but the policy, the requirements is just too high for a local farmer to meet. You first of all have to get one hectare, not all farmers have one hectare. They have maybe 0.25 hectares or even less than that. So they say a farmer has to show one hectare, that is one condition. Second, you have to go and make a union of 10 people. Thirdly, you have to open account. Most of these people they don't know how to open account, they don't know how to write, so how can they? Fourthly, they won't give you money. If you want, like land clearing they will give you agent. Your account will be there with money, they say they will put 210 thousand naira in your account but that money you will not see them. If you are a miller, you have account with like Union Bank, you will supervise me. If I need land clearing, I will come to you, you will go and see my one hectare to estimate the cost. If it is say 10 thousand naira, then I will write a paper, I will give you with my account number. And then you will go and meet manager and tell them that I will pay you 10 thousand for this work. Then that my account will be debited to your account. So you see they will not see money, so these local people they don't understand. It is too advanced for them at this time. Because they don't know how to read and write... And there are no banks here, they have to go to Sokoto. Only one micro-finance is here. You have to go down to Sokoto, and because of 20 thousand naira, I can't go to Sokoto, looking for what? To come and do what? So they are trying to pressurize them but they are not interested (P1: SRRBDA staff).

The above quote outlines some of the issues the ABP is grappling with and some flaws in the conceptualization and implementation of the programme. First, the farm area requirement of a hectare for each farmer is not feasible for many of Nigeria's smallholder who operate farms less than a hectare. Second is the coming together of at least 10 farmers before they can access the

credit scheme. While this union can be easily made, default by one smallholder may affect the others, hence this may be problematic for smallholders to agree to. The requirement that bank accounts should be opened and preferably with a commercial bank is not feasible for most smallholders as this has its attendant literacy and distance challenges. The latter is manifested in the study area in the several kilometres (more than 70 kilometres) that smallholders would have to travel before they can get to Sokoto (the capital of Sokoto State) in a bid to locate a commercial bank. Further compounding the issue is the indirect access smallholders have to money but the need or requirement to maintain relations with many parties including banks, input providers and output takers (in this case millers and other agro-processing companies). This may pose challenges of access to and communication with the agents (parties) that may be staying several kilometres from the irrigation scheme. More importantly however, smallholders are left with no choice than to relate with banks, input providers and output takers, thus consequently dealing with terms they may not be able to dictate or control. In other words, with such arrangement, smallholders' negotiating powers are significantly reduced as they may have no option than to do the bidding of any of the parties.

In terms of physical capital, it emerged that smallholders do not have access to storage facilities they can keep their produce. This was highlighted by a participant:

Erm, some people are storing. But the problem is that they have to fight with rats. You know this place, we don't have good chemicals to use for storage. But I'm sure about 70 % of these farmers cannot keep their rice for a long time... It is affecting (their motivation) now. What can they do? (P1: SRRBDA staff).

Also, when a smallholder was asked what happens to the output after harvesting, he stated:

We sell them all because they cannot be stored (P7: Smallholder).

The statements above clearly suggests that there are issues regarding storage which inadvertently takes its toll on the productive capabilities of smallholder. Undoubtedly, the problem of storage affects farmers' motivation and may go a long way in negatively conditioning their productivity. Lack of storage facilities has been identified as a major contributor to post-harvest losses which has negatively affected production and income of Africa's farmers (Hodges, Buzby and Bennett,

2011; Yusuf and He, 2011; Tefera, 2012; Kaminski and Christiaensen, 2014). Moreover, given that smallholders cannot stock their produce but are left with no option than to sell, they are therefore rendered susceptible to the vagaries of the market.

Human capital especially in form of knowledge and understanding of modern farming and irrigation technique is also deficient among the smallholders. This is despite the importance of human capital in improving productivity, livelihoods and food security. This very much was revealed in the interviews with participants. Commenting on the level of understanding of the farmers, a participant stated:

More has to be done because these farmers need to be sensitized in terms of awareness... I said this because there is high degree of poverty and illiteracy, so the government and the NGOs have to enlighten the farmers. The turn out of the farmers in the raining season is 100% but in the dry season which is the time we expect 100% because of the irrigation infrastructures, because the irrigation is for the dry season, in the raining season we have rainfall but the turnout is low in the dry season, so they have to enlighten them. federal government finds this place suitable because of proximity to water resources but the farmers, there is something they have not capture, they need to understand that they need to cultivate all year round and not only during the raining season (P2: SRRBDA staff).

Also another participant highlighted:

The problem is that these farmers they fail to understand things easily, you have to continue trying and continue trying. They are not educated, a lot of them are illiterates. So we are trying to show them this is a new policy that government wants you to do. If the aim of bringing this dam around this area, then try to farm irrigation farming not wet season (P1: SRRBDA staff).

Reflecting on the unwillingness of the farmers to embrace change, the participant continued:

The problem with the farmers is that they fail to understand that everything is changing now, the way you farm 100 years you want to still continue with it. So that's we are trying to show them that now things are changing. If you are farming

for 20 years, and what you get then is what you are still getting now you have to change. So that instead of you getting one bag you begin to have five bags so why don't you try this (P1: SRRBDA staff).

The above quotes are indicative of the challenge of inadequate knowledge and understanding of irrigation agriculture and its technique among the smallholders. Majority of the farmers are not formally educated and do not readily align their motives for farming to the objectives of the scheme. Emerging from the analysis is also the complexities for smallholders to embrace change and incorporate new ideas into their farming practice. In terms of training attendance, there is evidence that not all farmers are present in trainings organised as a participant stated:

If you tell a farmer, come to a meeting it is not easy he doesn't want to leave his farm and then come and spend five hours or two hours. We have to sometimes go to their village heads (P1: SRRBDA staff).

The above statement highlights the difficulty in convincing farmers to leave their farm and attend trainings. In other words, despite farmers' deficient human capital stock, some are not motivated to improve on this and have perhaps not seen or understood the benefits of attending training programmes. As Meijer *et al.* (2015) note that risk and uncertainty play a significant role in the adoption of new technologies in agriculture, this can also be extended to training as smallholders may not be willing to incorporate new ideas and attend training if the value such training will add to them is not conspicuous.

The study also explored the existence of other livelihood strategies by the smallholders. In other words, the research sought to ascertain the extent to which smallholders diversified their livelihoods. It clearly emerged that many farmers did not diversify their livelihoods, while many of those who diversified were limited to livestock production. Describing how smallholders diversify into other activities, a participant stated:

At the end of the year most of them use to buy motorcycle, some use to diversify their money to other Agricultural sector in terms of poultry and animal husbandry, when they gather money they use to buy cows and keep it with the cattle rearers... But the only thing they have to do is because they have nothing to do, either to rear

only rear the goats, cows and when the time of irrigation comes they have to do it (P4: SRRBDA staff).

When smallholders were asked if they engaged in other livelihood activities, some responded in the affirmative as one farmer stated:

Yes, now the one I really concentrate on is farming but sometimes (I do) business and some other smaller things (P6: Smallholder).

Also, another smallholder diversified his livelihood by having livestock as he stated:

We rear cows, rams, goats and others (P5: Smallholder).

Contrariwise, some smallholders have irrigation farming as their sole livelihood source as one participant highlighted:

I don't do anything else apart from this irrigation farming, which is what I use to feed my wives, children and parents (P7: Smallholder).

In the same vein, another participant noted:

I don't have another job that I'm doing apart from this irrigation farming that am into (P7: Smallholder).

It is evident from the foregoing that smallholders' livelihood diversification is greatly limited. While many did not engage in other livelihood activities, those who have partially diversified livelihoods were only involved in livestock production in addition to their irrigation farming activities. This corroborates Mortimore and Adams' (2001) observation that the first phase of diversifying out from farm in North East Nigeria is into livestock ownership.

Despite the profusion of evidence which indicate that diversification is positively associated with improvements in farmers' household welfare status (Babatunde and Qaim, 2010; Fabusoro *et al.*, 2010; Awotide *et al.*, 2012; Akaakohol and Aye, 2014), there is evidence of low levels of diversification by smallholder households which may be due to the nature of the scheme. Seasonality and climate change have been recognized as push factors which may force farm

households to engage in other livelihood activities apart from farming (Ellis, 1998; Loison, 2015). Diversification, for instance, has been identified as an adaptation strategy to climate change by farmers (Tambo and Abdoulaye, 2013; Yila and Resurreccion, 2013; Burnham and Ma, 2015). Accordingly, the low level of livelihood diversification may be due to the presence of the irrigation infrastructure which ensures all year round cultivation by the smallholders.

10.3.3.4 Market Constraints

The importance of market access to farmers cannot be overstated. Access to market for farmers entails being able to procure farm inputs and services as well as the ability to supply agricultural produce to purchasers. From the foregoing, it is evident that smallholders are involved in both input and output markets. For smallholders, access to markets contributes positively to higher income, improved livelihoods and poverty reduction. Where access to market is lacking or not guaranteed, this negatively affects productivity with attendant implications for income generation and livelihood security.

Smallholders in the irrigation scheme are confronted with challenges relating to both the input and output market. Despite the fact that their access to markets is important to stimulating productivity, these farmers face numerous constraints in their ability to access agricultural inputs and to sell their products. This clearly emerged from the interviews conducted with participants.

Regarding agricultural inputs, availability, accessibility and affordability are critical elements of the input markets for smallholders. Agricultural inputs which facilitate agricultural production was a major constraint for many smallholders in the irrigation scheme. A participant described the situation thus:

There are mechanized infrastructures, but if you don't have money the tractors will not work for you, because the tractor man is private, we don't have any government tractors. The major problem they have is farm input. Before they use to get farm input from the government but because of nonchalant attitude on the part of the farmers, federal government stopped that... They are supposed to pay, government has subsidize it, despite the fact that government has subsidize it, some of them still did not pay, so government withdraw the service from them... The major problem

they are encountering is farm input in the sense that some of them don't have financial capacity to go and buy fertilizers and chemicals (P4: SRRBDA staff).

Furthermore, another participant stated:

A lot has to be said, we have to face the challenge, the federal government has the responsibility of providing the extensions and inputs which I won't say they are not doing but more need to be done. (P2: SRRBDA staff).

The above quotes underline the fact that input access is a challenge to farmers. Availability of input, in this instance tractors, does not necessarily translate to affordability for the smallholders. Apart from the availability of land and water, farmers need inputs to help in land preparation and cultivation which apparently are in short supply. Over the years, government have assisted in providing these for farmers but this is reducing partly due to budget constraints and farmers defaulting. Farmers have the responsibility to pay subsidised rate for inputs but some defaulted in payment, which contributed to halting of the provision of such inputs to farmers. The inadequacy of inputs is no doubt affecting production as a smallholder stated:

We don't get enough (produce). You see fertilizer, herbicides and pesticides all these, squanders our money (P7: Smallholder).

In a similar vein, another smallholder highlighted

You know farm work needs a lot of things we have challenge of fertilizer, chemicals, you see that is pesticide, we have challenge of insects, and you see fertilizer is very expensive and that's a problem, if you take a small portion of land it consumes a lot of fertilizer and even what you have gotten so there is no gain (P8: Smallholder).

Smallholders are of the opinion that inputs they needed are costly, and thus do not produce enough owing to input and financial constraints. This is despite that increased use of input, it is believed, would lead to increased yields and prosperity for farmers in sub-Saharan Africa (Belt *et al.*, 2015; Adjognon, Liverpool-Tasie and Reardon, 2017; Sheahan and Barrett, 2017). The challenge with input evident in the study is consistent with Sheahan and Barrett's (2017) assertion that low use of modern input characterizes African agriculture, although variation exists across countries. The

latter notion is reiterated by Adjognon, Liverpool-Tasie and Reardon (2017) who observed that input purchase is increasing in some countries in sub-Saharan Africa. Nevertheless, the inadequacy of inputs for smallholders is reinforced in this study. In another vein, Adjognon, Liverpool-Tasie and Reardon (2017) observed that non-farm employment is an important source of cash for purchase of farm inputs. This however may not be applicable in the study area owing to limited diversification into other activities by the farmers.

Input provision can be facilitated via several mechanisms which may involve partnering with other entities such as financial institutions, private organisations, non-governmental organisations (NGOs), and multilateral organisations. Under the scheme, there have been efforts to collaborate with some organisations in the provision of inputs but the results have been a mixed bag. For instance, a participant stated:

Like last two years, there is one company that came in, it gave seed, it gave fertilizer but at the end the seed is not good. Yes at the end, he ran away. They are looking for him, some people didn't get anything. The rice did not grow. That's why now, it is difficult for somebody to come in and convince them that they have good seeds. They don't believe in hybrid seeds because they suffered from that situation (P1: SRRBDA staff).

The problem of seeds as an input reared its head in the study area. Globally, there are continuously issues with seeds; whether it is its insufficiency for some farmers, the monopoly by some seed companies or the inability of some seeds to reproduce other seeds that would be useful (albeit germinating and producing crops). Here in the study area is the issue of unproductive seeds which consequently led to trust issues between the providers and the smallholders. To put it succinctly, farmers have relinquished control over the reproduction of seeds which has moved into the ambit of formal science, research, commerce and industry (Yapa, 1996).

When the participant was asked if this was atypical or has always been the experience with partners in the supply of input. He stated:

You know this NGOs, sometimes they go into market, they just buy and re-bag them, without going to research institutions or professionals. Yes they do that. Now like

this IFDC, now they try last year now they were happy. Now they come in now again, they increase more land. We give them more land because farmers were happy last time. I was there, you know what they would do? They say ok, we have two plots and they will say you 100 farmers take this, this 100 people will do modern farming. Then we would tell them these people do your own farm then after we compare. But at the end this modern farming would double the output of this local farming. So that's why we are trying to teach them (P1: SRRBDA staff).

From the above quote, it is apparent that the issue lies with the lack of engagement with research institutions or professionals before using the seed brought by an NGO in previous years. In recent years however, a research institution was engaged with who brought the input, tested it among farmers who saw the positive outcome before embracing its usage. The corollary therefore is the validation of the potency or fertility of inputs before their introduction to farmers.

Relating to government assistance in input provision, it could be stated that despite the consensus that government is not doing enough to support input provision for farmer, the little government is doing is also problematic in its organization. One participant highlighted such issues stating:

It is only maybe land clearing and the supply of fertilizers to farmers under GES. Even that GES did not favour our farmers because if as me I fill that form and give them my phone number. They will just text you and say that, like me they said that I should go to (somewhere that is) 200 kilometres from here to collect three bags of fertilizer. But it is not government I think that did that one, it is the people within the system because you know I can't go there. So they will say that they sent to people but they didn't respond. And they will sell it out. That's why I think they planned it that way. So at the end only few people get it (P1: SRRBDA staff).

The Growth Enhancement Support (GES) scheme was initiated under the Agricultural Transformation Agenda (ATA) which was established in 2012, and encapsulates government's strategy to provide subsidized inputs to farmers, while also curtailing the activities of middle men who over the years have been responsible for the diversion of farm inputs for their selfish gains. The strategy includes direct support for farmers through the use of mobile phones to facilitate input

access. However, it is evident from the study that there are still issues revolving around distribution and logistics of fertilizer distribution under the government scheme to assist farmers. Notwithstanding that not all farmers have mobile phones, farmers are also discouraged by the distance they would need to cover before they can get access to the input. The quote also points to issues of diversion of inputs by those responsible for distribution, an indication that the new strategy for distribution has not totally forestalled diversion hitherto witnessed in national input provision for farmers.

In terms of output markets, smallholders under the irrigation scheme operate in local and national food markets. Their produce transits to both rural and urban areas, reaching other parts of the nation especially neighbouring states. Further analysis also indicated that while some of the output are sold to offtakers who are millers, others are transported to markets to be sold by the farmers themselves. These two approaches to selling outputs have not come without their attendant problems. These, coupled with other issues represent significant output market challenges smallholders are confronted with. These emerged through the interviews conducted. Highlighting the problem of market for produce, a participant stated:

And at that time during bumper harvest, farmers are suffering because there are no ready market to sell their produce. Only on few occasions somebody will come in, and buy 100, 200 bags. While after all, a farmer can have up to 500 bags. No market, we have been complaining of this but those people would come and tell them lies (P1: SRRBDA staff).

The participant highlighted the issue of a ready market for farmers to sell their produce. This would unquestionably affect their motivation to cultivate and production capacity. In terms of relations of smallholders with millers who are off-takers, there appears to be an unequal power relations between them. This was gleaned from an excerpt from an interviewed participant who stated:

Ehn ehn, that is our main problem now. Many NGOs, government have millers telling us, we will gather farmers and they just tell them they would give them the seeds, the chemicals and at the end they would buy their rice, but some even almost all of them don't fulfill their promises. The selling of their produce, that's where we would just zero down. Because during the, at the end of each season. Presently

the bag of rice at the market is 7000 now, you know instead of the millers to come and buy it at good price, they will just buy it at the rate of 4000 or 4500. But to get good gain, the minimum a farmer should sell the bag is 5000 (P1: SRRBDA staff).

The above quotes illustrates how the negotiating power of smallholders in output market is weakened. In the absence of storage facilities, farmers are left with no choice than to sell during harvest and thus reluctantly concede to millers (off-takers) demands, becoming “price takers” in the process. The absence of storage facilities renders farmers prone to market fluctuations and undoubtedly contributes to post-harvest losses. Regarding the latter, Lipinski *et al.* (2013), for instance, observed that more than two-thirds of food loss or waste in sub-Saharan Africa is attributed to production and storage, while (Affognon *et al.*, 2015) in their meta-analysis reported that 84% of post-harvest losses in the same region was related to storage.

In another vein, although entities occasionally come to the irrigation scheme to purchase farmers' output, farmers mostly take their produce to markets that are located several kilometres away from their location. Efforts to take advantage of these markets brings about some inherent challenges. This was described by a participant thus:

We have Goronyo, the local government headquarters. Then today, we have another one at Chida, just some kilometres from Sokoto. If you take it there, you know from here to that market you have to pay 200 naira per bag from the farm. So you know additionally, you will pay the local government revenue. Then after you pay the commission for the man that will sell. And if you go there, if the buyer didn't come from outside, not within the local government, maybe you will not sell it. You have to either find a place to keep it for another market or you transport it back, additional cost for you (P1: SRRBDA staff).

Evidently, transportation to output markets and its cost are big barriers to production. Farmers have to travel several kilometres to where markets are incurring costs along the way. Failure to sell the produce when transported to markets also result in additional costs, either of storage or transportation back to point of origin. This unarguably would weaken farmers' position when dealing with buyers in such markets. The combined effect of lack of storage and inability to sell

produce in the markets would be the narrowing of smallholder productive capabilities. As FAO, IFAD and WFP (2015) note, smallholder productivity and market access are interlinked such that the movement of foods from surplus to deficit areas is facilitated and price signals are transmitted to farmers in a way that allows for the adjustment of production and input use. Moreover, Oni (2013) implicates unstable prices of agricultural produce as one of the factors inhibiting agricultural production and investment in Nigeria. As “price takers” therefore, these smallholders are weak participants in the market (UNCTAD, 2015), with most of the prices or profit being captured by intermediaries, millers or processors. Inadequate access to market in the study area would no doubt affect the motivation of farmers to produce more. It is unreasonable and unfeasible for farmers to increase production when they know that they do not have ready market to sell their produce.

10.3.3.5 Deficient Governmental and Programmatic Support

How government contributes to smallholder agriculture is important to the productivity and livelihood security of farmers. This is because smallholders may lack protection against market vagaries or imperfections, necessary physical infrastructure and other farm inputs, expertise on modern farming techniques among others. As a result, government’s efforts in ensuring agricultural development and that farming is a profitable venture for smallholders through the provision of services and resources cannot be underplayed.

Government support for smallholders in the irrigation scheme is insufficient, considering the observation and excerpts from interviews of participants. This is despite government’s continuous and renewed focus on promoting smallholder agriculture in particular and agricultural development in general. The inadequate support received from the government was highlighted by the smallholders as one stated:

The only thing I get from the government is water and nothing else because even fertilizer is difficult for us to get as it is we buy a bag for about 8500 (P7: Smallholder).

Another farmer noted:

Ok, honestly the help (from government) is what we've been looking for but have not gotten (P8: Smallholder).

Farmers were unanimous about lack of sufficient support from the government to boost their agricultural activities. Their view was also supported by irrigation staff who paradoxically were government employees. An SRRBDA staff noted:

A lot has to be said, we have to face the challenge, the federal government has the responsibility of providing the extensions and inputs which I won't say they are not doing but more need to be done (P2: SRRBDA staff).

The above quotes are indicative that governmental support is inadequate for the achievement of the objectives of the project. This corroborates evidence in literature that has highlighted the fact that support from government to Nigeria's agricultural sector is insufficient (Nchuchuwe and Adejuwon, 2012; Oni, 2013). This is particularly typified in the scheme in the provision of farm inputs and agricultural services. The latter was pointed out by some staff who commented on the problem of inadequate experts in the irrigation scheme. One of them stated:

We are short of staff, we need a lot of field overseer to give the report of what happen on the field... We are lacking in numbers of agricultural extensionists and number of the staff we have here (P4: SRRBDA staff).

Another participant also noted:

Staffs are also retiring every day, no new employment, the policy has also changed (P2: SRRBDA staff).

Apparently, lack of adequate agricultural personnel who have been trained and are competent in knowing what the issues the farmers are grappling with are, and how to go about solving them has been a major challenge in the irrigation project. The foregoing is related to the work of agricultural extensionists, hence the presence or otherwise of these professionals was interrogated. Highlighting the absence of extensionists and the reasons behind such in the scheme, a participant stated:

We don't have. Zero. You can't see any Agricultural extensions here. Firstly at the start, we have extension officers. Even we have the schools. But since they remove rural development, we lost livestock, we lost fisheries, we lost agric extension, we lost fertilizers and chemical. All these were transferred to the Ministry of Agriculture. So there is no synergy between Ministry of Water Resources and Ministry of Agriculture (P1: SRRBDA staff).

Furthermore, another participant added:

There is a problem of understanding the policy makers. Initially when the river basin water was created we have the academy training department, we have the livestock, the water resources and agriculture were together, but because of changes in government, water resources was taken out of ministry of Agriculture (P2: SRRBDA staff).

The foregoing quotes are evidence of the policy flip flops of the government and lack of adequate cooperation among relevant Federal Ministries and parastatals responsible for agriculture and rural development. Over the years and in a bid to cut cost due to budget constraints, successive governments have merged and unmerged both the Federal Ministry of Agriculture and Rural Development (FMARD) and Federal Ministry of Water Resources (FMWR). This has led in some instances to either the duplication of responsibilities or confusion as to who owns the burden of responsibility for some issues and activities. Evidence suggests that there is lack of synergy between the two Ministries that share many similar objectives for agriculture and rural development. The irrigation project does not have resident agricultural extensionists as these officers are with the Ministry of Agriculture and would only be available for Ministry of Agriculture-led projects or initiatives. It is indeed incongruous to observe that the Ministry of Agriculture do not participate sufficiently in the irrigation scheme, which defeats the purpose of having the irrigation scheme after all. Certainly, if the irrigation scheme is to boost agricultural production and improve national food security and farmers' livelihoods, then participation of the Ministry of Agriculture is not important but ought to be total.

Inadequate support from government further extends to the failure of the other two tiers of government to assist or contribute in any meaningful way to the irrigation scheme. The scheme is considered a federal government initiative, hence the local and state governments do not provide necessary support for the programme. This was highlighted by a participant:

The state and local government supposed to be afflicted with this program so that they can provide their support (P2: SRRBDA staff).

The issue obviously lies in the conceptualization process and whether or not local and states government were included in the stage and the policy document. A cursory look at the River Basin Development Authority (RBDA) Act No. 35 of 1987 indicates that state government were only mentioned in the process of acquiring land for any programme of any of the RBDAs, and were not given any other responsibility in the Act.

Adequate maintenance of irrigation infrastructure is also problematic in the scheme. This very much was described by a participant thus:

The irrigation area and dam, we don't have maintenance culture. If somebody tells you that now if we write a report that this and this, needs to be maintained, needs attention, those up higher there they think that we are planning to just have money, that's our problem, maintenance culture of our area (P1: SRRBDA staff).

The problem of maintenance was highlighted by the participant who also pointed out the challenge of obtaining approval for some maintenance activities. It cannot however be overstated that sustainability of irrigated agriculture partly hinges on adequate maintenance of irrigation infrastructure (Sharaunga and Mudhara, 2018), and failure to do so would have negative implications for agricultural productivity. The quote also alludes to trust issues within the government as the participant noted their demand for maintenance arouses suspicion from superiors at the basin headquarters.

The foregoing is indicative of issues relating to poor project management particularly the absence of adequate monitoring and evaluation (M&E) process in the project. Suffice to state that if proper M&E is being done, issues of mistrust in terms of the genuineness of maintenance claims (and its

financing) would not arise. Consequences of inadequate M&E is also manifested in corruption and the diversion of inputs highlighted earlier. The problem of M&E is also illustrated in the following statement by a participant:

Errm, let government or any private organization if they can bring in, not talking about bringing them in. And then not all the real farmers are getting the all these loans that we heard government is giving (P1: SRRBDA staff).

Apparently, there is a mismatch between what government is saying and what they are doing, or rather the extent to which they implement what they set out to implement. This exemplifies the problem that is associated with programme implementation in the scheme, particularly the absence of an adequate M&E process.

10.3.3.6 Other Issues

The other challenge in the irrigation scheme is related to how circumstances smallholders find themselves have contributed to a sense of bewilderment and continual dependence on government for solutions. This is evident in an excerpt from a smallholder. When asked how the challenges farmers are facing can be tackled, he stated:

You see we don't know how we can solve these problems, but we just do our work if we don't get we won't kill ourselves, if God helps us and we get that is all... Now we, you see you are the one to advise us, we don't have any way out. If you check and find solutions then fine things will be made better, we just do it if God helps us then that's fine, because farm work is complicated you might be hoping that this place is good and it turns out the other way round (P8: Smallholder).

From the above quotes, two things are notable. First is the sense of bafflement as the participant is confused on what to be done to resolve the problems confronting smallholders in the scheme. Second is the passing of the buck to government to come up with solutions to the many problems smallholders are confronted with. This is often emblematic of the way farmers shirk their obligations and wait for government to come up with solutions to challenges. While not absolving government of their duties and responsibilities, it is also important for farmers to organize themselves both personally and collectively to effect change. Freire (2018:47) asserts in his

seminal and emancipatory book, *Pedagogy of the Oppressed*, freedom is not acquired by gift, but must be pursued vigourously. It is not an ideal located outside of man, nor an idea which becomes a myth. Economic freedom, for smallholders, must involve them knowing first the root causes of their problems and organizing themselves to take actions in resolving them.

10.3.4 Contributions of the Project

This section explores the impact the irrigation project is having on smallholder households and the community in general. As the goals of the project includes the improvement of livelihoods and food security, the sections serves to consider the extent to which some of these aims are being realized. This was done by interrogating what the project has achieved from the interviewed participants.

10.3.4.1 Increase in Physical Capital

There is evidence of physical capital increase among smallholders. Such increases have been fostered by the presence of irrigation infrastructure for the use of the farmers. This was highlighted by a participant thus:

Their income has been increased for individual farmer, before they cultivate only one time in a year which is millet, you can see they have now change their houses, they are riding better motorcycles now and better cars (P1: SRRBDA staff).

Along similar lines, a smallholder stated:

Well I have not bought a car because I can't afford it but I have a motor bike, I also have small radio to listen to world news (P7: Smallholder).

Evidently, some smallholders have had an appreciable increase in their physical capital stock as a result of the project. Investment in physical capital no doubt increases the capital stock available to each smallholder and would further contribute to production increase. Also, such capital can act as a buffer by helping smallholders to recover from shocks and stress or maintain decent livelihoods during such periods.

10.3.4.2 Food Security

There is evidence that the project is contributing positively to food security in Nigeria as agricultural output from the scheme is being transported or sold to neighboring states. Further, the major purpose of the scheme which is dry season farming ensures that crops are produced all year round which are consumed by smallholder households and sold to other parts of the country. A participant described the benefit thus:

Not only northern Nigeria, even in African that is neighbouring countries as I told you a lot is being produced. I cannot give you the figure now, from the past 13 years when the irrigation takes up here the production is increasing every year, both in the raining season and dry season. So the indication of the turnout is a progress in the production (P2: SRRBDA staff).

Also, another participant added:

In fact the project is contributing to their lives positively. In the sense that they are able to feed themselves and the family... The project is contributing positively to northern Nigeria and not only northern Nigeria alone, because they have their produces being sold to other states that are not producing the kind of vegetables, so they are able to sell their products to other states apart from their states (P4: SRRBDA staff).

The above quotes buttresses the fact that not only does the project contribute to food security of smallholder households, but in some way to that of the country. Suffice to note at this juncture, that food security has various dimensions; availability, accessibility, utilization and stability. While information about all of these are important, the interview was only able to interrogate the first two dimensions from smallholder households. Smallholders unequivocally stated they never stayed without food the previous year, but have had their food needs met either from their farm produce or income generated from their output. A smallholder stated:

Sometimes I bring from the farm if I am opportuned to plant them during the rainy season but if it finishes then I buy from the market (P6: Smallholder).

Also, another smallholder said:

We buy them from the market, that is things we don't cultivate (P7: Smallholder).

Evidently the source of food for smallholder households have been from own production and the market. Attempt was also made to investigate the dietary pattern of smallholder households. When smallholder were asked what constituted their normal meal in a normal day, responses showed the dominant food group is carbohydrate. For instance, a participant stated:

In the morning we take pap and akara, in the afternoon we prepare rice and in the evening we eat tuwo and change the meal the next day (P7: Smallholder).

Also, another participant noted:

You know we cannot do without tuwo, in the evening we can take tuwo, in the morning if a person can afford it then he or she can take tea, in the afternoon you eat whatever you get... if you cannot afford it you can buy noodles, or the locally prepared one (P8: Smallholder).

Tuwo is a Nigerian meal prepared from rice flour or corn flour, and it is most common in the Northern parts of the country. This is a common meal taken by smallholder households, and this in addition to other foods consumed indicates that their diet is skewed heavily towards carbohydrate. Obayelu, Okoruwa and Oni (2009) note an increase in the intake of carbohydrates foods in Nigeria at the expense of foods high in proteins and vegetables.

10.3.4.3 Other Benefits

In addition to the benefits the project has recorded earlier highlighted, the project has also been valuable in other areas. This section focuses on other merits or impacts of the irrigation scheme. Firstly, the scheme is contributing positively to improving the livelihoods of the smallholder households. This very much was gleaned from the comments of the interviewed smallholders. One of them stated:

I am happy with what I get my family members too, because when I get I feed them as I am supposed to (P7: Smallholder).

Expressing satisfaction with his work, another smallholder indicated:

Yes (I am satisfied with my work), I get enough to take care of my family I don't have any problem. That is just what I do (P7: Smallholder).

The above quotes are indications that households' livelihoods are being positively impacted as a result of the irrigation scheme. This is in line with one of the intentions of the project; to improve the well-being of farmers.

Also, the project has led to increased production among the farmers. One participant described the positive situation, saying:

You know sometimes a farmer can work on less than one hectare and end up with less than 100 bags of output of rice, but now that these people come in wet season, Rice is 100 % in wet season (P1: SRRBDA staff).

Also, another participant expounded further:

As I told you a lot is being produced, I cannot give you the figure now, from the past 13 years when the irrigation takes up here the production is increasing every year, both in the raining season and dry season. So the indication of the turnout is a progress in the production (P2: SRRBDA staff).

The above statement is testament to the fact that smallholders have been able to boost production as a result of the irrigation scheme. This is a result of the irrigation infrastructure which makes it possible for farmers to cultivate all year round.

The obvious benefit derived by smallholders particularly in terms of output increase owing to the irrigation infrastructure has led to an increase in smallholder population as many farmers are attracted to the scheme. The latter quote alludes to the fact that the turnout of farmers had increased because of increased production. This view was also corroborated by a participant who stated:

They (the farmers) have been increasing. In fact this year has been the highest. You know this application which will give you what we, that's GRA – government reserve. And these farmers you will see they have increased and instead of leaving the place dry and waiting for the wet season, now they have started and they come

out en masse. At least instead of 20 per cent now we are getting up to 50 per cent (P1: SRRBDA staff).

Evidently, there have been an increase in the population of farmers involved in irrigation farming in the study areas. This is further substantiated by the fact that 50% of the available irrigated land was being utilized, compared to the 20% hitherto utilized in former seasons.

Finally, the increase in production and the ability to cultivate all year round has led to a reduction in rural-urban migration in the study area. This very much was gathered as a participant stated:

It (rural-urban migration) has reduced because after the raining season, rain starts around May ending and by September it seized, during the time of dry season there will be no activities. Most of them leave here to go to cities or downtowns to look for other jobs. But with the provision of this irrigation infrastructures that has been developed for them, they now find it suitable to stay at home to cultivate the land and get money instead of searching for jobs in other parts of the country (P2: SRRBDA staff).

With the advent of the irrigation scheme, there has been a drastic reduction in rural-urban migration. Farmers who previously abandon farming activities owing to the non-availability of water during dry seasons and migrate to other areas in search of other opportunities are motivated to stay because of the irrigation infrastructure and the understanding that they can cultivate all year round. This evidently suggest that one of the objectives of the project, which is the reduction of rural-urban migration, is being realized through the scheme.

10.4 Chapter Summary

The chapter has considered intrinsically, the enablers, constraints and benefits of the project. Using qualitative data and analysis, it is evident that the project has achieved mixed results. While some objectives of the scheme is being realized, the scheme is being laid back by many challenges confronting irrigation staffs and particularly smallholders involved in the project. Although some of these challenges are inherently associated with the smallholders themselves, many have exogenous dimensions, either due to market imperatives or to the contradictions of both the project

as well as the associated policies and programmes of the government. The latter dimension thus necessitates deliberate positive interference in the affairs of the smallholders.

The next chapter discusses and integrates the findings of both the quantitative and qualitative aspects of the study, while it also brings closure to the thesis by providing relevant research and policy implications emanating from the study.



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CHAPTER ELEVEN

CONCLUSION: THE CONTRADICTIONS OF SMALL-SCALE IRRIGATION AGRICULTURE

11.1 Introduction

This chapter presents a summary of the empirical findings of the research and provides relevant implications of, and conclusions for the study. The chapter critically discusses the findings vis-à-vis its linkage with the theoretical notions of the study. In other words, the findings are summarized in relation to the theoretical frameworks as well as the philosophical notion that underpinned the research. Also, limitations of the thesis and future research directions were provided. Furthermore, the empirical, methodological and theoretical contributions of the thesis are expounded. The chapter also elucidates on appropriate research and policy implications of the research. Finally, the thesis is brought to closure with relevant concluding remarks which restates the main points of the research.

11.2 The Political Economy of Small-Scale Irrigation Agriculture in North West Nigeria

“We can very widely see the visible foot, in state policies that dismantle social welfare systems; deregulate land markets; remove import controls and food subsidies; impose agro-exporting regimes; and expose millions of agrarian petty producers in the South to competition with heavily subsidized food transnational corporations and highly capitalized agricultural producers in the North” (Araghi, 2009:112).

It is incontrovertible that capitalism and globalization have disrupted the global food and agricultural system, while its impacts on smallholder agriculture have been a mixed bag. Taking centre stage in the global discussion around agriculture therefore, has been the continued relevance and persistence of smallholder agriculture in the light of the increasing saturation of the global economy by capitalism. Indeed, the foregoing led Marx to predict the eventual disappearance of small-scale agricultural producers (Bjørkhaug, 2012). In a similar vein, argument is rife about the efficiency of small scale farms and their ability to contribute to economic growth and poverty reduction compared to large scale farms. Their location in rural areas, use of simple technology,

non-integration to markets among others, have been touted as factors inhibiting their expansion. In essence, the performance of small farms is constantly doubted.

Owing to the sheer number of smallholders in Nigeria, smallholder agricultural development has been prioritized, hence the need for their continual assessment. The irrigation scheme under study, one of the largest in the country and designed as a surface irrigation system, is intended to cater for over 10,000 farmers. Major crops grown include, inter alia, rice, wheat, millet, sorghum and melon. Land tenure under the irrigation scheme is customary in nature and land is transferred through inheritance. After and despite the development of the irrigation infrastructure by the government, irrigated plots were transferred back to the traditional owners who are farmers for agricultural purposes with due consideration of the size of their respective lands prior to the infrastructure development. As such, smallholders are land owners, an indication that rights to plot are socially and historically embedded.

Land preparation and cultivation are mostly done by farmers themselves using hand tools, albeit some hire tractors for cultivation purposes. Other major inputs include seeds, fertilizers and pesticides which are purchased in the markets, although some are supplied often on credit by retailers, government supported agents and NGOs. Farming in the irrigation scheme is commercial in nature and can also be categorised as family farming as agricultural labour and production is mainly organized around the family. However, most irrigation smallholders are men which contradicts quite a number of evidence in literature of the significant proportion of women involved in Nigeria's agriculture. Furthermore, there is evidence of some form of sustainable agricultural practices among smallholders as many engaged in mixed cropping, crop rotation and shifting cultivation. The nature of the project has also succeeded in reducing out-migration particularly during dry season as farmers are able to cultivate all year round.

In terms of markets, inputs are available locally in the markets, although some are procured from suppliers on credit either through personal or government arrangement. Savings or investment in other capitals also facilitate the availability of funds to finance inputs. Also critical in expanding smallholders' productive capabilities is the ability to sell outputs. While many smallholders transport their produce to local markets to be sold, agro-processors are often off-takers of

agricultural produce and are linked with smallholders either directly or through government supported initiatives such as Transforming Irrigation Management in Nigeria (TRIMING) and Anchor Borrowers' Programme (ABP). The foregoing mechanisms thus act as enablers of agricultural production for the smallholders. In a similar vein, it could be posited that savings by some smallholders and investment in other capitals are evidence of accumulation from below. This is indeed necessary for the promotion of rural entrepreneurship and rural development, as well as the elimination of the structural causes of food insecurity and poverty (Cousins, 2008).

Empirical analysis of efficiency of the irrigation smallholders indicate that there is substantial room for improvement as the mean efficiency was 86%, although this was higher than that computed from a meta-analysis of 156 frontier studies in Nigeria (71%) by (Ogundari, Amos and Okoruwa, 2012). The implication of the foregoing is that the performance of most farmers under the study in terms of their efficiency is not worse relative to many farmers in other parts of the country. However, disparities exist among farmers in terms of their efficiency levels. In terms of input, land, fertilizer, seeds and labour in descending order contributed the most to smallholder production. Furthermore, factors that influenced the technical inefficiency of farmers are diverse ranging from farmers' experience, education, credit access, generation of off-farm income and number of times plot is cultivated. In terms of human capital, experience rather than schooling is positively associated with efficiency, thus highlighting the importance of practical education and the possibilities for expanding the productive capabilities of smallholders through farmer training. Despite the importance of financial capital in improving efficiency, majority lacked access to credit while nearly half of the sampled smallholders did not generate off-farm income.

Class dynamics is manifested in the relations of production in the irrigation scheme. More specifically, the exploitation tendencies of capital (how capital exploit labour) is evident in the unequal relations between input providers, millers as well as other agro-processors on the one hand, and smallholders in the project on the other hand. Due to the lack of financial capabilities, smallholders often rely on input providers for the supply of input on credit for farmers. Although this provision enables cultivation to take place, the fact that it is a credit arrangement preclude the ability of smallholders to shape the terms of such arrangements. Millers or agro-processors are also reliant on the market for huge profit at the expense of farmers. Often, millers have prior

agreement with farmers about the sale of the latter's produce, with some defaulting in the agreements. The problem of lack of a ready market for the sale of produce is further compounded by storage and transportation problems which has rendered smallholders "price takers." Lack of storage facilities makes smallholders to sell output at going rates rather than keep till later times to take advantage of market fluctuations. In what Akram-Lodhi and Kay (2010a) refer to as the inevitability of capital to exploit labour, smallholders as price takers are thus at the mercy of purchasers most of whom are intermediaries or processors who seemingly capture a huge portion of the profit. Moreover, the distance to markets, deficient infrastructure as well as inadequate access to assets and information contribute significantly to increasing transaction costs for smallholders, which further inhibits the commercialization process (Makhura, 2001).

Literature alludes to the *subsumption* of petty commodity production, in which case there is a preference on the part of capitalists to invest in inputs and processing industries as well as rural financial systems owing partly to the seasonal and biological nature of agriculture (Buttel, 2001; Bernstein, 2010; Bjørkhaug, 2012; Makki, 2012). There is evidence of the commodification and *subsumption* of agricultural production as capital continues to penetrate and dictate agricultural production to the extent that smallholders are at the mercy of agro-industrial capitalists. Rather than invest in irrigation agriculture, agro-industrial capitalists prefer to settle in input and processing industries and value chains, as well as the financial system. This particular kind of relations of production facilitates exploitation and serves as the basis for accumulation as surplus value is extracted from smallholders.

Both specialization and differentiation are evident in smallholder irrigation agriculture. Indeed, market imperatives shape the action of class forces, evident in and/or leading to the forced sale of produce and specialization among smallholders. Smallholders did not rely on their own production for all their food needs as they patronize the market to meet some food needs, an indication of specialization in agricultural production. It must be stated however that it would be reductionist to associate this solely to the mechanisms of the market and capital, as climate and soil characteristics would definitely preclude the cultivation of some crops in the irrigation scheme.

Class differentiation and polarization within irrigation agriculture is seen in the differing and conflicting classes of agro-capitalists and smallholders. The inability to successfully compete in the market for many smallholders contributed to the increasing differentiation both among them, and also among capitalists. Smallholders are price takers, both of their produce and other food needs of their households which are not produced on their individual farms. Among the smallholders themselves, there is marked differentiation as the study identified five distinct classes of smallholder households based on their efficiency levels, income and food security status. Households are categorized into: (a) *households with high food security, income and efficiency levels* (10.5% of the total) (b) *households with average food security and income but high efficiency levels* (27.3%) (c) *households with average efficiency levels but food insecure and income poor* (32.9%) (d) *households with low efficiency levels, food insecure and income poor* (16.1%) and (e) *households with low efficiency levels, income poor but food secure* (13.1%). Following Bernstein's (2010) assertion that complexities exist in differentiation and that heterogeneities in class is influenced by other factors that are not homogeneously distributed such as social differentials, factors contributing to the differentiation among irrigation smallholders were years of experience, farmer training, farm size and diversification of livelihoods.

It is also important to explain the influence of capitalism on smallholder irrigation agriculture through the lens of Friedmann and McMichael's (1989) notion of the corporate food regime. The food regime provides a critique of the internationalization, corporatization and domination of the global food system by transnational and agro-industrial companies particularly in the areas of food technology, processing and distribution within a capitalist system, and the consequent subjugation of the peasantry. The global corporate food regime affects smallholders who have no choice than to participate in the market. For instance, despite the proposal to ban importation of rice by successive governments to encourage local production, importation is still ongoing while smuggling is still widespread. This no doubt affects the sale of output by farmers who lack adequate protection and have had to contend with lower prices of produce from outside the country's borders.

Furthermore, there is evidence of the overdependence on seeds from external sources by smallholders. Indeed, it is undeniable that the global politics of food is very much related to the

politics of seed. Yapa (1996:69), in his argument that development causes modern poverty through “socially constructed scarcity”, alludes to how technologically improved seeds have facilitated constructed scarcity. For him, there has been a manipulation of sources of supply in which case over time, some sources have been neglected, de-developed, and gradually disappear. In essence, farmers have surrendered control of the reproduction of seeds which is set to intensify into the future with advances in gene research on seeds (Yapa, 1996). This is also applicable, to some extent, to the growing reliance on inorganic fertilizers. For many irrigation smallholders therefore, the purchase of inputs represents significant cost most of which passes over to input providers and research institutes as profits. As Watts and Peet (1996) put it regarding seeds, “improved seeds ... are not simply technical and ecological, but are also social and cultural insofar as they bear the imprint of the hegemonic culture of capitalist modern science” (Watts and Peet, 1996:262).

It is also apposite to ask, what in essence has been the role and character of the state in small-scale irrigation agriculture? Although it set out to assist smallholders through programme and policy initiatives, the initiatives may be hurting them after all. The study brought to light how irrigation agriculture in the study area is being transformed by the state. Indeed, government policies and programmes have been double-edged particularly relating to their outcomes. There is evidence of policy flip-flops by the government which has led to the removal of agricultural extensionists from the scheme, and consequently reduction in the number of training programmes for smallholders.

Despite the good intention of the government, some of the government programmes, rather than significantly assist smallholders, have facilitated farmers’ exploitation. The Anchor Borrowers’ Programme (ABP), for instance, was put in place to enhance input and output access for smallholders, and consequently facilitate access to value chains. The programme made provision for diverse agents to be contracted or engaged by farmers either for land preparation, as input providers, or as off-takers of output. This has however favoured these agents while the powers of the smallholders are weakened as they lack direct control of how the funds are administered and were also not contacted during the policy formulation phase. Inadequate mobile communication technologies, long distance to input facilities and diversion of inputs were also some of the problems plaguing the programme. More critical is the fact that smallholders are obliged to deal with banks, input providers and output takers on terms they may not be able to shape or control.

Akin to what Marx observes in Russia where continuing linkage to the global market resulted in the unholy union of state, capitalists and merchants at the expense of the peasantry (Akram-Lodhi and Kay, 2010a), there is evidence of an interventionist state indirectly and, more particularly, inadvertently working in tandem with agro-processors and input providers, to exploit irrigation smallholders through the workings of capitalism.

As McMichael (2009) points out, the incongruities of the food regime is not limited to class relations but also include political relations that aids the global movement of food on a large scale, leading to the enrichment of some while others are left behind. Such political relations are reflected in Nigeria's government policies relating to agricultural imports, financing, input provision and output marketing. In all these, the relegation of public good for private benefit is self-evident in the action of the state. In terms of input provision, for instance, government has over the years reduced its support and has rendered smallholders susceptible to the vagaries of the market, along with its exclusionary tendencies. The origin of the deficient government support is traceable to the Structural Adjustment Programme (SAP) which was adopted by the Nigerian government in 1986. What SAP succeeded in doing was to dismantle agricultural commodity boards, liberalise agricultural trade with the popular notion that agriculture needs to be private-sector led and that government's role should be limited to the provision of enabling environment and policies for private-sector driven agricultural growth.

Where government has indicated support, such have been half-hearted, lacking drive, measurable targets and financial backing. The storage programme initiated by the government is a striking illustration of the foregoing and how this affects smallholders' sale of output. In expectation of increased levels of grain production nationally, the federal government put in place the Strategic Grain Storage Reserve Programme (SGRSP) in 1989. The objectives were to provide relief in the event of natural disasters, drought, etc; ensure price stability and food security; and provide a ready and accessible market for local produce acting as Buyers of Last Resort (Olajide and Oyelade, 2002:464). To achieve the objectives, 33 metal silo complexes were to be built each with a capacity of 25,000 MT. However, more than a decade later, twenty three silo complexes were still at various stages of completion and eight silos were completed with total available capacity of 186,000 MT although capacity utilization was 2% (Olajide and Oyelade, 2002). There have been some progress

thereafter as Olomola (2015) reports that the federal government decided to complete the remaining storage projects by 2008 in a bid to increase the strategic food reserve capacity from 300,000 MT to 600,000 MT. About 15 billion naira was earmarked for the projected increase, although the nation actually needs up to 2 million MT silos capacity. Despite the laudable plan, many of the silos have remained uncompleted due to funding constraints (Olomola, 2015). Besides underfunding of both the construction project and of the grain procurement itself, Olajide and Oyelade (2002) highlighted other challenges plaguing the programme to include inefficiencies in the grain procurement which do not allow producers to sell directly to the silos but have witnessed the concomitant proliferation of middlemen, smuggling of grains into the country, as well as bureaucratic bottlenecks. The foregoing issues further serve to limit the capacity of smallholders to be guaranteed a ready market for their produce.

11.3 Political Ecology of Natural Resource Use Among Irrigation Smallholders

Generally, one of the major importance of political ecology is its ability to provide the conceptual tools to analyse the nature of the interactions between humans and the environment. In relation to this study, political ecology provides a lens through which the analysis of social and environmental change as well as the factors and processes responsible for such changes is explored. In light of this, relevant questions were interrogated in the study area utilizing political ecology. These include inter alia: what factors and stakeholders are involved in environmental and social change in the study area? How does nature shape and is shaped by humans or societal structures and how do both determine natural resource access in the irrigation scheme? What are the social implications of environmental change in the study area?

Smallholders and irrigation officials as land managers, make excessive demands on resources due to production pressure and this has led to flooding, erosion and loss of soil fertility. The incidence of flooding around the irrigation scheme is illustrative of how nature affects and is affected by human actions. Although dams mostly contribute to the reduction of floods, they can often worsen the problem particularly when such dams do not take holistic account of all the possibilities for extreme flood events. This is where climate change is implicated as unanticipated increase in rainfall potentially increases the risk of flooding. The importance of flood control and the need for such to be systematic cannot therefore be understated. Although irrigation dams store water to be

used especially in times of drought, controlled and planned releases of reservoir water is important in order to prevent dam failure or too much pressure on the dam's weir or spillway in the event of too much inflow into the dam. In the absence of a well-articulated plan for these releases, they can also result in flooding and erosion of farmlands. Incidence of flooding also increases erosion downstream, potentially washing away shrubs, grasses and trees along river banks. Besides climate change, worsening the incidence of flood is environmental destruction as deforestation and the concomitant desertification could conceivably increase the run-off of water from land.

From the perceptions of stakeholders in the irrigation scheme, soil erosion albeit present has not had a profoundly significant effect on productivity. Otherwise, it would have generated much interest. For as Blaikie (1985) noted, soil erosion will not reduce in developing countries until it begins to eat into the accumulation potential of the dominant classes. Furthermore, although the problem of soil nutrient deficiency is palpable in Africa, there is a great deal of unevenness in terms of the magnitude across space. Scoones (2013) avers that soil nutrient scarcity and indeed surplus, rather than being fixed is complex, dynamic, plural and differentiated across space and scale, with distinct management implications. Mortimore and Harris (2005) also suggest that the dominant narrative of soil degradation in sub-Saharan Africa must be tempered with some caution. In their research, they found that compared to soil constraints or rainfall, policy had a major influence in determining yields per hectare or food output in West Africa. It must be stated however, that the important role of sustainable soil fertility management featured prominently in their recommendations.

Despite evidence of beneficial land management practices especially in form of intercropping and manuring in the irrigation scheme under study, soil erosion and degradation as a result of human activities are perceived environmental challenges. In response to the declining quality of the soil, farmers are increasingly intensifying the use of fertilizers in the scheme. However, the incessant application of inorganic fertilizers cannot be said to be a sustainable agricultural practice. Whilst fertilizers have helped smallholders to increase production, this do not necessarily improve the fertility of the soil or reverse soil degradation. Indeed, the vicious cycle of fertilizer application is currently underway in the irrigation scheme which, taking a cue from Clark and York (2008), would only lead to a vicious cycle of ecological problems. Here, capital is implicated once again

as it “subordinates nature in its pursuit of endless accumulation and production” (Clark and York, 2008:13-14).

Without contending the presence of exploitation in pre-capitalist times, Robbins (2012) argues that given declining economic margins under globalization and market imperatives, costs and risks are increasingly passed downward to individual producers whose prerogative would be to extract from the ecosystem to offset their losses. Soil quality depletion is also associated with growing pest problems stemming from intensification with consequent increase in pesticide application which cumulates into a chemical treadmill of inputs (Robbins, 2012). Following Marx’s thesis of the Metabolic Rift, Clark and York (2008) explain that capital has the inherent propensity to violate natural conditions that safeguards nature’s vitality thus generating rifts in, and undermining the natural cycles and processes that enables regeneration, which consequently leads to succession of shifts on the part of capital and continuous environmental degradation. The reality is fertilizers, like many other chemical inputs, can only sustain or increase agricultural production, but could not resolve the metabolic rift in the nutrient cycle (Clark and York, 2008).

In another vein, increasing competition over the use of natural resources in the irrigation scheme is manifesting into conflict between irrigation farmers and herders, thus hindering progress in agricultural production. Certainly, complexities exist in the negotiation and contestation over the use of natural resources by the farmers and herders. More critically, factors responsible for the conflict are multipronged, exhibiting historical, environmental, political and economic elements. These conflicts have resulted in loss of lives and limbs, material losses and also have the tendency to increase the incidence of poverty and food insecurity.

These conflicts are manifestations of the contestations around the construction of livelihoods and natural resource access among both parties. As Moritz (2010) notes, farmers are in constant competition with herders over the use of natural resources. The material contradictions of both productive systems have had an effect in shaping the societal histories, influencing for instance, the setting up of rules governing land use and the enclosure of lands either for agricultural or grazing purposes (Turner, 2004). Accordingly, herders who are historically pastoralists found the irrigation project as spaces of enclosures which have come to redefine how livelihoods are

constructed in the study area, denying them access to natural resources (land or pasture and water) and hence their means of livelihood construction. Farmers on the other hand, are beneficiaries of the irrigation scheme who view herders as a group that tampers with the irrigation infrastructure and crop, thus interfering negatively on their means of livelihood construction.

Relating to the nature of the conflicts, Turner (2004) asks whether the conflicts over natural resources are driven by resource scarcity or by resource availability. As currently manifesting in the irrigation scheme, conflicts between both parties are driven by a combination of both resource scarcity and resource availability. Invariably, land and water are available but are being used by irrigation smallholders for crop production. Pasture is however not available as land is being converted for irrigation purposes, although farmers' plants constitute new pastures for herders' flocks. Conflicts in the scheme are, drawing on Turner (2004), therefore largely driven by relational scarcities rather than absolute scarcities of resources, produced through human intervention (irrigation project).

Moritz (2010) distinguishes between structural and processual factors explaining conflict between farmers and herders in West Africa. Structural factors responsible for conflicts between both parties include inter alia, resource scarcity, decline in interdependence between agricultural and pastoral economies, institutional failure, historical and political context as well as differences in cultural orientation (Moritz, 2010:140). These factors were also identified by many scholars in literature (see for instance, Baca, 2015; Dimelu, Salifu and Igbokwe, 2016; Adeoye, 2017). Furthermore, increasing number of farms and herds, climate change as well as the concomitant desertification and deteriorating environmental conditions have escalated conflict incidence between both parties (Baca, 2015; Adeoye, 2017). Climate change, unfortunately, is being given little prominence in the discourse, but remains an underlying and significant reason behind the conflicts. Adeoye (2017), for instance, notes that over a third of cultivable land fifty years ago has turned into deserts in eleven of the Northernmost states in Nigeria. This has engendered competition over a diminishing natural resource pool, and the social implication of environmental change is reflected in the several incidences of conflict. Evidently, the desertification of the Sahelian region in Nigeria is a major threat to the livelihoods of both herders and farmers.

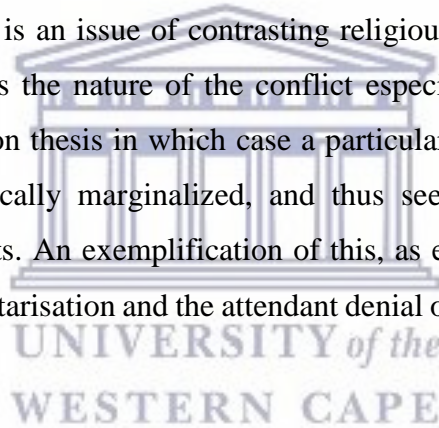
Moritz (2010) however points to the collapse of symbiotic relations between both parties as the underlying reason for the escalating conflicts. This is however not true of the case study as there is evidence of mutual and symbiotic relations between them. Farmers still procure compost cow manure to use on their farms, while herdsmen patronize farmers purchasing cattle feeds from them. Processual factors explaining the escalation or otherwise of conflicts are crowd formation (or increase in participation), direct confrontation, initial casualties and the role of intermediaries (Moritz, 2010). The implementing agency for the irrigation project serves as an intermediary and facilitator of dispute resolution between both parties, regularly communicating and organizing meetings to air complaints, and to resolve issues of difference between them. However, given the mission and objectives of the irrigation project, the extent to which their involvement as a mediator between both parties would be non-partisan remains questionable.

The foregoing is also very much related to what Baca (2015) sees as the tendency by the provincial and political elites in West Africa to favour sedentary populations over pastoralists. This indeed plays out in the policies and programmes of government that privileges crop production over livestock production. The irrigation scheme which is an initiative of the government is primarily geared towards improving crop production, which according to Dimelu, Salifu and Igbokwe (2016), constrains the use of the available natural resources for other competing uses. The irrigation infrastructure and land area have thus become spaces of enclosures for herders who are deprived of access to these natural resources. Each resulting encroachment into these spaces, therefore, may not be about the resources per se but may be as a result of the quest to access more spatially-fixed resources such as access paths to water or more productive floodplains (Turner, 2004; Adeoye, 2017). Robbins (2012) explaining the environmental conflict thesis, argues that resource enclosure or appropriation by states or social elites politicizes environmental problems as a specific group get hold of collective resources to the detriment of others and further produces increased scarcities which increasingly generates conflict between groups. Incontrovertibly, this calls to question the importance of considering the overarching implications on other groups, of the development initiative geared towards a specific group.

In another vein, it is important to reference other broader socio-economic and political reasons responsible for the persistent nature of the conflict between both parties. For instance, Turner

(2004) distinguishes between two types of conflict currently manifesting; the “unreflective, in-the-moment scrambles for available resources or ... the more strategic contests that reflect an intentional politics centered around maintaining access to resources into the future through invocations of moral claims, historical precedent, and community norm” (Turner, 2004:871). While the former may be as a result of poor herder management due to lack of labour manpower, the latter is reflected in the intentional damages inflicted by herders on farms. Evidence however points to the manifestation of both under the irrigation scheme as farms are entered into both intentionally and unintentionally by herders’ flocks.

The simple reduction of the struggles as competition over resources may merely be part of the whole picture as these struggles are often as a result of broader social tensions. Indeed, the incessant farmer-herder conflicts in Nigeria also have historical, political, ethnic and religious undertones. For instance, there is an issue of contrasting religious identities among both parties which particularly characterizes the nature of the conflict especially in North Central Nigeria. There is also the marginalization thesis in which case a particular group consider themselves as being politically and economically marginalized, and thus see conflicts as avenues for the contestation of power and rights. An exemplification of this, as earlier mentioned, has been the unwavering promotion of sedentarisation and the attendant denial of right to self-determination for pastoralists.



11.4 Smallholder Households and Food Security

Agriculture influences the food security status of smallholder households in a number of ways. Directly, the contribution of agriculture to food security is reflected in the food sources that are from farmers’ own production, while indirectly agriculture assists in the generation of income which can be used to purchase food. The irrigation project is contributing positively towards food security as smallholders indicated their households had never stayed without food the previous year, with their food needs being met either from own production or the market. This however does not imply that these households were food secure as the dietary pattern indicates a diet that was heavily skewed towards carbohydrates at the expense of other food categories.

The study indicates a high prevalence of food insecurity among smallholder households as nearly half of all the households were food insecure, corroborating evidence in literature that food security levels in rural areas where majority are involved in agriculture are relatively high. This problematises the agricultural sector as one beset with poor performance and inadequate productivity, which in turn leads to food availability and accessibility challenges for smallholder households. Although dependence on own food production assisted to a certain degree, issues of dietary diversity strongly came to light as smallholders did not consume a diversified range of food groups. Households with higher production efficiency had higher income and food security levels, although households that fall into this category were few. This is illustrative of how improvement in farmers' efficiency could lead to improved food security. Expectedly, household income was a major determinant of food security as households with higher income levels had lower risks of being food insecure owing to the fact that they have better resources to purchase healthy and nutritious foods.

More notably, it is paradoxical to observe that in an era of globalization and neoliberalism, small-scale food producers are persistently those highly at risk of food insecurity. The global food system is deeply immersed in capitalism, with its attendant unequal relations which privileges an elite few at the expense of a struggling masses. The corporate food regime has brought with it problems of inadequate access to the markets for both sale and purchase of food for smallholder households. Lack of adequate market access and storage problems force smallholders to sell produce cheaply, thus reducing income that may be used to augment other food needs that are not produced on their farms. This undoubtedly deepens challenges of food insecurity among smallholder households.

Income becomes increasingly significant in the light of the limited crop diversification as a result of specialization among smallholders. Specialisation and the concomitant lack of adequate diversification in crop production may have contributed to the food insecurity challenges faced by smallholders, particularly dietary diversity issues. As options from own production are limited, smallholder households would therefore need more income to purchase food in the market. As Wenhold *et al.* (2009) rightly assert, even though sustained increase in production may improve the household access to greater food supply, this does not necessarily translate into household food security if the increased yields is coming from a single crop production. The increasing dependence

on the market for food needs creates food accessibility challenges for smallholders as income to purchase available foods is limited. While it would be insufficient to hold specialization solely accountable for the limited crop diversification in the scheme as climate and soil characteristics constrains the cultivation of some crops, suffice to state that market imperatives have led to the glorification of the cultivation of some crops at the expense of others. Focus has been on grain products particularly rice at the expense of vegetables, legumes and other protein-rich foods. The result is low dietary diversity scores in many smallholder households.

Farm size was the most significant determinant of food security among the households as food insecurity increases with decrease in farm size, thus underlining its importance. Households with higher farm sizes are likely to cultivate more thus increasing production which in turn leads to increased income generation and food security. There is also the likelihood of increased crop diversification owing to larger farm sizes. Possibilities to expand farm size however depend on a variety of factors including but not limited to land availability and farmers' motivation. In light of the increasing competition for the use of land which is also finite, sustainable intensification of available agricultural lands may be the way to go. The essence of the clarion call for increased production among smallholders when they are not guaranteed a ready market for the sale of their produce is also incongruous. In other words, it is simplistic to advocate that for smallholder households to improve food security, farmers must intensify production to raise incomes as their motivation is invariably dented because of market constraint.

The importance of human capital in improving smallholder households' food security status was also highlighted. Education, farmer experience and farmer training are all parts of the human capital stock many smallholders possess and were significant determinants of household food security, as they all contributed positively to food security. More than a third of the smallholder households however had no formal education and have not received any training on the scheme. Lack of these assets therefore negatively affected their food security status. For smallholder households with any combination of the three (education, farmer experience and farmer training), it is expected that the characteristics would lead to better farm management practices thus improving yield. Further, such households are likely to earn more income and make better nutrition

decisions. The corollary of this is thus higher food security levels for households with the foregoing human capital stock.

It is however instructive to note the contradiction in the relationship of formal education with food security and technical efficiency (productivity), as formal education impacts positively on food security but negatively on technical efficiency in the study. While it is posited that education would lead to increase in human capital stock and income earnings as well as better nutrition decisions for the household, which altogether contributes to improved food security, the incongruity evident in the relationship of the foregoing phenomena is indicative formal educational knowledge is more relevant and put to use more in farmers' homes than on their farmlands. It also reiterates the fact that in smallholder agriculture, formal education is not necessarily as important as informal education acquired through farmer training and several years of learning by doing.

11.5 Livelihoods, Assets and Diversification in Smallholder Irrigation Agriculture

A main thrust of the study was also to examine smallholder livelihoods in the irrigation scheme. Using the sustainable livelihoods framework, assessment of livelihoods was done by examining the capital assets smallholders possess and those they lack, perception of their wellbeing, the influence of these assets on their wellbeing as well as livelihoods diversification among smallholder households. Relating to social capital, evidence points to the derivation of some benefits by being members of the Water Users Association (WUA). Many respondents noted that their group was influencing project decisions and that being members of WUA had been beneficial to them as they learn and make suggestions to one another. This group is also treated as a formal entity particularly by financial institutions, thus enhancing the ability of farmers to secure credit.

There is evidence of low income levels among smallholders which constraints their involvement in active savings, affecting close to two-thirds of the smallholders. This no doubt affected their ability to access financial capital as an overwhelming majority lacked access to credit facilities, thus constraining their production capabilities. Results also indicate a significant association between savings and credit access. Although there have been some government schemes to enhance credit access such as the ACGSF and ABP schemes, these schemes have not had the desired effect as many smallholders were yet to benefit. Moreover, conditionalities for some of these schemes are quite stringent for the smallholders which implicates the conceptualization and

execution process of these schemes. For instance, the seemingly indirect access to funds for smallholders and the requirement to liaise with banks and other intermediaries such as input providers and output takers weakens smallholders' negotiating powers and makes them relinquish control over terms of the ensuring agreement.

For majority of smallholders, participation in the project have led to an increase in physical capital assets. Farmers have been able to acquire new farming equipment and electronic appliances. About two-thirds had been able to build houses from their participation in the scheme. These assets no doubt can assist by serving as buffers during instances of stress and shocks. On the other hand, vehicle ownership was virtually non-existent while smallholders also lack access to storage facilities. While the former contributes to transportation challenges, the latter leads to post-harvest losses. These unwanted outcomes renders smallholders vulnerable to market vagaries, forcing their hands as they tend to sell produce cheaply.

Smallholder farms in the scheme could be regarded as family farms as these constitute the main source of labour for farm operations. An overwhelming majority do not employ outside labour on their farms. Smallholders had experienced improvement in their farming skills while many smallholders have benefitted from farmer training through programmes such as ADP and TRIMING. Nevertheless, many are still deficient in the knowledge and understanding of modern farming and irrigation techniques whilst complexities persist in smallholders' willingness to embrace change and incorporate new ideas.

In another vein, availability of natural capital assisted smallholder in their production pursuits. Although the size of the respective farms was less than a hectare, smallholders are owners of the lands as these were transferred to them through inheritance. This assures security of tenure and further enables smallholders to take responsibility for the management and fertility of their lands. Through the irrigation scheme, water is available throughout the year which facilitates the ability to engage in all year cultivation by the smallholders. Despite this provision however, not all smallholders engage in all year round cultivation, thus defeating a major purpose of the project. Notably, perception of majority of the smallholders was that there had been an improvement of their livelihoods and those of their households. The study also examined the determinants of

livelihood outcome among smallholder households. There is evidence that smallholders are leveraging on social capital assets through their affiliation with WUA. Surprisingly, the influence of financial capital on livelihood outcome was not significant. Nevertheless, the shortage of financial capital was pervasive among smallholders which undoubtedly influenced their productive capabilities.

The influence of physical capital on improving livelihood outcome was only significant in relation to the physical infrastructure around the community. This is due to the overwhelming evidence that physical infrastructure in terms of roads and telecommunication improved market access which, in turn, enhances smallholders' ability to purchase inputs or sell outputs. Relating to natural capital, farm sizes were less than a hectare which is in line with evidence in literature. Farm size is positively correlated with perception of improvement in the quality of life and chimes in with other studies that found evidence of decrease in poverty as farm size increases. The relatively smaller size of farms generally in the scheme incentivizes smallholders to explore diversification possibilities in the study area.

Human capital's importance to livelihoods improvement is evident in the significant contribution of household size and farmer training to livelihood outcomes. Training improves farmers' agricultural knowledge which consequently enhances their production capabilities. The end result is thus improvement in livelihoods of smallholder households. The number of household involved in the farms increases the probability of perceiving improved quality of life, a justification of the adoption of family labour as a farming style among smallholders. Further, while literature is replete with evidence that higher household size leads to increased poverty among households, this study takes another course by exploring the nature of the relationship between household members involved in cultivating the family farms and households' wellbeing which literature has sparsely treated. The positive relationship between the two variables highlights the potential of increased family labour supply to improve agricultural intensification and productivity, thus counteracting the greater consumption needs and anticipated poverty effect of such households.

Due to its poverty reduction potential on households, livelihoods diversification was also explored among the smallholder households. Livelihoods diversification strategies adopted by smallholder

households were non-farm activities such as petty or small business trading, handicraft and transportation; livestock ownership; and migration which led to remittance receipts. While the first two were significant livelihood strategies, the latter's importance was only minimal as reflected in the proportion of households with remittance receipts and its usefulness as a criterion variable in the canonical solution. This is reflective of the limited importance and role of migration as a diversification strategy among smallholders. The foregoing thus throws up the question of why smallholder households were reluctant to migrate.

Undeniably, one of the reasons for limited migration was the nature of the project which ensures the provision of water for all year round cultivation, even in dry season where most farmers in other similar climes do not cultivate. In another vein, there has been a persistent clamour in some quarters for smallholders to exit agriculture in the light of the constant debate about their performance. However, attendant questions of “exit to what?”, “exit to where?”, and “are there attractive options?” have been left underexplored. As previously noted in this study, the main thrust relates to prospects. If smallholders are not sure of the “opportunities” in the sector or the geographical space they would be exiting to, then motivation to exit would be lacking. Carolan (2012) for instance, points out that developing economies' non-farming sectors hardly grow fast enough to take in the surplus labour that would be leaving agriculture. It is rather simplistic to recommend exit out of agriculture and moving, for instance, to urban areas as though these spaces are devoid of poverty, unemployment and other social vices. Moreover, it is important to ask what will become of smallholders' agricultural land should they exit agriculture. Is it to be taken over by big-scale agriculturalist with capitalist tendencies? As Levien (2012) asserts in his study of farmers in India, in the absence of attractive options from agriculture, farmers would rather keep their land than hand it over to capital. Furthermore, the fact that smallholders, as with many other people, have some moral and emotional attachments to their land cannot be easily dispensed with.

11.6 Critical Realism and Smallholder Irrigation Agriculture: An Attempt at Retroduction

Critical realism seeks a more thorough understanding of phenomena, thus its emphasis on the search for in-depth explanations of causal mechanisms. The logic through which this is achieved is referred to as “retroduction”, which involves the movement from the level of lived experiences

and observations to the level of postulation about the underlying mechanisms and structure that are responsible for the phenomena involved (Mingers, 2003). Retrodution is thus the central mode of inference in critical realism and aims at identifying “the necessary contextual conditions for a particular condition to take effect and to result in the empirical trends observed” (Fletcher, 2017:189). Following Fletcher's (2017) approach to retrodution, the process of retrodution was utilized to understand the causal mechanisms at work relating to smallholder irrigation agriculture in the study area. In other words, retrodution was done in order to investigate the conditions that were responsible for some of the issues which emerged in this study. The emerging critical realism concepts were *italicized* to demonstrate the retrodution process.

As emphasized in the study, smallholders are “price takers” both at the input and output markets as input providers and output takers rely on the market to accrue profit at the expense of smallholders. *Commercialization and commodification of agricultural production* have led to differentiation and specialization in production, which in turn increases food insecurity as reflected in insufficient dietary diversity. Inadequate access to markets negatively affects smallholders’ income, reduces the ability to access financial capital and increase food insecurity. Further compounding the challenges is the overdependence on seeds and inorganic fertilizers among smallholders who have relinquished control over the production and reproduction of these inputs to intermediaries and transnational companies. In another vein, excessive demand on natural resources which led to flooding, erosion, soil fertility loss is driven by the *commercialization and commodification of agricultural production*.

Major policy changes on the part of the government was also a causal mechanism behind the productivity constraints experienced by farmers. Evidence indicates that many agricultural policies were driven by the desire on the part of government for agriculture to be private sector led and subject to market forces while government would concentrate on providing the enabling environment and policies for the sector. This was responsible for the withdrawal of extensionists and the consequent decrease in farmer training, reduction of subsidies and the dissolution of agricultural commodity boards. Further, the study points out that the present policies and programmes have not been altogether beneficial for smallholders as middle men and financial institutions were actually benefitting from such schemes at the expense of smallholders. Under

these circumstances, there is evidence of *ceded state control* to some external forces thus leading to major policy changes and flip-flops, which altogether is a condition that has constrained productivity and facilitated the exploitation of smallholders.

Considering the incidence of flooding and desertification around the study area, it is concluded that *climate change* is a key causal mechanism shaping the pressure on the environment. This phenomenon is also a major causal mechanism shaping the nature of the conflict between farmers and herders in the study area. Ideally however, it is imperative to point out that climate change shapes, and is shaped by, the nature of human intervention in the area.

Between farmers and agricultural intermediaries on the one hand, and farmers and herders on the other hand, there is evidence of *unequal power relations* in their dealings with the state. This is a condition which has led to smallholders ceding control over the terms of their dealings with agricultural intermediaries and banks under the government initiated programmes. Further, the condition has led to the irrigation scheme being enclosed spaces for herders and the state privileging crop production over livestock production. In another vein, although lack of access to natural resource and collapse of symbiotic relations fuels conflict between herders and farmers, *the material contradictions of the productive systems* for both parties is a necessary and underlying condition for the continuing conflict.

Given that in the process of retrodution, there is a constant movement between empirical and deeper levels of reality in a bid to comprehend the phenomenon being studied (Fletcher, 2017), the process proceeds to further identify the specific structural mechanism that may be common to, and may have necessitated all the causal mechanisms identified so far. Evidently, the basic structural condition which permits the existence and persistence of the identified mechanisms is *capitalism*. Although capitalism was not mentioned explicitly in the empirical work particularly the data collection, the capitalist system with its exploitative tendencies and the attendant veneration of neoliberalism pervades the food and agricultural system, and is the key condition necessary for the actualization of other identified causal mechanisms. The system is responsible for the commodification of agricultural production, motivated policy changes by the state, results

in climate change, fuels unequal power relations, and is implicated in the decline of symbiotic relations and increasing incidence of farmer-herder conflicts.

11.7 Rethinking Irrigation Agriculture towards Sustainability, Food and Livelihood

Security: Research and Policy Implications

The study has highlighted how the mechanism of capitalism affects smallholders and their households. The thesis however does not seek to disparage in absolute terms the capitalist system, for as much as it has its cons, there are some merits that are attributable to the prevailing relations of production. For instance, the notion that capitalism engenders competition which leads to productivity improvement and innovations is an enduring merit of the system. More so, there is no doubting that other alternatives are not without flaws. In essence, every system is inherently problematic. What the study has however unpacked is how capitalist system affects negatively irrigation smallholder agriculture. Without dwelling too much on alternatives to capitalism or rather leaving that broad arena to much broader studies of the workings of capitalism, it is imperative to ask that within the prevalent relations of social production, what strategies can be adopted to limit exploitation and ensure improved productivity, livelihoods and food security for smallholders.

Rogers (2014) argues that the way the state is conceived is fundamental to the way state's potential in facilitating change is appraised. Responsibilities of actors within the state, he notes, include making judgments and taking actions that promote the balance of preferences in society and preclude circumstances where individually rational interest that are pursued leads to collectively irrational outcomes (Rogers, 2014). In this context, the state serves as a mediator between diverse inputs and on this basis, a producer of policy outputs. These policy outputs are reflective of the respective weights to the views of diverse interest groups. There is however a tendency for states, either advertently or inadvertently to work in the broad interest of capital, which often connotes a shift away from the state working in the broad interest of all (Rogers, 2014).

For Rogers (2014) therefore, the state is an essential aspect of the extant relations – capitalist social relations, because even work is organized around the basis of capitalism which implies that the roles and responsibilities of the state is shaped and determined by the capitalist system for which

it is part. Despite the fact that the state is styled in the fashion of the prevailing social relations, it cannot be presumed that its characteristics are fixed and functionally determined as the relations that the state is comprised of are in a continuous state of crisis (Rogers, 2014). In other words, as capital is in a constant state of crisis, so also is the state which is a production of capitalist social relations in a constant state of crisis. As such, there are possibilities for considerable changes of the state's role within the prevailing capitalist social relations (Rogers, 2014).

The notion that free market is inherently free and fair has long been disputed and doubted. In many climes, unrestricted and fair competition projected by neoliberalism and capitalism is itself impracticable as some entities have clear advantages over others. In the food system, some of these advantages include monopoly and monopsony conditions as well as the offer of subsidies to some farmers in some climes (Carolan, 2012b). McIntyre *et al.* (2009) note that continuing the prevalent market-driven production system without any changes could worsen the incidence of poverty and food insecurity.

As a result of the foregoing, state interventions in form of strong institutions and regulations are needed in order to alleviate the flaws of the free market system. It indeed smacks of double standard for some developed countries to advocate for removal of subsidies in developing economies' food and agricultural system while their farmers remain heavily subsidised. Drawing on Isaiah Berlin's conceptualization of positive freedom in his support for government intervention, Carolan (2012) suggests that positive freedom involves the use of constraints to assure the prosperity of minnows and deliver interventions that would improve people's capabilities particularly in developing nations. Coming up with policies and programmes that are pro-smallholder is important given that they constitute a significant proportion of the population in developing countries, and here government must be deliberate in these interventions in the quest for change. As Carolan (2012) puts it, food security in developing countries would be achieved *because* of smallholders, as opposed to *in spite of* them (emphasis in the original) (Carolan, 2012:116).

On a national scale, it is critical to interrogate the kinds of policies that should be promoted, which would favour smallholders. Should priority be on national food sufficiency or national comparative

advantage in food production? While it is a given that self-sufficiency can only be promoted to the extent that production is enabled by climatic and edaphic factors, Otero, Pechlaner and Gürcan (2013) note that benefits accruing from comparative advantage can be upturned as soon as large multinational corporations (MNCs) gain competitive advantage at the expense or deprivation of small producers. While comparative advantage enables specialization in those sectors or unit in which players are most efficient, competitive advantage leads to monopoly over profits obtained through the monopoly over certain products (Otero, Pechlaner and Gürcan, 2013). Consequent to the foregoing, policies that must be prioritized should strive for a balance between ensuring self-sufficiency and accentuating comparative advantage. Further, as comparative advantage is not synonymous with competitive advantage, these policies must ensure the protection of smallholders such that they do not metamorphose into the veneration of competitive advantage and of capital, to the detriment of smallholders.

The above however does not oppose trade as it were, but suggests the promotion of policies that advance or work towards agri-food trade surplus. Here, Carolan's (2012) idea of *reflexive glocalism* could play a critical role in both research and policy formulation. In the understanding of and deliberation about food, reflexive glocalism does not glorify the global at the expense of the local, and versa. It espouses thinking about food both critically and reflexively. Reflexive glocalism entails thinking about food in such a way that acknowledges that consumers do not exist in a vacuum; that features of food quality are sociologically produced; that one scale or political practices is not necessarily better or favoured than others; that means are to emphasized as opposed to predefined ends; and that rejects a cure-all solution to all problems (Carolan, 2012:281-283).

While many have tended to explore possible implications in terms of changes in state and capitalist institutions, as well as policies, it is noteworthy that smallholders also have roles or responsibilities to actualize the desired changes. For smallholders, political representation must be a priority. In essence, continued or renewed politicization of smallholder farming is needed if productivity, livelihoods and food security are to be improved. Indeed the nature of rural politics would be of utmost importance to effect change, and thus improve livelihoods and food security. Rural politics has been categorized into three viz; official politics, everyday politics and advocacy politics (Borras Jr, 2009). As official politics involves the formulation, implementation and contestation

of policies where authorities in state and non-state organisations are the primary actors (Borras Jr, 2009), smallholders need to participate actively or intensify their participation in official politics and the electioneering process to influence policies. Everyday politics forms the basis of political systems and would relate to how smallholders organize their everyday lives, take or initiate actions on a daily basis, as well as how issues are framed or politicized among them. Oftentimes, everyday politics sets the motion for advocacy politics which often entails the involvement of civic societies and social movements.

Among irrigation smallholders, the possibility to metamorphose into a social movement can be explored in order to advance collective goods. The term movements, Cleaver (2017) posits, does not only calls to mind struggles for change, but also connotes the absence of any center or hierarchical organizational structure that could direct the prevalent, recurring protests and associated actions. This could be facilitated by the extant Water Users Association (WUA), which is present in almost every irrigation project in Nigeria. In other words, smallholders have to be interconnected and establish a pattern of *networks*, which could be not only of the local WUA, but regional or national and even transnational. As Cleaver (2017) notes, the deeper and wider the interconnectedness, the more successful these movements can be. Conversely, the greater the isolation, the higher the likelihood of failure. For irrigation smallholders in Nigeria, this could open up the possibility to join up existing transnational social struggles or movement who share similar interests, values, visions or ideologies.

Here, the Zapatista and Via Campesina movements and their modus operandi could offer possible approaches or tactics for irrigation smallholders. The Via Campesina movement is perhaps the most notable peasant organization in the world, boasting millions of members. Albeit not altogether opposed to trade, Via Campesina's proposal to ensure food security entails the programme of food sovereignty. The food sovereignty movement aims to ensure that states have the right to define their own food and agriculture, have democratic control over the food system, can determine the degree to which they want to be self-reliant, and also emphasizes the need to protect small-scale producers to ensure food security and guard against inequitable competition with agribusiness MNCs (Otero, Pechlaner and Gürcan, 2013).

The Zapatista movement in Chiapas, Mexico effected change in two manners. First was the redelineation of the boundaries of their transnational social movement, ousting overbearing donors and looking out for new associates in similar structural positions such as Via Campesina and other local peasant organisations in Chiapas. Secondly, they changed the governing principles within their networks, insisting on influence over current partnerships with privileged supporters, enforcing guidelines, disapproving external control of programmes and sanctioning outsiders who contravened their regulations (Andrews, 2010:90). The Zapatista movement was not only organized around local indigenous networks but extends to much wider networks outside of the region aided by computer communications via the internet which allowed for conscientization and for information to travel far and wide (Clever, 2017). For irrigation smallholders in Nigeria, telecommunications can be used as some farmers already have access to phones while internet can be adopted to reach farther audiences and transregional or transnational networks.

In a similar vein and still with regards to advocacy politics within irrigation smallholder agriculture, there is perhaps a role for civil society to play in advancing the interests of smallholders. Civil society may assist in conscientizing the minds of smallholders, and not to be subsumed by capitalist institutions. While some non-governmental organisations are the making of capitalism and would support capitalist relations, some such as those opposed to the disruption of the ecosystem can assist in exploring alternative ways of organizing relations of production.

The coming together of irrigation smallholders for collective action would also go a long way in improving their social capital which can be leveraged on for productivity improvement. Furthermore, although smallholders presently derive some benefits as a result of their affiliation with WUA, it is suggested that in order to alleviate the prevailing credit access issues, smallholders should come together to initiate a cooperative scheme to strengthen savings and facilitate credit access. With this kind of cooperative society, farmers can access loans or credit faster while risks are shared.

Although human capital contributes significantly to productivity, household food security and income status, there is room for improvement of this capital stock among smallholders. In the light of the importance of experience and practical education in the scheme, farmer training must be

intensified as it can relatively offset for lack of experience among some smallholders. The disjuncture in policy direction which has led to the non-availability of agricultural extension services in irrigation agriculture should be rectified. This would include the harmonization of some of the objectives of both the Federal Ministry of Agriculture and Rural Development (FMARD) and the Federal Ministry of Water Resources (FMWR), as well as the clear delegation of responsibility (who is responsible for what) in those ministries and other relevant government parastatals in order to adequately provide some needed assistance and inputs for irrigation smallholders.

These trainings must also not assume to know what the needs of smallholders are, in a bid to avoid situations where information are simply passed across to them. In other words, the tendency towards a top-down approach must be jettisoned and such trainings should be participatory, in which case smallholders have a say in the process, inputs and outcome of the training. While some may argue that smallholders' ability to make the most appropriate decisions is not assured, nevertheless their non-involvement in decision making gives the impression that what they know is not important, hence inconsequential. This may however ultimately lead to non-acceptance or rejection of both the ownership of the intervention and the intervention itself.

The way smallholders view their world, their challenges and solutions to such challenges may be at variance with those assumed on their behalf. More so, farmers' indigenous knowledge is important and is a significant contributory factor towards improving production. Also, participation ensures ownership of the decisions or outcomes of such trainings by smallholders. As such, approaches that are inclusive and participatory are imperative to understanding the multifarious challenges confronting smallholders, hence must be given precedence. Smallholders should also contribute in the processes of knowledge production relating food and agriculture, particularly those that embrace the sustainability of agri-food and ecological systems. In essence, policies and solutions must be derived from and with smallholders, and not for them.

Lack of effective storage facilities has presented many problems including post-harvest losses, or to put it in more general terms, food waste. The overarching implication of food waste is that in the midst of the clamour to double food production by 2050, it is highly likely that food waste will

more than double in 2050 (Carolan, 2012b). It is thus important to tackle constraints to market access and storage problems that is leading to post-harvest losses amongst irrigation smallholders. This requires, among others, getting to the root of the challenges confronting the Strategic Grain Reserve Programme (SGRP) of the government. Solutions to the issues would include adequate funding of the programme, removing inefficiencies in grain procurement and bureaucratic bottlenecks, as well as tackling smuggling which includes more tight control at checkpoints and the deployment of technology such as satellite imaging.

Smallholders can access niche market by collective action; that is coming together to approach off-takers. The total quantity of output required by off-takers would then be divided among the smallholders. In this way, individual smallholder within the group would know the quantity of output required of him. To prevent default by buyers that was revealed in the study, the terms of agreement can involve a “take-or-pay” contract which stipulates that the buyer must either take the stated minimum quantity of the output or pay the seller for the shortfall.

Presently, the institutional procurement program is the deficient Grain Reserve Programme which needs to be improved and linked with smallholders. It is also recommended that the government expand institutional procurement programmes to include school feeding schemes, food assistance schemes and link smallholders to such institutions to facilitate procurement from them. Government should also initiate policies that stipulates the patronization of smallholders in value chain agriculture. Here, agro-processors, manufacturing industries and retail or supermarket chains could be mandated that a percentage of the raw materials or retail items must be sourced from smallholders. In another vein, access to finance for smallholders must be improved. Although collective action of smallholders can contribute to facilitating this, microfinance and insurance schemes must be simplified for easier access by smallholders.

The study highlights the importance of farm size to productivity, food security and wellbeing. Seeing that it may not be feasible to increase farm size into the future, it is recommended that sustainable intensification which involves the improvement of yields from existing farmlands while minimizing the negative impacts on the environment be adopted among smallholders. It was also emphasized that improvement in efficiency of smallholders is associated with improved

income and food security. This underlines the need to improve smallholders' efficiency by enhancing those factors that significantly contribute to efficiency in the study. As income contributed positively to food security, improving food security among smallholder households would thus include ways of increasing household income through improving smallholders' efficiency, improving crop diversification and livelihood diversification.

Livelihoods diversification among smallholders should however focus on non-farm activities such as small business trading and transportation, as well as livestock production. The latter has been highlighted to have the potential to contribute to sustainable agricultural practices among smallholders. Migration of smallholder households (especially in dry seasons) is low, and not supported or recommended in this study as it negates the aim of the irrigation project. The thesis has argued that the contention for the exit of smallholders out of agriculture smacks of Marxian explanation of the way in which people are expelled from previous social relations (the primitive accumulation) to capitalist determined social relations where surplus would be extracted more via labour exploitation. More so, the issue of uncertainty of opportunities in other areas further renders migration unpopular among smallholders. Regarding migration to urban areas, for instance, as smallholders lack the capabilities to take advantage of opportunities (which may not even exist) in urban areas, migration from rural areas would only lead to migration of poverty and food insecurity to urban areas and the proliferation of urban slums.

The pursuit of increased productivity, food security and wellbeing for smallholders however needs to be achieved with due consideration for the preservation of the environment. Ensuring sustainable agriculture can thus rely on *agroecology* which offers a way to turn the tide against climate change, biodiversity loss and unsustainable use of natural resources. Seeing that it originated from the convergence of two disciplines; agronomy and ecology, agroecology seeks to combine ecological principles to agro-systems design and management (United Nations, 2010; Carolan, 2012b; Sjostrom, 2015). Conventional agriculture, as presently practiced, offers an unsustainable option to the challenges of global food security and poverty. Agroecology, on the other hand, takes into cognizance that environmental degradation in the production of food cannot continue into the future. The United Nations (2010) also notes that agroecology offers merits that can work in tandem with some conventional approaches and strongly promotes economic

development. Agroecology thus emphasizes the production of more food in manners that ensures environmental sustainability and social equity (United Nations, 2010; Dan-Azumi, 2011).

The main principles of agroecology are the recycling of nutrients and energy on the farm as opposed to the incessant application of external inputs; the integration of livestock and crop production; biodiversity or the diversification of species; as well as an emphasis on productivity and interactions within the agroecosystems. (United Nations, 2010:6; Dan-Azumi, 2011). Agroecological approaches also include integrated nutrient management, agroforestry and water harvesting in dry lands. It also acknowledges and emphasizes local indigenous knowledge, local food system experiences and alternative agriculture including food production (Carolan, 2012b). Agroecology contributes to food security in at least two dimensions; it improves yields thus increasing availability and reduces poverty thus increasing accessibility. Secondly, it improves food or nutrient diversity owing to its emphasis on a diversified farming system. Consequent to the foregoing features and importance of agroecology, agroecological principles must be emphasized and intensified in Nigerian agriculture.

Attempts to achieve the above mentioned must be government and/or public policy driven and it is recommended that a reference be made to agroecology in national policy documents on agriculture. Furthermore, there must be that will on the part of government to mobilise non-governmental organisations and civic society, farmers as well as government ministries and parastatals associated with agriculture to contribute to the promotion and implementation of agroecological principles and techniques in irrigation agriculture. In another vein, systematic flood control measures which includes controlled and planned release of reservoir water need to be put in place by the authorities in charge of irrigation schemes in order to prevent flooding and the attendant destruction of soils and farmlands.

In response to the continuing conflict between herders and farmers in Nigeria, it is important that policies formulated relating to land use should not privilege one occupation or way of life over another and must acknowledge the right to self-determination of both parties. The study also brought to light and thus recommends that in the development of any intervention for a particular

group, the effects of such interventions on other groups must be appraised and resolved. Provision of access to resources such as pasture and water to herders must also be prioritized by government.

As a solution to the present conflict, the Federal Government's recent proposal of cattle colonies which would require the acquisition of huge expanse of land in each state has provoked public outcry about the feasibility and implications of the plan. There is also difference of opinion as to the solution to the present impasse between the Federal Government and many State Governments. Suffice to state at this juncture, that by virtue of the Land Use Decree of 1978, all urban lands within any state are vested on the Governor of the State who administers for the common good of the state, while all rural lands are vested on the Local Government Chairman (the third tier of government). The upshot of this is that the Federal Government requires approval from any state before they can use any land within the state. Hence, the "buy-in" from the state governments is required for the plan to be actualized.

Cattle colonies, as proposed, are bigger in scale than ranches (sometimes 30 or 40 times bigger) and would host hundreds of herders at a time. There, cattle owners can co-exist, and have or share access to water resources and fodder. More critically however, the implication of the development on other particular groups and their economy have not been well thought through and has elicited the negative responses against the plan. The plan would definitely lead to displacement of people from their original land and disruption of their social and economic lives. There have been logical arguments that annexing scarce arable land to be used for cattle colonies would adversely affect agricultural production in rural communities. Further, in the likely event of the establishment of these colonies, questions relating to the ownership of land and the national resource stock therein, that is whether it belongs to the government, the traditional communities or the herdsmen that would occupy the colonies needs to be critically considered.

On the other hand, many have rather called for the implementation of a ranching system as opposed to cattle colonies. This would involve the individual acquisition of land for ranching purposes. Such individuals can be supported by the government through the provision of credit facilities and they would also have to negotiate the terms of agreement with the original owners of the land. Nevertheless, whether the choice is cattle colonies or ranching system, these rather tends towards

the “sedentarisation” of herders’ way of life. Indeed, many herders know no other life than being pastoralists – people that are always on the move. In other words, they are nomads, and not “sedentarists”. Given that this group do have a right to self-determination, any attempt to alter their way of life should rather be optional, and not by compulsion.

This would lead to the conclusion that plurality of choices could be the way to go to resolve the herder-farmer issue. While ranching system is favoured in this thesis as opposed to cattle colonies, grazing routes should also be implemented, made obvious, and enforced for herders opposed to the ranching system and its sedentary features. Furthermore, a national survey of herders and their characteristics is important as cattle population and herder population which is presently unknown should be the basis of planning for Nigerian herders. Also, conflict resolution at the local level and intensification of symbiotic relations between farmers and herders should be encouraged.

11.8 Future Research Directions

The research has attempted to unpack the dynamics of agricultural production, food and livelihoods security among irrigation smallholders in North West Nigeria. It has identified enablers and constraints of smallholder productivity as well as factors affecting their livelihood and food security status. Apart from the need to extend such research to other regions and projects, the research has also thrown up further research questions that are worth unravelling. In line with the findings of the research, it would be apposite to seek answers to the following questions in the future: how have changes evident in the rural production process over the years affected poverty (reduction) among smallholders in Nigeria? What are the potentials of collective action and advocacy politics in enhancing smallholder agriculture in Nigeria? What policy options can mediate positively between human-environment relations in smallholder agriculture in Nigeria? What are the structure and dynamics of the Nigerian food and agricultural market and what policy options can contribute to enhancing market access for smallholders in Nigeria? What are the perceptions of herders in the continuing farmer-herder conflict and what alternatives for resource access are both suitable and acceptable to them?

11.9 Contributions of the Thesis

Specifically, the contributions of this thesis can be categorized into three; empirical, methodological and theoretical. Empirically, the thesis contributes to existing body of knowledge in agrarian and livelihoods studies by linking smallholder productivity to livelihoods and food security of smallholder households. Quite a number of studies have focused on any of the three phenomena, but not the entire three the study examined. Hence the study bridges this gap in research. Further, no study, to the best of the researcher's knowledge, has attempted a differentiation of smallholders based on their efficiency, income and food security status and attempted a regression of these against some other socio-economic characteristics of households.

Methodologically, the thesis utilizes mixed methods to unravel the research questions. The combination of both the quantitative and qualitative research methods helps to offset the weakness found in either of them, hence its increasing popularity. The integration provided by the approach helped to provide a better understanding of the research questions. It effectively allows for linkages or connections of resonating findings to be made. The qualitative aspect helps to provide detailed explanations for some of the findings observed in the quantitative section. Furthermore, the use of canonical correlation for assessing the relationship between livelihood strategies and livelihood capitals, as well as the application of cluster analysis for identifying categories of smallholders based on their productivity, income and food security status are major methodological, or analytical contributions of the study.

Theoretically, the thesis engages with a number of scholarly ideas to unpack the dynamics of production, poverty and food security in irrigation agriculture in North West Nigeria. While the political economy of food and agriculture was adopted to examine the macro-processes influencing food security and agricultural production among smallholders, political ecology was used to understand the nature and dynamics of human-environment relations, as well as other power structures contesting the use of natural resources in the irrigation area. The livelihoods approach was adopted to assess changes in smallholders' capital stock and their implication on poverty and food security status of smallholder households. Furthermore, the stochastic frontier production function was used to assess the efficiency in production of irrigation smallholders.

The plurality of theoretical and conceptual notions adapted in the study introduced a level of rigour to the analysis and robustness to findings emanating from the study. The study has established how these theoretical notions can be combined to understand both the micro and macro processes or factors influencing the sustainability of irrigation smallholder agriculture and the prosperity of smallholders. The thesis clarifies the nature of the relationship between efficiency, income and food security of smallholder households. It examines how livelihood capitals are significant to smallholders' productivity and food security of their households. The thesis also illustrates how nature or the environment affects, and is affected by, human intervention (in this case the irrigation project), a major concept in political ecology. From a critical realist perspective, the application of *retroduction* to understand the causal mechanisms necessitating some conditions evident in smallholder irrigation agriculture was also a significant contribution of the thesis.

11.10 Concluding Remarks

Undeniably, smallholder agriculture has gone full cycle, from the prediction of their eventual disappearance to the acceptance of their enduring characteristics as well as the fact that reduction in poverty and food insecurity cannot be achieved without due regard for small-scale agricultural production. Nevertheless, it is paradoxical to observe the continued persistence of poverty and food insecurity among smallholders who are food producers, despite their present and potential production capabilities. The study has pointed out some of the enablers and challenges of irrigation smallholder agriculture, and how these affects poverty and food security among smallholder households. It also identified the prevailing capitalist system (a system upon which smallholders' livelihood is based) as the basis or the necessary condition for the manifestation of these challenges. While the study does not argue for an alternative to capitalism as every system is inherently problematic, it suggested ways in which smallholders' capabilities and livelihoods could be strengthened even within the extant relations of production.

Evidence from the study indicates that not all smallholders involved in the irrigation scheme are efficient in production, although their efficiency performance is not worse relative to most studies carried out in Nigeria. Smallholders' efficiency in production, income and food security status were however positively associated. Hence improvement in smallholders' productivity has the potential to improve food security and reduce poverty among their households. Also, smallholder

households' deficiency in livelihood capitals negatively affects their productivity, income and food security status. The study further confirms that smallholders are really not a homogenous group as there was some degree of heterogeneity in terms of their efficiency, income and food security status as well as some other socio-economic characteristics.

The dialectical relationship between human and nature within the irrigation scheme has been more or less parasitic, with humans exploiting nature in manners that are unsustainable. This portends serious implications, both for man and the ecosystem upon which humans thrive. The thesis highlights and acknowledges that a thorough understanding of the mechanism through which nature affects, and is affected, by human intervention is a prerequisite for effective policies. Policies to protect the ecosystem must therefore be driven by rigour, research and a grasp of the dynamics of environmental resources use.

To enhance smallholder productivity and achieve poverty reduction and food security among smallholder households, the thesis, among others, argues for renewed politicization or repoliticization of smallholder agriculture particularly engagement in advocacy politics. As markets are not altogether free or fair, deliberate and purposeful intervention in smallholder agriculture by the state is of utmost importance. The state must be proactive in providing enabling environment, policies and programmes needed for the prosperity of smallholders. The integration of sustainable practices in modern agriculture and agroecology, with an acknowledgement that smallholders' traditional knowledge is important must also be given due priority.

Finally, the thesis argues against a "one-size-fits-all" solution and advocates for plurality of approaches to resolving the multi-faceted challenges confronting irrigation smallholders. Therefore, approaches that advance equitable, productive and sustainable systems and solutions to the panoply of problems confronting smallholder agriculture are recommended. The foregoing must be given precedence to ensure smallholder prosperity and to preserve our agriculture, our ecosystem, and indeed our future.

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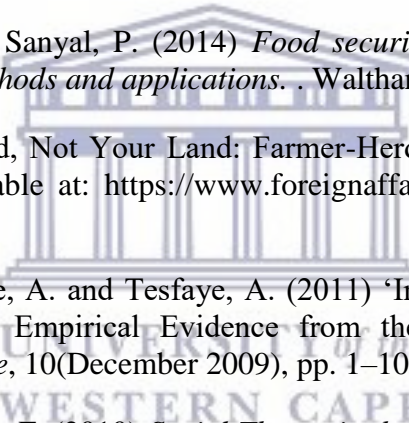
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APPENDICES

Appendix 1: Example of Survey Questionnaire



Private Bag X17, Bellville 7535, Cape Town, South Africa

Telephone : (021) 959 3858/6 Fax: (021) 959 3865

E-mail: pkippie@uwc.ac.za or mdinbabo@uwc.ac.za

Sustainable Irrigation Agriculture for Food Security and Poverty Reduction Among Smallholder Farmers in Northern Nigeria

Smallholder Farmer Questionnaire

Dear Respondent,

This questionnaire is designed to collect information on the above research topic. All information supplied will be used for academic purposes only. I shall be grateful if the questions are answered truthfully and carefully. You are well assured of the required confidentiality.

Thank you.

INSTRUCTION: Please tick or fill in the gap as appropriate.

Project Location:

SECTION A: Socio-Economic Characteristics of Respondent

1. Gender (1) Male [] (2) Female []
2. Marital Status: (1) Single [] (2) Married [] (3) Divorced [] (4) Widowed []
3. Age: (1) 25 years and below [] (2) 26-35yrs [] (3) 36 -45yrs [] (4) 46-55yrs []
(5) 56-65yrs [] (6) Above 65yrs []
4. Are you the head of the household? (1) Yes [] (2) No []
5. Educational Status: (1) No formal education [] (2) Primary School [] (3)
Secondary School [] (4) Tertiary [] (5) Others (please specify)
6. Average monthly income of Household Head
7. Occupation of the household head: (1) Cultivates own land or family land [] (2) Herding
[] (3) Student [] (4) Others [] Pls Specify.....
8. Household/Family size: (1) 0-2persons [] (2) 3-4persons [] (3) 5-6 persons []

(4) 7-8persons [] (5) 8-12persons [] (6) 11-12 persons [] (7) Above 12 persons []

9. Age distribution of household members (Please write how many members fall in each group)

(1) Children less than year (2) Aged between 10 and 20

(3) Aged between 21 and 30 (4) Aged between 31 and 65

(5) More than 65 years

10. Did your household participate in any nonfarm activity last year? (1) Yes [] (2) No []

11. If yes, please specify,

Activity	Income received in Naira
Working on other's land	
Handicraft	
Small business	
Petty trade	
Other, Pls specify.....	

12. What irrigation project are you participating in?

13. What year did you become involved in the Irrigation Project?

Section B: Farm Size

14. Total Area owned (in hectares).....

15. Total cultivable land (in hectares).....

16. Total land cultivated in 2015 cropping season (in hectares).....

17. Average distance from the homestead (in km).....

18. Do you have any rented land for the 2015 cropping season? (1) Yes [] (2) No []

19. If yes, what is the size of the rented land (in hectares).....

20. Amount of money paid for the rented land (in naira).....

21. Have you rented out land for the 2015 cropping season? (1) Yes [] (2) No []

22. If yes, what is the size of the rented out land (in hectares).....

23. How many times did you cultivate your land last year? (1) Once [] (2) Twice []

(3) Three times [] (2) More than three times []

24. Is water from irrigation available all year round? (1) Yes [] (2) No []

25. If No, why?

.....

26. What is the total amount of money you paid for irrigation water in 2015 (in naira)?.....

27. What is the average distance from irrigation site to the farm plot (in km)?.....

Section C: Input Acquired

28. Have you used the following farm inputs during 2015 cropping season?

Type	Quantity in Kg	Mode of Acquisition 1 = Purchased 2 = Donated 3 = Borrowed	Total value in Naira		
			Purchased	Donated	Borrowed
Seeds					
Organic Fertilizer					
Chemical Fertilizer					
Pesticides					
Other					

29. Have you used the following farm equipments and tools during the 2015 cropping season?

Type	Quantity	Mode of Acquisition	Total value in Naira
Hoes			
Axes			
Animal Power (Oxen)			
Ploughs			
Tractor			

30. Labour used in production for 2015 cropping season

Activity	Family Labour in man days (Number of people x Number of days)	Hired Labour in man days (Number of people x Number of days)
Clearing		
Land preparation		
Planting		
Weeding		
Harvest		
Other activity		

31. Total amount of money paid for hired labour (in Naira).....

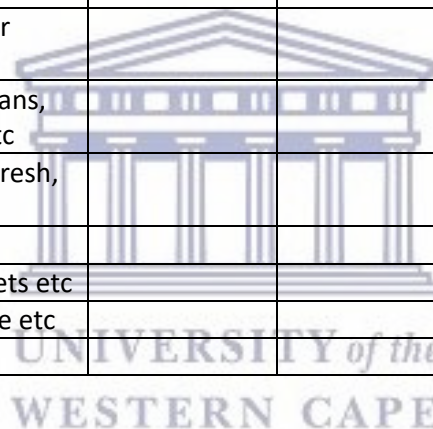
32. Have you used animal power (oxen) in the production of crops in 2015?(1) Yes [](2)No []

33. If yes, how much (in oxen days)?.....

Section D: Income and Agricultural Productivity

34. Crop production for 2015 cropping season

S/N	Crop Type	Total Area cultivated in hectares	Value of Output in Naira	Output used for home consumption in Naira	Output sold in the market in Naira
1	Cereals – rice, sorghum, pasta, bread, wheat, biscuit etc				
2	Roots and tubers – yam, cassava, potato, sweet potato etc				
3	Vegetables – spinach, cabbage, tomato, onion etc				
4	Fruits – orange, mango, banana, water melon, lemon, avocado etc				
5	Meat, poultry, offal – goat, camel, sheep, cow, chicken, liver, kidney, heart etc				
6	Eggs				
7	Fish and seafood – dried or fresh				
8	Pulses/legumes/nuts – beans, nuts, peas, seeds, lentils etc				
9	Milk and milk products – fresh, powdered, yoghurts etc				
10	Oil/fats – oil, fat, butter				
11	Sugar – sugar, honey, sweets etc				
12	Miscellaneous – tea, coffee etc				



35. Have you been farming before you joined the irrigation project? (1) Yes [] (2) No []

36. If yes, what was your monthly income then?

37. What is your monthly income now?

38. How much income did the household generate from the following sources for the 2015 cropping season?

S/N	Source	How much income did the household receive (in Naira)
1	Crop production	
2	Sale of animals	
3	Milk, butter and cheese, egg production	
4	Remittance/transfer received	
5	Wage payments to all family members	
6	From Non-farm activities	
7	Others, pls specify.....	

39. Number of Livestock owned

S/N	Type of Livestock	Number of Livestock owned	Value of Livestock in Naira
1	Cattle		
2	Goat/Sheep		
3	Oxen		
4	Poultry		
5	Other		

Food Security

40. Please indicate the type of food, amount household spent on the food, as well as the source of food over the last 7 days

	What foods have been eaten in the household in the last 7 days	Please answer as appropriate (Yes or No)	Amount Spent (Naira)	Days eaten over the past week	Main Food Source (see next column for food source codes)	Food Source Codes
A	Cereals – rice, sorghum, pasta, bread, wheat, biscuit etc					1 = own production (crops, animals) 2 = hunting, fishing 3 = gathering 4 = borrowed 5 = purchase 6 = exchange labour for food 7 = exchange items for food 8 = gift (food) from family relatives and friends 9 = food aid
B	Roots and tubers – yam, cassava, potato, sweet potato etc					
C	Vegetables – spinach, cabbage, tomato, onion etc					
D	Fruits – orange, mango, banana, water melon, lemon, avocado etc					
E	Meat, poultry, offal – goat, camel, sheep, cow, chicken, liver, kidney, heart etc					
F	Eggs					
G	Fish and seafood – dried or fresh					
H	Pulses/legumes/nuts – beans, nuts, peas, seeds, lentils etc					
I	Milk and milk products – fresh, powdered, yoghurts etc					
J	Oil/fats – oil, fat, butter					

K	Sugar – sugar, honey, sweets etc					10 = others, specify.....
L	Miscellaneous – tea, coffee etc					

41. Was the income you generated in 2015 from your irrigated farm enough to cater for your household food needs? (1) Yes [] (2) No []

42. Over the past year, how often, if ever have you or anyone in your household gone without enough food to eat? (1) Never [] (2) Just once or twice [] (3) Several times [] (4) Many times [] (5) Always [] (6) Don't know []

Livelihood Capitals

43. How many people are you employing in your farm? (1) 1 [] (2) 2 [] (3) 3 [] (4) 4 [] (5) 5 [] (6) 6 [] (7) 7 and above []

Do you have access to sufficient clean water? (1) Yes [] (2) No []

44. How many of the household members were sick over the past year? (1) None [] (2) 1 [] (3) 2 [] (4) 3 [] (5) 4 [] (6) 5 [] (7) 6 [] (8) 7 and above []

45. How many people are you employing in your farm? (1) 1 [] (2) 2 [] (3) 3 [] (4) 4 [] (5) 5 [] (6) 6 [] (7) 7 and above []

46. Have you been able to do the following as a result of this project;

	Yes (1)	No (2)
Build a house		
Purchase a bicycle, motorcycle or cart		
Purchase a vehicle		
Purchase electronic appliances/gadgets for household use		
Purchase new farming equipments		
Increase livestock ownership		

47. Are you involved in active savings? (1) Yes [] (2) No []

48. If yes, how often do you save? (1) Daily (2) Weekly (3) Monthly

49. Do you have access to credit facilities? (1) Yes [] (2) No []

50. Is there anyone or entity that you are presently owing money? (1) Yes [] (2) No []

Do you belong to any farmer group or association relevant to this project? (1) Yes [] (2) No []

51. If yes, how many farmer group or association do you belong to? (1) 1 [] (2) 2 [] (3) 3 [] (4) 4 and above []

52. Please state names of the farmer groups or association relevant to this project that you belong to

.....
.....
.....
.....

53. Do you think the group or association you belong to is influencing decisions taken on the project? (1) Yes [] (2) No []

54. If yes, has the group been beneficial to you? (1) Yes [] (2) No []

55. Have you received any training through the irrigation scheme? (1) Yes [] (2) No []

56. If yes, please specify the topics covered.

.....
.....

57. Would you say you have acquired more skills and better farming technique by being a beneficiary of the irrigation project? (1) Yes [] (2) No []

58. If yes, please specify the types of skill.

.....
.....

59. Has the project been able to attract infrastructure like roads and telecommunications to the project area? (1) Yes [] (2) No []

60. If yes, do you think this has enhanced access to market for farmers in order to sell produce? (1) Yes [] (2) No []

61. What land management practices did you engage in on your farm land (You may tick more than one)? (1) Manure or compost [] (2) Burning [] (3) Contour ploughing [] (4) Reduced tillage [] (5) Intercropping []

Thank you for your participation and cooperation.

Appendix 2: Interview Questions



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Telephone : (021) 959 3858/6 Fax: (021) 959 3865

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Interview Questions

Sustainable Irrigation Agriculture for Food Security and Poverty Reduction Among Smallholder Farmers in Northern Nigeria

Guiding Questions for Sustainable Irrigation Agriculture for Food Security and Poverty Reduction Among Smallholder Farmers in Northern Nigeria

(For Implementing Agency)

1. What are the goals and objectives the project intends to achieve?
2. What are the strategies the project team uses in achieving its goals?
3. Can you briefly explain the organisational structure of the project (team)?
4. What is your role in the project and how does your role relate to other roles in the project team?
5. What mechanisms do you have in place for beneficiaries to be participative in the project?
6. How are the project goals and objectives being achieved?
7. How has the project met the needs of the beneficiaries?
8. What had been the benefit of the project to beneficiaries?
9. To increase agricultural production, what farming practices do the farmers engage in? Is it that they put more land into use or they rely on farm inputs such as fertilizers, or both?
10. How do you think the project is contributing to the improvement of lives of beneficiaries?
11. How do you think the project is contributing to food security in Northern Nigeria?
12. What are the effects of the farming and irrigation practices on the environment and on human health?

(For Smallholder Farmers)

Agricultural Productivity

1. Who owns the land you farm on and how did you acquire/lease it? Who has access to the land?
2. What are the major agricultural activities you are involved in?
3. Is water always available from the irrigation site to your farm? If not, why?

4. Have people received support from the government or any agencies with regards to the irrigation project?
5. What is the gender of the majority of the farmers on this irrigation project, and why is this so?
6. What is harvest like in a normal year? What was harvest like in the last cropping year? Are there differences? If so, why are there differences between the harvest in the normal year and the last cropping year?
7. Has there been increase or decrease in the number of livestock you own? What was responsible for this?
8. What are the main sources of income on average in a normal year for your household? Does this change over the year? How and what is responsible for this?
9. What are the main costs/expenditure for the people in a normal year for your household? Does this change over the year? How and what is responsible for this?
10. Are there any problems with suitable land for agriculture?
11. Could you tell us about the fertility of your land? Do you think your land is fertile, and why?
12. Have there been changes in agricultural productivity and why?
13. To increase agricultural production, what farming practices do the farmers engage in? Is it that they put more land into use or they rely on farm inputs such as fertilizers, or both?
14. Do you have any problem with soil erosion or flooding and why? Have there been major changes recently, including drought, flooding, etc?
15. What do you see as alternative in improving your farming practice?
16. What do you see as an alternative to farming?
17. Are there any problems in marketing your agricultural produce and why?
18. Are these problems affecting your motivation to farm the more?
19. Are you able to sell all of the agricultural products that are not used for household consumption?
20. Do you sell directly to marketing boards, middlemen or at the market?
21. Are farmers/households migrating to or away from the irrigation project area and why?

Sustainability

1. What type of tools do you use? To what extent do you use them?
2. What tools are traditional and what tools have been introduced through the irrigation project?
3. How would you compare the traditional tools with the one introduced through the irrigation project
4. How costly are these tools and how do you afford them?
5. Do you use chemical fertilizers? If yes, how often and what type? If no, why and how do you ensure productivity?

6. Do you use pesticides? If yes, how often and what type? If no, why and how do you treat diseases and infections on farmlands?
7. What type of seeds do you use? Do you use hybrid seeds? If yes, how does it compare with traditional seeds?
8. What managerial skills/techniques/practices do you utilize in water conservation?
9. What managerial skills/techniques do you utilize in soil conservation?

Livelihood Capitals and Institutions

1. Do you belong to any farmer group or other associations relevant to the irrigation project?
2. Is this group influencing project decisions and how you farm, how and why?
3. How are farmer groups and the local community involved in coordinated resource management?
Please explain and give examples
4. How easy is it to save from your farm proceeds?
5. Do you have enough money to meet the needs of your household?
6. Do you have access to loans, credit to be able to increase your farm productivity/yields? How much monetary assistance is given to you and other farmers?
7. What water or land management technique did you practice on your farm?
8. What physical assets do you have? Did you acquire most of these assets before or after you joined the irrigation project?
9. What is the role of your household members in your farm? Are they engaged in any farming activity?
10. Tell us about any training you have attended on irrigation agriculture?
11. Are you satisfied with the present livelihoods of your household, and why?
12. Are you satisfied with the present livelihoods of the farmers on the irrigation site, and why?
13. How open are organizations/government to input from you and your farming community?
14. Do you participate in agricultural extension activities? If yes, how often? Please describe what you do
15. What other development activities and services have you participated in? (planning and implementation)
16. What do you think of agriculture and irrigation officials?

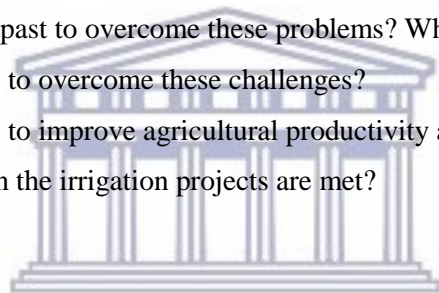
Food Security

1. How does your household obtain their food? Does this change over the year? How and what is responsible for this?
2. What is the average family diet in a normal year? Who is responsible for meeting the food needs? What is the number of meals? Who prepares these and how?

3. Where does the food come from (production, market, exchange, donation, solidarity)?
4. Who eats what? Are there differences in diet between children, women and men? What are they?
5. Are there seasonal shortages of food in the household in a normal year? What do people do to meet their food needs then? Do you normally collect wild foods, what kind?
6. Has there been any change recently in the people's diets, since when and how? Why?
7. What do people do to avoid food shortage in the family?
8. How is the access to market? What are the main market days? Have there been any changes in people selling or buying? Why? Ask the same questions about livestock,

Perception of main problems (for both Implementing Agency and Farmers)

1. At the moment, what do you think are the main problems smallholder farmers are facing with regards to the irrigation project? Can you describe them?
2. Has this always been the case? If not, when and how has this changed and why?
3. Will these problems become worse, why?
4. What did people do in the past to overcome these problems? What are they doing now?
5. What are your suggestions to overcome these challenges?
6. What are your suggestions to improve agricultural productivity and to ensure that the goals and objectives of embarking on the irrigation projects are met?



UNIVERSITY of the
WESTERN CAPE

Appendix 3: Sample Letter of Consent for Survey Questionnaire Administration



University of the Western Cape

Private Bag X17, Bellville 7535, Cape Town, South Africa

Telephone : (021) 959 3858/6 Fax: (021) 959 3865

E-mail: pkippie@uwc.ac.za or mdinbabo@uwc.ac.za

Letter of Consent for Survey Questionnaire

Title: Sustainable Irrigation Agriculture for Food Security and Poverty Reduction Among Smallholder Farmers in Northern Nigeria

Researcher: Daniel Adeoluwa Adeniyi

1. I confirm that I have read and understood the information sheet explaining the above research project and I have had the opportunity to ask any questions about the project.
2. I understand that my participation in this study is voluntary. I am free not to participate and have the right to withdraw from the study at any time, without having to explain myself. I am aware that this interview might result in research which may be published, but my name may be/ not be used.
3. I understand my response and personal data will kept strictly confidential. I gave permission for members of the research team to have access to my anonymised responses. I understand that the information derived from this research is confidential and treated as such.
4. I agree that the data collected from me to be used in the future research.
5. I agree to take part in the above research project.

Name of the participant:.....Signature..... Date

If you have any questions about the research study itself, please contact my supervisor Dr. Mulugeta F. Dinbabo at The Institute for Social Development (ISD), University of Western Cape on phone number +27219593855, his email address is: mdinbabo@uwc.ac.za

Appendix 4: Sample Letter of Consent for Semi-structured Interview



University of the Western Cape

Private Bag X17, Bellville 7535, Cape Town, South Africa

Telephone : (021) 959 3858/6 Fax: (021) 959 3865

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Name of the participant:.....Signature..... Date

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Appendix 5: Sample Information Sheet for Survey Questionnaire



Private Bag X17, Bellville 7535, Cape Town, South Africa

Telephone : (021) 959 3858/6 Fax: (021) 959 3865

E-mail: pkippie@uwc.ac.za or mdinbabo@uwc.ac.za

INFORMATION SHEET (for Survey Questionnaire Respondents)

Project Title: Sustainable Irrigation Agriculture for Food Security and Poverty Reduction Among Smallholder Farmers in Northern Nigeria

What is this study about?

This research project is being conducted by Daniel Adeoluwa Adeniyi, a student at the University of the Western Cape. You are invited to participate in this project as you are a stakeholder in the Irrigation Project in Northern Nigeria. The purpose of this research is to empirically assess the relationship between irrigation agriculture, smallholders, productivity, sustainability, food security and poverty reduction in Northern Nigeria. It is hoped that the research will provide suggestions and recommendations to beneficiaries of the projects (smallholders), the respective River Basin Development Authorities (RBDAs) which are the implementing agencies, as well as related organisations in Nigeria and other developing countries.

What will I be asked to do if I agree to participate?

If you agree to participate in this research project, you will be asked to fill in a questionnaire aimed at assessing the relationship between irrigation agriculture, smallholders, productivity, sustainability, food security and poverty reduction in Northern Nigeria. The questionnaire will take about 30 minutes to 1 hour to fill in.

Would my participation in this study be kept confidential?

Your personal information will be kept private and will remain anonymous if that is your choice. You will be required to sign a consent form to protect your privacy and confidentiality while participating in this study. The identity of the people completing the questionnaire will be kept confidential and details of identity will only be provided voluntarily or used only with consent. The information collected will be kept safe and used for the purpose for this research project. In this research report, identity of the participants will be protected to the maximum.

What are the risks of this research?

There are no risks involved in participating in this research project. From the beginning, aims and objectives will be clear.

What are the benefits of this research?

This research is not designed to help the participant personally. The findings from this research will however provide recommendations for effective and sustainable irrigation practices to all stakeholders.

Do I have to be in this research and may I stop participating at any time?

Your participation in this research is completely voluntary. You may choose not to participate and to stop participating at anytime you want. If you stop or decide not to participate, you will not lose anything.

Is any assistance available if I am negatively affected by participating in this study?

There are no negative effects that could happen from participating in this study.

What if I have questions?

This research is being conducted by **Daniel Adeoluwa Adeniyi**, a student at the University of the Western Cape. His contact details are +234 805 215 1953; +27 73 003 8018; adeolu.adeniyi@yahoo.com

If you have any questions about the research study itself, please contact **Dr. Mulugeta Fitamo Dinbabo** at The Institute for Social Development (ISD), University of the Western Cape, his contact details are, +27 21 959 3858; mdinbabo@uwc.ac.za

Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

Professor Julian May
Head of Department: Institute for Social Development
School of Government
University of the Western Cape
Private Bag X17
Bellville 7535

This research has been approved by the University of the Western Cape's Senate Research Committee and Ethics Committee.



Appendix 6: Sample Information Sheet for Semi-structured Interview



University of the Western Cape

Private Bag X17, Bellville 7535, Cape Town, South Africa

Telephone : (021) 959 3858/6 Fax: (021) 959 3865

E-mail: pkippie@uwc.ac.za or mdinbabo@uwc.ac.za

INFORMATION SHEET (for Interview Respondents)

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What is this study about?

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What will I be asked to do if I agree to participate?

You will be asked to share information, opinions and suggestions on irrigation agriculture which you are either a beneficiary or an employee of the implementing agency. You will also be asked to share information on livelihoods and food security. The interview will take 30-45 minutes and it will take place at the irrigation site or the RBDA offices. The

interview will be conducted on one to one session between the interviewer and the participants.

Would my participation in this study be kept confidential?

Your personal information will be kept private and will remain anonymous if that is your choice. You will be required to sign a consent form to protect your privacy and confidentiality while participating in this study. The identity of the people to be interviewed will be kept confidential and details of identity will only be provided voluntarily or used only with consent. The information collected will be kept safe and used for the purpose for this research project. In this research report, identity of the participants will be protected to the maximum.

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Do I have to be in this research and may I stop participating at any time?

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Bellville 7535



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