# IMPACT OF REGIONAL AGRICULTURAL PROJECTS ON SMALL FARM SECTOR PRODUCTIVITY AND SOCIOECONOMIC GROWTH IN EAST AFRICA

BY

ENOCK WARINDA
(MPhil. Forestry Economics and Management)

A Thesis Submitted in Fulfilment of the Requirements for the Degree of *Doctor of Philosophy* in Agricultural Economics

Department of Agricultural Economics and Agri-Business
School of Agriculture and Veterinary Sciences
South Eastern Kenya University

February 2016

## DECLARATION AND APPROVAL

I hereby declare that this thesis titled "**Impact of Regional Agricultural Projects on Small Farm Sector Productivity and Socioeconomic Growth in East Africa**" is my original work and has never been presented in this or any other University known to me for the award of any degree.

_____ _____

***Warinda Enock*** ***Date***

***A70/MAI/30008/2013***

This thesis has been submitted with our approval as University supervisors

_____ _____

***Prof. Dickson Nyariki*** ***Date***

***Department of Agricultural Economic and Agribusiness***

***School of Agriculture and Veterinary Sciences***

***South Eastern Kenya University, Kenya***

_____ _____

***Dr. Stephen Wambua*** ***Date***

***Department of Agricultural Economic and Agribusiness***

***School of Agriculture & Veterinary Sciences***

***South Eastern Kenya University, Kenya***

_____ _____

***Prof. Reuben Muasya*** ***Date***

***Department of Dry-land Agriculture***

***School of Agriculture & Veterinary Sciences***

***South Eastern Kenya University, Kenya***

## ACKNOWLEDGEMENT

I wish to express my deepest gratitude to my supervisors Professor Dickson M. Nyariki, Dr. Stephen Wambua, and Professor Reuben Muasya for their untiring and constant encouragement, valuable guidance and useful comments on the thesis drafts. I greatly appreciate Professor Nyariki for his very specific attention to details, as well as insistence on clear chronological flow of facts. Thanks to Dr. Wambua for always emphasizing full explanation for unclear statements and always dialoguing with me. Thanks to Professor Muasya for his very heavy attention to quality of this thesis.

I wish to acknowledge the support of my former Executive Director, Dr. Fina Opio for allowing me to continue with my studies while in the employment of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA).

I also sincerely wish to thank South Eastern Kenya University (SEKU) for providing me the opportunity to be one of the students in the institution.

Sincere appreciation also goes to the Directors General of the National Agricultural Research Institutes (NARIs) for providing relevant support in the evaluation processes. I am also grateful to the enumerators of the surveys, without whose efforts this study would not have been such successful. These include: Alice Mukarugwiza, Bisangwa Jean de Dieu, and Augustin Keelo (Rwanda); Benedict Musumba, John Oloo, Josky Gwaka, Lutumia Cosmas (Kenya); Nzigiyimana Augustin (Burundi); Andrew Keloi, Asama Keefa, Brian Mageni, Jackline Wacki (Uganda); and Elvis Nyerere, Gabriel Enock, Listom Mwalugula and Mary Domba (Tanzania). To them all, I say: Thank you. I also greatly appreciate the assistance provided by Mr. Kevin Were, Mr. Mercy Sebuliba, Mr. Junior Kamanyire, and my son, Gerald Omondi, all for assisting with data entry.

Finally, I sincerely wish to thank my dear wife, Florida Warinda, and our four children (Loice, Gerald, Sharon and Moses) for their understanding, moral support and encouragement even during the times I should have given them attention.

## DEDICATION

I dedicate this thesis to the Most Gracious and Living God. Your love and grace towards me has enabled me to complete this piece of work. To you, Oh LORD, be all the glory.

# TABLE OF CONTENT

## LIST OF TABLES

## LIST OF FIGURES

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ASARECA | Association for Strengthening Agricultural Research in Eastern and Central Africa |
| AUC | African Union Commission |
| BXW | Banana Xanthomonas Wilt |
| CAADP | Comprehensive African Agricultural Development Program |
| CBOs | Community Based Organizations |
| CBSD | Cassava Brown Streak Disease |
| CGIAR | Consultative Group for International Agricultural Research |
| CIAT | Internacional de Agricultura Tropical |
| CIMMYT | International Maize and Wheat Improvement Centre |
| CIP | International Potato Centre |
| CMD | Cassava Mosaic Disease |
| COMESA | Common Markets for Eastern and Southern Africa |
| CRP | CGIAR Research Projects |
| DiD | Difference in Differences |
| EAC | East Africa Community |
| FAAP | Framework for African Agricultural Productivity |
| FAO | Food and Agriculture Organization |
| FARA | Forum for Agricultural Research in Africa |
| IAASTD | International assessment of agricultural knowledge, science and technology development |
| ICIPE | International Centre for Insect Physiology and Entomology |
| ICRAF | World Agroforestry Centre |
| ICRISAT | International Crops Research Institute for the Semi-Arid Tropics |
| IITA | International Institute for Tropical Agriculture |
| ILRI | International Livestock Research Institute |
| IFPRI | International Food Policy Research Institute |
| ISFM | Integrated Soil Fertility Management |
| M&E | Monitoring and Evaluation |
| NARS | National Agricultural Research Systems |
| NEPAD | New Partnerships for African Development |
| NGOs | Non Government Organization |
| NRM | Natural Resources Management |
| OFSP | Orange Fleshed Sweet Potato |
| PSM | Propensity Score Matching |
| QPM | Quality Protein Maize |
| ReSAKSS | Regional Strategic Analysis and Knowledge Support System |
| RECs | Regional Economic Communities |
| RPs | Regional Projects |
| TAC | Technical Advisory Committee |
| TFP | Total Factor Productivity |
| TIMPs | Technologies, Innovations and Management Practices |
| TLU | Tropical Livestock Unit |
| TTBDs | Tick and Tick-Borne Diseases |
| USAID | United States Agency for International Development |
| WTP | Willingness to Pay |

## ABSTRACT

Regional projects hereby refer to projects implemented in more than one country. The countries of focus are Burundi, Kenya, Rwanda, Tanzania, and Uganda. The purpose of the study was to build the thesis that regional projects generated more impacts and significantly contributed to: increased agricultural production and productivity; enhanced stakeholders' access to financial services; increased incomes; profitable land uses; and up-scaling of technologies, innovations, and management practices (TIMPs).

Primary data were collected through targeted and focused interviews. Household surveys comprised respondents' socioeconomic and demographic characteristics of the farmers. Secondary data source included documents from the various ministries of agriculture and livestock development, Central Bureau of Statistics, as well as evaluation reports and other publications by FAO, IFPRI, World Bank and USAID. Through multi-stage sampling technique, a total of 1,160 smallholder farmers were interviewed. Farmers engaged in regional projects were regarded as beneficiaries, and vice versa. Quantitative data were analyzed using Statistical Package for Social Sciences (SPSS) software, while Chi-square tests were done to identify related parameters. Regression models were also fitted to evaluate the impacts of these regional projects.

Results show that regional projects generated more regional public goods for end-users than the projects implemented at individual country levels. Compared to non-beneficiaries, the beneficiaries recorded:(i) up to 26.5% increase in revenues, and an average annual income of US$ 259; (ii) a reduction in farm expenditure by 11.6 percentage points; (iii) an increase of 23% and 32% respectively on milk production and number of improved cattle breeds; (iv) over 100% increase in productivity and spillovers of selected commodities such as cassava, millet, striga-resistant sorghum, climbing and bush beans, and low-cost tissue culture banana varieties; (v) over 82% satisfaction with membership-related benefits; (vi) significant financial gains for the unemployed youths who receive annual wages of up to US$ 131; (vii) enhanced policy formulation and harmonization processes, including heightened policy analysis; (viii) joint tackling of regional problems, such as the maize lethal necrotic disease (MLND) in Kenya, Uganda, Tanzania and Rwanda; and (ix) significantly high level of farmers' confidence in the management of availed TIMPs – a score of 2.1 on

the 5-point Likert Scale. Other benefits for beneficiaries included: increased farm-related outputs; early plant maturity and harvest; reduced farm labour; reduced time spent on the farms; increased food and nutrition security; more skills on soil and water conservation; and increased awareness and adoption of TIMPs.

The study concludes that (i) the regional projects work and have significant benefits to the targeted end-users in EAC; (ii) the generated and adopted TIMPs have positive impact on small farm sector productivity; (iii) the beneficiaries are satisfied with availed, up-scaled and adopted TIMPs; (iv) there is increasing adoption of assorted TIMPs within the selected agricultural domains; (v) there are clear controlling factors leading to differential adoption levels of TIMPs across borders. Similarly, the regional projects effectively delivered assorted benefits to the respondents, such as: increased farm-related outputs; early plant maturity and harvest; reduced farm labour and time spent on the farms; increased food security among the targeted households; better nutrition and access to high quality food; better soil and water conservation; increased soil fertility; preservation and conservation of the environment; heightened collaboration among the partners; increased income; capacity building; and increased awareness and adoption of TIMPs.

The study not only makes a contribution to an under-researched area in the contributions of regional agricultural projects, but also provides insights into how to scale out sustainable benefits from on-farm activities in the region. Thus, it is recommended that new cost-reducing approaches such as introducing subsidies and tax exemptions on all farm inputs should be explored to help boost net profits for farmers. More farmers need to be linked to agri-food value chains such as through boosting of capital for group lending, establishment and/or strengthening of rural marketing cooperatives and farmer groups, and facilitation of producer associations to access low-cost equipment. More strategic and demand-driven capacity strengthening initiatives should be introduced to the non-beneficiaries, including availing of vital information on commodity prices in different markets, commodities in demand, and alerts on price fluctuations.

# CHAPTER ONE
# INTRODUCTION

## 1.1. Summary

This chapter provides a summary of the research. It summarizes the study background, including vital statistics that warrant this research. It also focuses on the statement of the problem, articulates the research objectives, the underlying hypotheses and how they are tested. The justification and limitations of this study are also elucidated.

## 1.2. Background to the Study

In nearly all countries and regions, national boundaries often enclose geographical areas that, given similarities in agro-ecological, political, socio-economic and cultural, as well as human aspirations, have the potential to benefit from the same development initiatives. Spatially and temporally, the closer the country is to the epicenter of the initiative, the greater the benefit. Given the nature of the distribution of the agro-ecologies of the African countries, there is high potential of benefit accruing from regionally implemented projects, programs and assorted development interventions,

On the other hand, in Africa, the importance of agriculture in development has been recognized through initiatives such as the Comprehensive Africa Agriculture Development Program (CAADP) of the New Partnership for Africa´s Development (NEPAD) and the Framework for African Agricultural Productivity (FAAP). Conformance to these initiatives requires African countries to adhere to the Maputo Declaration that requires a 10% Gross Domestic Product (GDP) share allocated to agriculture with 1% channeled to research (AUC 2003, 2006). Unfortunately, most of the sub-Saharan African countries, including the East African Community (hereinafter EAC, and taken to mean Secretariat, East African Legislative Assembly, and the Governments of Partner States), have moved from a food surplus to a food deficit region over the past 50 years since independence (Keya and Rubaihayo and Rubaihayo, 2013).

Notwithstanding the foregoing, FAO (2013) estimates that the world's population will increase by 2 billion to exceed 9 billion people by 2050. Feeding this population

means that global agricultural production must increase by 60% from its 2005-07 levels. Studies have shown that more than half of the populations within the Eastern and Central Africa (ECA) sub-region have a prevalence of food inadequacy of 51.6%, while agricultural productivity is still low, poverty deep and widespread, and food and nutrition security precarious (Charles et al., 2010; FAO, 2013; Heisey et al., 2011; Kristjanson et al., 2010; Thornton et al., 2011; Amwata et al., 2015).

The increase in population from 35 million in 1960 to 145 million in 2012 (FAOSTAT, 2013) warrants the adoption of more efficient technology, innovations and management practices(TIMPs) to enhance productivity among smallholder farmers. Improved agricultural performance, especially at this farm level requires investments that boost productivity growth, strengthen markets, improve rural linkages between the agricultural and non-agricultural sectors, and promote regional cooperation (Omamo et al., 2006; Walton, 1994; Gijsbers and Contant, 1996; Eponou, 1998; Perrault, 2001; Parker, 2011; TAC, 2001; de Janvry and Kassam, 2001, 2004).

In seeking to reverse these trends, and following challenges in achieving the Maputo Declaration, the African Union issued its Malabo Declaration in June 2014. It commits African Union member states to, among other things: (i) recommit to the CAADP process; (ii) increase both public and private investment finance in agriculture; (iii) end hunger in Africa by 2025; (iv) reduce post-harvest losses by half; (v) halve poverty by 2025 through inclusive agricultural growth and transformation; (vi) boost intra-Africa trade in agricultural goods and services; and (vii) enhance resilience in livelihoods and production systems to climate variability and other shocks (AUC, 2014). Similarly, the African governments, through the African Union developed a 50-year plan, tagged “Agenda 2063” to address food and nutrition security (AUC, 2014). They recognized that this agenda is achievable through inclusion of women (and youth) as main players in agricultural production and household wellbeing, as they grow over 80% of staple foods (IAASTD, 2009).

However, attempts have seldom been made to identify research and development projects that cut across national boundaries, and even where these exist, their impacts on small farm sector productivity and socioeconomic conditions are scarcely documented (World Bank, 2008). Results show that well-designed regional projects

that generate, disseminate, spillover, spill-in, and facilitate adoption of TIMPs have great potential to help African countries achieve the ambitious growth targets for agricultural sectors (Alston, 2002).

It is against this background that some regional agricultural research organizations embarked on the promotion and implementation of regional projects, and adoption of approved TIMPs to avoid trapping millions of smallholders and subsistence farmers in low yield production. Among the priority productivity enhancing TIMPs for regional projects included: (i) the development of gender-responsive land productivity enhancement and saving technologies; (ii) the development of climate smart technologies; and (iii) enhanced natural resource management.

This study was conducted to determine the level to which the regional projects have impacted on small-farm sector productivity and the implications on socioeconomic growth of targeted groups in EAC. It focused on determination of the effectiveness of these regional projects, especially with respect to generation of regional (as opposed to national) public goods for end users. In this thesis, regional public goods refer to products, services and knowledge and information materials generated via use of public resources. They include the generated TIMPs such as crop varieties, breeds, germplasm, and livestock feeds. Small farm sector is hereby categorized on the basis of: (i) the agro-ecological zones in which the farmers operate; (ii) the type and composition of their farm portfolio and landholding; and (iii) the average annual revenue they generate from farming activities (Dixon et al., 2003)

### 1.3. Statement of the Problem

In as much as agricultural productivity in sub-Saharan Africa has been increasing since the mid-1980s, this result has been merely to restore the levels achieved in the early 1960s, and irrespective of government efforts to reverse this trend, its deterioration has persisted (Nyariki, 1997, 2011). Similarly, evidence abounds indicating that high inefficiency and low productivity in agriculture in sub-Saharan Africa have significantly affected the demand and supply dynamics in most agricultural markets (Nyariki and Thirtle, 2000), thereby posting disincentives to the smallholder farmers.

To compensate for the persistent shortfall in food supply, Africa receives the highest per capita quantity of food aid in the world, amounting to over 3 million tons of food per year (Conway and Toenniessen, 2003). Within EAC, in as much as more land has been opened for cultivation, productivity per unit area has remained virtually unchanged since 1980 (Salami et al., 2010). Progress towards alignment, harmonization and coordination of regional projects as well as initiatives, interventions and activities with national strategies and priorities as defined in the National and Regional Agricultural and Food Security Investment Plans have been slow and inconsistent (AUC, 2014).

Based on the above, and as Africa struggles with adoption of relevant TIMPs, national agricultural research systems (NARS) have not only generated useful TIMPs that can help improve food production and enhance agricultural productivity (Feder et al., 1985; Mugisha et al., 2004; Nankinga et al., 1994; Yaron et al., 1992; Mugunieri et al., 1997), but that can also be availed to help boost impact of regional projects. However, very little evidence exists on the contribution of the regional projects in enhancing smallholder income and agricultural production and productivity.

### 1.4. Objectives of the Study

The main objective of this study is to evaluate the impacts of the regional projects in enhancing agricultural productivity and socioeconomic growth among small-scale farm sectors in EAC.

The specific objectives are:

1. To determine the effectiveness of the regional projects in generating regional public goods for smallholder farming households.
2. To evaluate the impacts of adopted TIMPs on small farm sector productivity.
3. To determine the levels and rates of adoption of different TIMPs within selected agricultural development domains (HLL, LLL, HHH, and HLH)[1] as well as to document the factors that contribute to differential adoption levels across borders.

[1] Domain refers to agricultural potential/market access/population density—for example, HLL = high potential, low access, low density. H = high; L = low. The domains (HLL, LLL, HHH, and HLH) are selected because the agriculture-based growth in these domains is important offers better scope for both poverty reduction and benefits from regional cooperation.

4. To assess smallholder farmers' satisfaction with products and services, including TIMPs and knowledge management from the regional projects.

### 1.5. Hypotheses

1. The regional projects do not work and have no benefits to the targeted end-users in EAC.
2. The generated and adopted TIMPs have no impact on small farm sector productivity.
3. The beneficiaries are dissatisfied with availed, up-scaled and adopted TIMPs.
4. There is no adoption of different selected TIMPs within the selected agricultural domains.
5. There are no factors contributing significantly to differential adoption of TIMPs across borders.

### 1.6. Testing the Hypotheses

The relevance of regional projects, including their benefits to the targeted end-users in ECA was determined by assessing how the regional projects generated regional public goods for the end-users, as opposed to country specific projects when both enjoy equal access to resources. It was also confirmed by evaluating their critical contributions to enhanced access to credit facilities, increased access to inputs and services, as well as intra- and inter-national trade following policy harmonization, infrastructure development, up-scaling of TIMPs (e.g. germplasm, cultivars, and doses), and improved human resources. The impact of the generated and adopted TIMPs on small farm sector productivity will be determined by calculating the rate of change in agricultural productivity from these regional projects through adoption of selected TIMPs.

The hypothesis that the beneficiaries are dissatisfied with availed, up-scaled and adopted TIMPs will be tested by comparing the beneficiaries and non-beneficiaries' levels of satisfaction with the TIMPs introduced to them by extension staff and scientists. Satisfaction will be measured by their willingness to adopt new TIMPs, enroll in farmer groups, and pay for availed services and products.

## 1.7. Justification of the Study

The overall total factor productivity (TFP) growth rate in sub-Saharan Africa is 0.5%, while the average annual growth in food demand is projected to be 2.83% per year from 2000 to 2030, primarily due to population increase (GAP, 2012). This deficit urgently demands for accelerated productivity growth rates, sustainable land expansion as well as production intensification. Projections further indicate that as the global population moves towards 9+ billion by mid-century, an estimated 100% increase in food production is required, up by 60% from 2005-07 levels. About 70% of this food must come from efficiency-improving technologies through use of new and current yield-enhancing TIMPs. About 10% must come from increased cropping intensity. Given also that farming in 2050 will occupy only about 1% more land than was used in 2008, transfer of these TIMPs across borders through regional projects has potential for increased productivity and helping reduce this deficit.

Based on the foregoing discussion, and given the continuing interest in regional development initiatives in Africa, investment in research to generate evidence on increased productivity is needed. Such investments focus on choices on projects that could be implemented in pan-territorial space as opposed to within individual countries, thereby limiting costs borne by one country. Therefore, this study evaluates the impacts that regional projects have with respect to small farm sector productivity and socioeconomic wellbeing of targeted beneficiaries. It helps show where investments in agriculture are most likely to have optimal benefits, besides illustrating how the generated and availed and up-scaled TIMPs have yielded payoffs in various agro-ecological systems.

## 1.8. Limitations of the Study

A research of this magnitude may be expected to evaluate the contributions of several regional and international agricultural organizations, especially the Consultative Group of International Agricultural Research (CGIAR) and its projects. However, to keep the study within manageable proportions for rigorous investigation and maintain focus, only projects implemented by ASARECA in partnership with other organizations and NARS have been included in this study. The study was limited to four agricultural development domains, some of which may have changed due to climate change and other environmental factors. In cases where rainfed agriculture

was practiced, the study did not control for climatic factors such as rain. In addition, due to time and resource constraints, this study did not attempt to evaluate the impact of regional projects on nutrition, or the factors affecting the choices of food groups. Farm level efficiency and productivity measures derived from Data Envelopment Analysis and Malmquist Total Factor Productivity indexes was not considered, given the nature of longer time series data required. Instead, the research focused on estimation of value productivity per hectare for selected commodities.

### 1.9. Organization of the Thesis

The thesis comprises eight chapters. Chapter one details the research background, problem, and research question, objective of the research and hypotheses, justification of the study, limitations of the study, and organization of the thesis. Chapter two provides literature review, including brief definitions of the terms used in the research, highlights of continental declarations by heads of states regarding agricultural research for development, brief historical perspectives of agricultural research at all levels, and highlights of the CAADP agenda. This chapter additionally provides brief discourse on regionalization of agricultural projects, total factor productivity as a measure of agricultural productivity, and impacts of regional projects, especially with respect to spillovers. It concludes by focusing on some of the gaps that this study seeks to address.

The third chapter deals with the methodology of the study, and mainly focuses on the conceptual model with hypothesized relationships pertaining to impacts of regional projects. It illustrates the background to research design in the thesis, target population and sample, unit of analysis, selection of key informants, research instrument, survey data, analytical tools of quantitative data, qualitative data collection, protocol and analytical approach of qualitative data. Chapter four focuses on the description of the socioeconomic setting of the respondents. It elucidates the FAAP principles that guide agricultural research for development in Africa, the agricultural development domains, and their relevance to agricultural development in the study area, diversity of household types within the study area, the respondents' demographic characteristics, variations in land holdings, land use options, tenurial systems, as well as land sizes across the gender categories.

The fifth chapter deals with the evaluation of the effectiveness of regional projects, including the benefits of the regional projects, farm income dynamics, current advances in enhancing agricultural policy environment, and comparative assessment of respondents' anticipated versus actually accrued benefits from the regional projects. It further quantifies the value added from regional projects; role of TIMPs generated and adopted; farmers' awareness and level of satisfaction with these TIMPs; value productivity of assorted commodities; and challenges faced in the implementation of regional projects.

Chapter six elaborates the impacts of regional projects, especially the factors that influence uptake of TIMPs generated from regional projects by smallholder farmers, as well comparison of benefits for beneficiaries and non-beneficiaries. It also describes in details the factors affecting food availability; spillover effects from the regional projects; the dynamics of stakeholders' access to markets, including access to market information and impacts created through use of the assorted information products. It focuses also on the assessment of stakeholders' participation in savings-credit groups, review of farm characteristics, especially land holdings, and tenurial systems.

The seventh chapter focuses on key research findings though selected fitted models. It details selected regression models for estimating respondents' willingness to pay for availed services, adopts multinomial regression models to determine the factors contributing to choices made by respondents, and applies double difference method to estimate the effect of regional projects on selected indicators. The eighth chapter succinctly provides conclusions and recommendations of the study, especially through synthesis of the overall research questions and objectives. It also summarizes key contributions to the theory and body of knowledge; potential future research directions; and limitations of this research.

# CHAPTER TWO
# LITERATURE REVIEW

## 2.1. Summary

This chapter takes a detailed review of the literature on agricultural research for development as well as provides an overview of progress made by governments in promoting agriculture. It focuses on the key terminologies used in this research; the declarations and decisions made on agriculture and food and nutrition in Africa as well as the historical perspectives of regionally implemented projects. It briefly describes the progress made in the CAADP agenda; discusses the theory of regional projects, including their potential benefits; as well as provides a brief discussion on the data on total factor productivity. Assessment of the impacts of regional projects, especially with regards to research spillover effects and food security implications in EAC are discussed, besides articulation of research gaps.

## 2.2. Definition of Terms

### 2.2.1. Domain

A domain is the spatial representation of preconditions or factors considered important for rural development, and can be characterized using stratification criteria that, based on theory and previous research, determine the comparative advantages of rural areas with respect to frequently occurring livelihood strategies. Agricultural potential, market access and population pressure are used, all in that order.

### 2.2.2. Agricultural Potential

According to Wood et al. (1999, 2003), agricultural potential encompasses rainfall, altitude, soil types and depth, topography, presence of pests and diseases that influence the absolute advantage of producing agricultural commodities in a particular place. It changes over time in response to changing natural conditions (such as climate change) and human-induced conditions (such as land degradation).

### 2.2.3. Agricultural Productivity

Productivity refers to a ratio of the output to input in relation to land, labour, capital and overall resources employed in agriculture. Similarly, agricultural productivity refers to the difference between resources put into agriculture (land, materials, labour,

time, and money) and the resources extracted from it (food and money). For example, crop productivity is a function of factors like physiography, soil type, rainfall, irrigation, etc. Productivity data include yields and acreage. Increase in productivity means enhancement of the total farm output and efficiency in resource utilization. Similarly, agricultural productivity measures the current yield levels for all economically important crops being produced by the selected households. The production data include the area and yield for each crop grown during the past year, as well as comparable data for each livestock system and other enterprises being carried out by the farm household. For major food crops, basic information on production management practices should be gathered, including varieties or hybrids and the amount of fertilizer being used.

### 2.2.4. Food Security

According to the Food and agriculture Organization (FAO), food security refers to "a situation that exists 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, 2002). Household food security is the application of this concept to the family level, with individuals in households being the centre of focus. This definition implies that food insecurity reflects uncertain access to enough and appropriate foods (Barrett, 2002). However, irrespective of how food security is defined, it is generally agreed that four distinct variables are central to the attainment of food security namely food availability, access, utilization, and stability of access.

### 2.2.5. Market Access

Ruecker et al. (2003) described market access as multi-dimensional component of the development domain. It includes distance to roads, conditions of roads, distance to urban centres, and degree of competition, access to transport facilities, access to international markets and types of commodities for trade. It is classified as high or low using a measure of potential market integration, which is also based on travel time from any location to the nearest five towns or cities, weighted by the population of the towns or cities.

In this thesis, three broad market types are considered, namely: (i) informal; (ii) formal, and (iii) structured public markets. Informal markets are hereby described as those markets characterized by few regulations, and have limited taxation on commodities traded therein. Similarly, the more formal markets are here clustered as those markets that operate using standard weights and measures. In such markets, jointly and clearly defined legal frameworks govern trade and associated businesses. The guiding principle regarding structured public markets is the fact that these markets are organized by public sector traders, specifically through engaging the buyers who offer standardized contractual buying arrangements, but not without clearly articulated pre-conditions to be fulfilled.

Robins (2011) indicated that the complexity of the market system typically reflects the volume and value of trade, the types of products being traded, and the number of market actors who want to make use of the system. He went further to state that the main types of products being traded include barter, roadside stalls, fixed marketplace, travelling salespersons, retail stores, auctions, commodity exchange, stock exchanges, futures markets, and online marketplace, including eBay.

### 2.2.6. Population Pressure

Pender et al. (1999) classified population pressure as high or low based upon rural population density of parishes, using a cut-off point of 100 persons per square kilometre. In this research, population pressure has been categorized as follows: (i) low: up to 50 persons per square kilometre; (ii) medium: 51 – 100 persons per square kilometre; and (iii) high: over 100 persons per square kilometre.

### 2.2.7. Small Farm Sectors

These are also known as smallholder farming, and refer to family farming, subsistence farming, and low-income farming (Adeleke et al., 2010). On the basis of farm revenues, smallholder farmers range from those producing crops only for family consumption to those in developed systems earning as much as US$ 50,000 a year (Dixon et al., 2003). Smallholder farmers, defined on the basis of land and livestock holdings, cultivate less than two hectares of land and own only a few heads of livestock. These farms represent 80% of all farms in sub-Saharan Africa, and contribute up to 90% of the production in some SSA countries (Wiggins, 2009).

Smallholding is small because of scarcity of resources, mainly land and capital. As such, in order to generate significant level of incomes require a high level of total factor productivity.

### 2.2.8. Agricultural Technology

Agricultural technology refers to products, services, techniques, and activities whose use results in increased plant and livestock productivity and higher yield improvements, including sustainable agricultural practices, efficient soil and water management, improvements in storage, handling and packaging of agricultural produce, enhanced processing, and other agricultural related processes. Similarly, Mackill et al. (2010) describes technology as the application of knowledge to the production and distribution of goods and services, as well as the conversion process that transforms the inputs of a business (or interventions) into outputs. It encompasses knowledge, tools, techniques and actions that are necessary to complete the transformation process.

Based on the above description, the available agricultural technologies can be used individually or in combination. In this study, the researcher broadly categorizes technology under the following themes and sub-themes (a) crop technologies; (b) livestock technologies; and (c) other types of technology (see Appendix 3 for details).

### 2.2.9. Demand Driven TIMPs

These TIMPs refer to what people need. They are generated to clearly respond to the identified agricultural need or priority concern of the stakeholders as well as to the needs of the EAC populace. They are usually site-specific. The demand for TIMPs is heavily dependent on the following factors: (i) local availability top majority of the respondents; (ii) affordability, such that adoption of the TIMPs may no longer be tied to costs; (iii) rapid expected returns associated with the utilization of the TIMPs, vis-à-vis without; (iv) limited technical know-how required before utilizing the TIMPs; (v) limited perceived risks tied to the use of the TIMPs; (vi) evidence of adaptability of the TIMPs in the local environment.

### 2.2.10. Innovation

According to Glaister (1989) and Rogers (1983), innovation refers to the modification and/or adaptation of a product or service; the introduction of a process or product that is new only to the given environment regardless of whether it has been used elsewhere before. In this study, an innovation is the implementation of a new or significantly improved product (good or service), process, a new marketing method, or knowledge (indigenous and exogenous) in a place or by people in a way that it has not been used before. It also involves any alteration of generated products, including technologies, rather than the creation of a new one. To qualify as an innovation, it must be economically viable, and it must be readily out- and up-scaled and replicable in other similar agro-ecological conditions.

### 2.2.11. Application, Diffusion and Adoption

Application is the use of TIMPs by a farmer or other producer over at least one crop season or equivalent production period in the case of livestock. Diffusion refers to the process by which an innovation is communicated through certain channels over time among members of a social system (Rogers, 1983; Adjeberg-Asem, 1988). From this description, four elements of a diffusion process stand out, including innovation, communication channels, time and the social system. Communication channels and social studies have been found to be key in the process of diffusion, among which include mass media channels. Adoption refers to the use of TIMPs by a farmer or other beneficiary in a sustainable way over an extended period of time.

In as much as there are several factors influencing adoption and diffusion of inventions and innovations, Blackledge (1979) also lists the following as key factors that inhibit the diffusion of the targeted TIMPs: (i) the absence of technical economic feasibility studies; (ii) market analysis to assess the product or process potential; (iii) unwillingness of the users of technologies to take risks on unproven technology; (iv) lack of adequate financing mechanisms; and (v) lack of capabilities to transfer completed research results as a package acceptable to the stakeholders.

### 2.2.12. New TIMPs

In this study, a distinction is made between new and continuing TIMPs. On the one hand, a technology is regarded as new when it is applied for the first time during the

research period. However, on the other hand, if it was applied during the previous periods prior to the research period, and is still being applied during the current research period, then it is regarded as continuing. In this thesis, if any of the improved TIMPs were newly applied in any of the crop cycles, the farmer is regarded as new, even if continuing practices were also applied.

Similarly, this study recognizes the main action agents for technology development and dissemination, viz.: (i) national research systems, (ii) public extension systems, (iii) universities, especially faculties of agriculture, (iv) farmers and farm households, (v) service institutions such as seed, fertilizer and pesticide distributors, veterinary services, credit agencies, and commodity traders, and (vi) government policy-making bodies. TIMPs are regarded as new if they have not previously been in use in the target area. Focus is put on the number of TIMPs that are:

- **Under research/development**, especially if they have not gone through research phase and made ready for testing before transfer to other people for adoption.

- **Under field-testing**, mainly if they have gone through screening during research phase and made ready for testing before transfer to other people for adoption. It may involve movement from on-station to on-farm research, through to on-farm verification, demonstrations and pilot production in village projects.

- **Made available for transfer/uptake**, specifically if they have shown proven net benefits, or have been approved by appropriate technical institutions responsible for authorizing the use, and have been tested by farmers on the farms. Uptake follows organized field days and visits, and engages research scientists, extension specialists, farmers, seed production specialists, government officials, and representatives from the universities.

### 2.2.13. Uptake Pathways

These refer to channels and processes through which the technologies and innovations reach the intended users. It can also be regarded as diffusion. Uptake pathways and/or

channels include the private and public extension system, farmer organizations, input distributors, and any other institutional arrangement available through which technology, knowledge and information can reach the end user.

### 2.2.14. Beneficiaries

In this thesis, project beneficiaries are hereby classified as either direct beneficiaries or non-beneficiaries. Direct beneficiaries include individuals within the target area that receive direct benefits (i.e., goods or services) from the activity. On the other hand, non-beneficiaries refer to those individuals that either receives indirect benefits from the activity, or none at all. An example to illustrate this differentiation is a project whereby participants in a water harvesting project benefit directly from improved water availability. On the other hand, the non-beneficiaries may not access water from these dams, but may benefit from other water points, since competition for these water points will have reduced due to the project's alternative water source.

### 2.2.15. Household

The simplest definition of a household, adopted by many United Nations sanction, is "a household is a group of people who live and eat together." In this study, a household comprises a person or group of persons generally bound by ties of kinship who live together under a single roof or within a single compound and who share a community of life in that they are answerable to the same head and share a common source of food (Casley and Lury, 1987).

## 2.3. Declarations

Within the continent, several Decisions and Declarations on agriculture and food and nutrition security have been made. These include: **(i)** the 2003 Maputo Declaration on Agriculture and Food Security in Africa [Assembly/AU/Decl.7 (II)]; **(ii)** the 2004 Sirte Declaration on the Challenges of Implementing Integrated and Sustainable Development in Agriculture and Water in Africa [Ex/Assembly/AU/Decl. 1 (II)]; **(iii)** the 2009 Sirte Declaration on Investing in Agriculture for Economic Growth and Food Security [Assembly/AU/12 (VIII)]; **(iv)** the 2007 Decision on Abuja Special Summit of the AU on Fertilizers [Assembly/AU/Dec.117 (VII)]; and **(v)** the 2007 Decision on the Abuja Summit on Food Security in Africa [Assembly/AU/Dec.135 (VIII)]; among others.

Notwithstanding the above Decisions and Declarations, studies (Nyariki, 2011; Mtei et al., 2013) have shown that both hunger and malnutrition still stand out as the major causes of poverty and underdevelopment in Africa. These twins have been shown to cause poor health, low levels of energy as well as mental impairment, thus leading to not only low agricultural productivity, but also low educational attainment. This reduced productivity and literacy have been shown to lead to even greater hunger and malnutrition (AUC, 2014; Liverpool-Tasie et al., 2011).

On the other hand, different approaches have been adopted to capture the advantages of multi-country collaboration in agriculture and natural resource management (NRM) research to address common problems. Each new approach promised greater impact in improving and securing livelihoods. However, there is little hard evidence that each new approach did in fact profit from earlier lessons. Although each had its advantages, the expected benefits from the successful planning, the combination of resources, the building of greater critical mass and the ability to test the successful approach under contrasting political, social, economic, technical and environmental circumstances have not materialized. Their impacts have hardly been incremental and remain disappointing (FARA, 2008).

### 2.4. Historical Perspectives

Despite Africa's potentially rich land and water resources, its farmers are among the poorest in the world. Agricultural productivity not only remains low, but also is falling further behind other regions of the world. Similarly, given that the vast majority of people in Africa derive their livelihood in agriculture, the weak state of the sector has profound implications on food and nutrition security (World Bank 2008, 2014). Punam et al. (2011) suggested that the agricultural innovations in Africa need to internalize the region's biophysical, institutional and socioeconomic constraints and establish efficient value chains to support sustainable growth and reduce poverty.

Trends in land, labour, and total productivity vary across different parts of Africa. However, notwithstanding this large spatial variation, some parts of Africa, especially those under good agricultural management have experienced significant agricultural

productivity growth since the mid-1980s. This growth is significant compared with agricultural productivity growth rates in Asia, Latin America and Near East. Studies have also indicated that between 1980 and 2005, TFP has risen the fastest, at an average annual rate of 2.26%, followed by land productivity at an average annual rate of 1.80%, and then labour productivity, at an average annual rate of 1.15% (Benin et al., 2011).

Past studies by scholars, including Scobie and Posada (1977) at CIAT and Flores-Moya et al. (1978) at IRRI estimated high rates of returns on CGIAR research investment of well above 50%. Evenson (2001) and Alston et al. (2000) generated some benefits of CGIAR-supported projects across crops and countries, thus confirming the widespread evidence of high economic rates of return for crop improvement research in the CGIAR. Pingali (2001) on the other hand concluded from his review of impacts and rates of return literature that there were relatively few "crop management and improved input use" and other NRM-related CGIAR impact studies to-date. This status has changed in areas with good agricultural practices.

### 2.5. Comprehensive Africa Agriculture Development Program (CAADP)

CAADP aims to improve food security and incomes in Africa by raising public investment in agriculture to 10% of budgets and stimulating agricultural growth of 6% per annum. CAADP has four pillars: (i) Land and water management – extending the area under sustainable land management; (ii) Market access – improving rural infrastructure and trade-related capacities for market access; (iii) Food supply and hunger – increasing food supply and reducing hunger; and (iv) Agricultural research and technology dissemination and adoption. The programme helps individual African countries to develop a Country Compact. This is the document that commits the government and the country's development partners to a common strategy for agricultural development. This study focuses on the fourth pillar. With over 30 African countries having signed a CAADP Compact, there is a considerable potential to create agricultural growth and reduce poverty and hunger for many people.

On the other hand, almost 10 years after the Maputo Declaration, CAADP is entering a new phase. As countries and Regional Economic Communities (RECs) move from planning to implementation, they face new challenges such as the need for: (i)

improving the policy environment to incentivize agricultural growth, food security and increased incomes, (ii) ensuring institutional capacity to drive faster and better implementation, and (iii) responding to emerging trends such as climate change, food and energy price volatility, and nutritional concerns, among others. Household food security is therefore regarded as the application of this concept to the family level, with individuals in households being the focus of concern (FAO, 2003).

### 2.6. Discourse on Regionalization of Agricultural Projects

Studies have shown that a regional approach to agricultural research and development (R&D) offers a myriad of potential benefits, especially for sub-regions with a mix of small and large countries, similar patterns of natural resource endowments and development constraints, and scarce public resources (Eicher, 2003; Abdulai et al., 2006; Pardey et al., 2007; Johnson et al., 2006; You and Johnson, 2010). You and Johnson (2010) observed that the regional approach offers greater scope and scale economies than is achievable by individual countries, thereby allowing coverage of a broader range of research topics and generation of the critical mass of human resource capacity needed for success.

Based on a meta-analysis of the reviews and evaluations of the eco-regional programmes by Berdegue and Escobar (2003), three major challenges facing the programmes were identified, namely: delivery of NRM research outputs that make a real impact on programme objectives; integration of biophysical and socio-economic and policy research; and design and management of effective partnerships. The review indicated that, in as much as the eco-regional programmes have made major advances in improving interaction between national programmes and CGIAR centres, few programmes have yet documented evidence of impact.

Binswanger-Mkhize and McCalla (2009) opine of the imperative of regionalization (of the countries) as a framework that would work as an anchor of a new foundation in agriculture. This process has potential benefits including boosting agricultural trade among land-locked countries, besides leading to infrastructure development and exchange of germplasm.

Studies have also shown that there is often a considerable lag in the adoption of technologies once they become available. This lag may represent various refinements that are made to make adoption practical and profitable. Delays are also incurred in learning about a new technology including: testing by individual producers to gain confidence in its use and evaluate its risks, assessing the need to write off previous investments, and undertaking the investments necessary for the full take-up of new technology. This process of awareness, interest, trial and acceptance is variously influenced by how producers view the new technologies in terms of their technical viability, economic feasibility and social acceptability. The conditions that govern these criteria also vary across producers, regions and over time.

## 2.7. Total Factor Productivity

Growth in total factor productivity (TFP) is strongly associated with the adoption of new technologies that raise yields and/or lower costs of production (Heisey et al., 2011). Between 1985 and 2008, the annual rate of TFP growth within sub-Saharan Africa was 1.3% (CAB International, 2011). As projections indicate 100% increase in global agricultural demand by 2050 due to population growth, energy demands, and higher incomes in developing countries, meeting this demand from existing agricultural resources will require raising global agricultural TFP by a similar level (Heisey et al., 2011).

Fuglie and Walker (2001) also found complementarity between public and private investments in crop genetic improvement, with public research in basic plant breeding spurring more private investment in crop variety development. On the other hand, R&D investments typically begin boosting TFP within 3-5 years, with benefits peaking after 10 to 20 years, and with some impacts lasting as long as 50 years (Huffman and Evenson, 2006; Alston et al., 2010).

Data analysis by Benin et al. (2011) indicates that only Ethiopia (out of all the ECA countries) has exceeded the CAADP target of 10%. None of the other countries representing the largest ten agricultural economies (Nigeria, Egypt, Morocco, Algeria, Sudan, Kenya, South Africa, Tanzania and Cote d'Ivoire) have achieved this target. Most of these top ten countries spent less than 5% of their total expenditure budget on agriculture. Studies also indicate that among the economic sectors that improved,

agriculture grew at 3.4% per year over 2001-2010, outpacing Africa's population growth rate, which was 2.5%, for the first time in the last three decades. Nevertheless, the agricultural sector's growth has lagged behind national economic growth in Africa. This slow growth is an obstacle to regional poverty reduction since most poor people are dependent on farming (Diao et al., 2012).

Raising productivity requires not only appropriate technology, but also sound policies to encourage farmers to adopt them and improve farming practices. However, agricultural research infrastructure and capacities in Africa have been eroded through years of neglect, primarily because of lack of public funding for agricultural research and development (Beintema and Stads 2006, 2011). NEPAD's national agricultural R&D investment target of at least 1% of agricultural GDP has also been missed by 75% of the countries within the continent, apart from Kenya, Uganda and Burundi in ECA. In 2008, for example, the average amount spent on agricultural R&D as a percentage of agricultural GDP stood at 0.6% for Africa.

Mallawaarachchi et al. (2009) explain that past studies have proved that research and development is a well-known pathway to productivity growth. It contributes a range of technological advances and knowledge that may lead to improvements in agricultural productivity in the long run. While there are significant time lags in this response, it is generally acknowledged that: (i) expenditure on agricultural research generates new knowledge that eventually leads to improved technology; (ii) improved technology may require new investment and practice change, but technology adoption by farmers increases productivity overall; (iii) higher productivity of agricultural resources lowers production costs, increases output (often involving less land), and releases some resources (such as labour) from agriculture to other sectors of the economy; and (iv) higher agricultural production tends to lead to lower commodity prices, passing some of the benefits of innovation on to the food industry and consumers.

### 2.8. Impacts of Regional Projects (Research Spillover Effects)

Implementation of regional projects contributes to research spillover effects – a phenomenon encountered when new TIMPs have applicability beyond the location or commodity for which it was generated (Bantilan and Davis, 1991). Studies have

shown that adoption of international public or private standards can benefit the consumer in situations where regulatory heterogeneity across importing countries or firms arises from chance differences, informational inadequacies or regulatory capture (Roberts and Josling, 2011). Studies such as those carried out by Omamo et al. (2006), Nin Pratt et al. (2011), and Johnson et al. (2011) shed light on the potential gains from implementing regional agricultural R&D strategies.

Early efforts to measure agricultural research spillovers are evident in the seminal work of Evenson (1989), which showed how larger research systems in the United States benefited smaller ones. More recently, Pardey et al. (2007) measured the potential extent of intercontinental research spillovers; Johnson et al. (2006) and Nweke et al. (2002) examined research spillovers for cassava in Africa; and Ahmed et al. (2000) did the same for sorghum and millet.

On the other hand, Byerlee and Eicher (1997) found large research spillovers for improved maize varieties across African countries, and Maredia and Byerlee (2000) found spillovers for improved wheat in a range of developing countries. Gabre-Madhin and Haggblade (2004) reviewed evidence on the transfer and adaptation of technologies across Africa and found significant spillovers especially for cotton and rice in West Africa, maize in East and Southern Africa, and cassava in West and Central Africa. These study findings illustrate the potential impacts of regional or multi-country projects in contributing to food security in sub-Saharan Africa.

Studies by de Janvry and Kassam (2001, 2004) and TAC (2001) elaborate advantages of regional approaches to research, main ones being: (a) increased economies of scale in research (due to high fixed entry costs) that can be captured through a regional approach when this would be difficult at the national level; (b) enhanced positive externalities that can be better internalized at the regional level than at the national level, creating greater incentives to invest in research; (c) ensured division of labour and specialization among the scientists in the region on a comparative advantage basis; (d) better opportunities for elevating research priorities above national political cycles to give greater continuity in research undertakings; and (e) heightened opportunities for scientists to exchange information on research issues specific to the region.

Increasing and sustaining the yield growth of sub-Saharan Africa's key staple crops and livestock is essential to meeting its growing demand for food over the next decade. Similarly, by borrowing research results (e.g., plant lines or varieties) from other countries, a country can shorten its research time and contribute to increased return to research investments (Alston et al., 1995). However, realizing this objective may not be quick if the business-as-usual scenario of engaging in small-scale national projects is maintained. Therefore, a shift from this business-as-usual scenario to the business-unusual mode is assumed to hold the key to the anticipated rapid growth in food security. Studies have recommended to governments to enhance linkages between agricultural and non-agricultural sectors, as well as to exploit opportunities for regional cooperation (Omamo et al., 2006).

Recent studies indicate that the number of undernourished people in Africa (EAC inclusive) reached an average of 210 million during the last decade. It is also further inferred from such studies that increased agricultural productivity can increase food availability, access as well as incomes for the targeted groups (Keya and Rubaihayo, 2013). Based on the above, it suggests that implementation of regional projects have great potential in generating multiple ripple effects than country-focused projects.

In theory, regional projects (including regional integration and collective action) in agricultural research and development among neighboring countries can lead to economies of scale and spillover benefits that permit research systems to jointly achieve the critical masses and cost savings needed to address problems beyond the capacity of individual systems (ASARECA/IFPRI, 2005). SROs view this approach as one major mechanism of enhancing sub-regional productivity. IITA also projects to decentralize and integrate regional research projects that focus on major agricultural constraints in Africa, especially on crops, farming systems and their natural resource base (IITA, 2012).

### 2.9. Food Security Implications

Adoption of new TIMPs has shown significant contribution to enhancing food security in sub-Saharan Africa. For example, through impact assessments, Maredia (2009) indicated that there is positive causal link between development interventions

that increase productivity and gains in producer and consumer welfare as a result of increased income (for producers) and lower prices (for consumers). In many parts of the world, the adoption of agricultural TIMPs has been seen to have positive effects on yields while limiting environmental impacts (Godfray et al., 2010; Foley et al., 2011; Balmford et al., 2012).

Experts agree that increased production must be achieved by increasing yields while using fewer resources and minimizing or reversing negative environmental impacts. This "sustainable intensification" approach is fundamentally about making the current agricultural system more efficient through the use of new technologies1 or by improving current production systems (Royal Society 2009; Foley et al., 2011; Balmford et al., 2012; Garnett et al., 2013; Smith 2013).

Advances in science continually create new technological potentials. But weaknesses in the region's agricultural research and extension systems prevent translation of that potential into rapid development and wide dissemination and uptake of productivity-enhancing TIMPs (Chema et al., 2004).

### 2.10. Research Gaps

Studies have shown limited evidence on the extent of the effectiveness of the regional projects in contributing to generation of regional public goods for smallholder farming families. There have been limited evaluations focusing on the impacts of availed regional TIMPs on small farm sector productivity and their socioeconomic growth. The levels and rates of adoption of these TIMPs have not been exhaustively documented, especially within the agricultural development domains and across common national borders. There is limited literature focusing on the levels of smallholder farmers' satisfaction with TIMPs and knowledge and information products from the regional projects. There are gaps in documenting the best combination of practices that generate optimal benefits for either of the two project models. Similarly, studies have indicated a sharp increase in TFP (2.26% annually) between 1980 and 2005. However, little is known whether the largest increase was from regionally or nationally implemented projects.

It is still unclear to what extent the regional projects have facilitated the promotion of regional collaboration in research activities between the systems, especially within the NARS. The extent to which the generated and disseminated knowledge, technologies, innovations and materials used for development-oriented programmes closely meets the needs of multi-national project implementers is unclear. The contribution of regional projects in strengthening the NARS to better engage all stakeholders, build capacity, increase cooperation amongst national, regional and international private and public institutions is unclear. Very limited evaluations have been undertaken to establish the effectiveness of implementation of regional projects in helping national governments fast track the achievement of the continental declarations on agriculture and food and nutrition security (such as the 2003 Maputo Declaration; the 2004 and 2009 Sirte Declaration; and the 2007 Abuja Decision). Thus, this research is anticipated to address the gap by assessing the role of regional projects in the uptake of proven TIMPs for quicker and wider generation of benefits for smallholder farmers.

# CHAPTER THREE
# RESEARCH METHODOLOGY

## 3.1. Summary

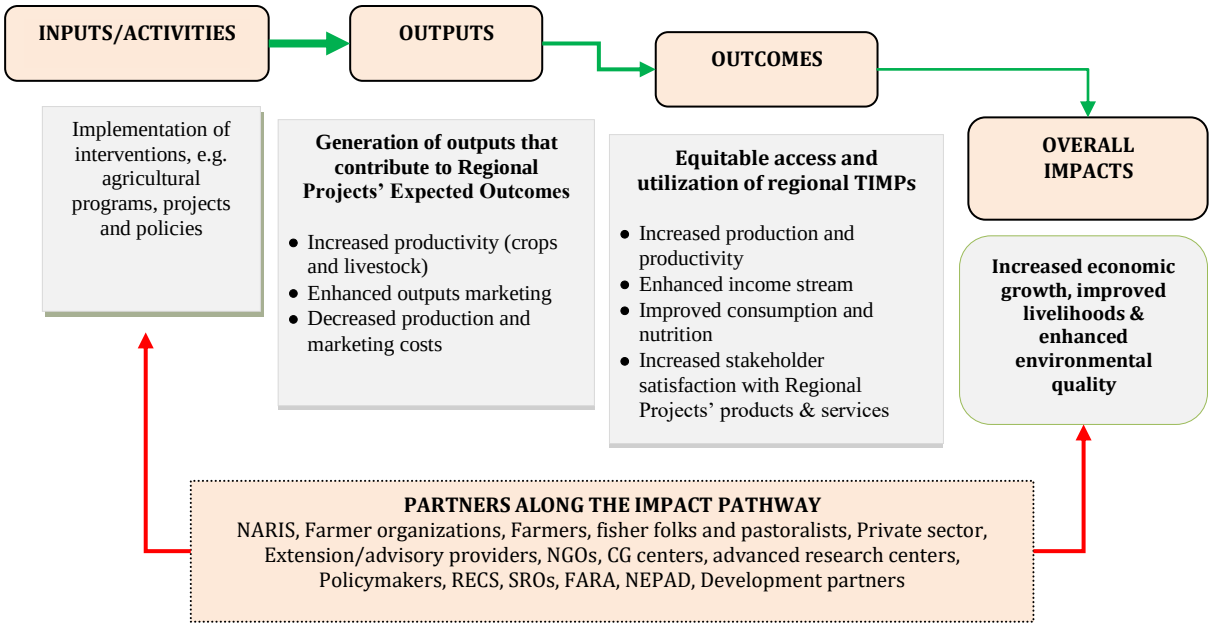
The aim of this chapter is to discuss the methodology of the research. It summarizes the conceptual framework underlying this study; provides the background to the research design; describes the location of the study area; besides illustrating the process of identification of the target population. The chapter further shows the process of sample size selection; reveals the data collection methods; and identifies the primary and secondary data sources. It describes the research instruments, including the econometric approaches; the statistical methods for data analysis and hypotheses testing used; as well as describes the data analysis procedures.

## 3.2. Conceptual Framework

### 3.2.1. Generalized Impact Pathway of Regional Projects

As part of developing the conceptual framework, the following theoretical impact pathway for regional projects was proposed (see Figure 1).

**Figure 1:** Theoretical impact pathway of regional projects in ensuring food security



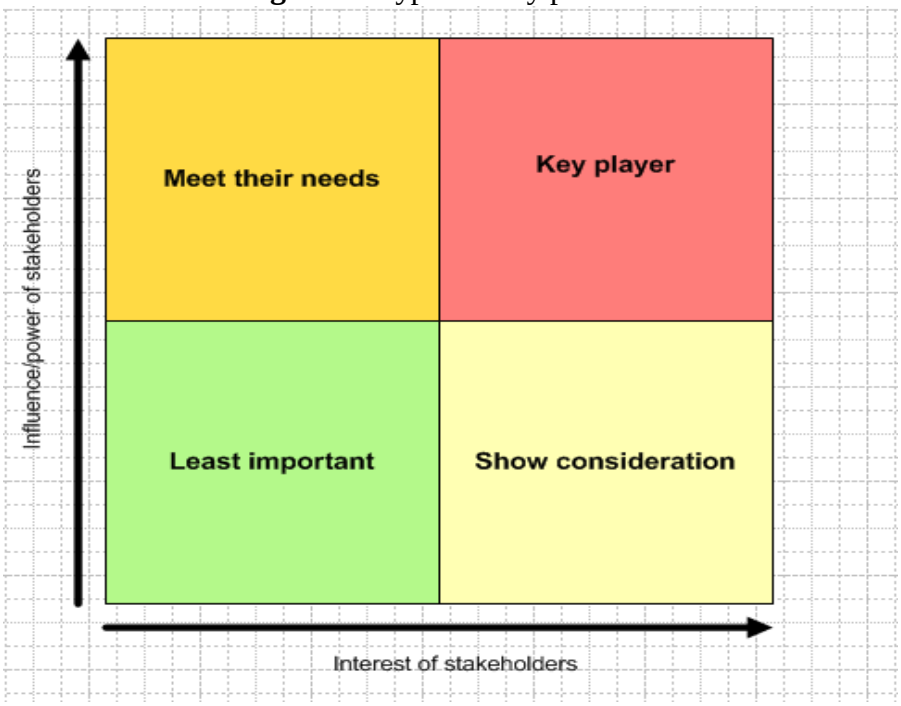

Source: Author's conceptualization

This pathway illustrates how targeted regional projects, together with participation of relevant key partners could contribute to increased economic growth and improved

livelihoods in the ECA. It is based on the prospective impact evaluation approach, whereby the researcher intends to assess whether the regional projects achieved the intended purposes, and also determine whether regional projects have more benefit packages than nationally or locally implemented projects.

On the other hand, the impact pathway also shows the different types of key partners that may determine the project performance. Their relationships with the projects are based on two main factors, namely: (i) how *influential* they are; and (ii) their degree of *interest* on the projects (Figure 2).

**Figure 2:** Types of key partners




Source: Bryson 1995:71-75

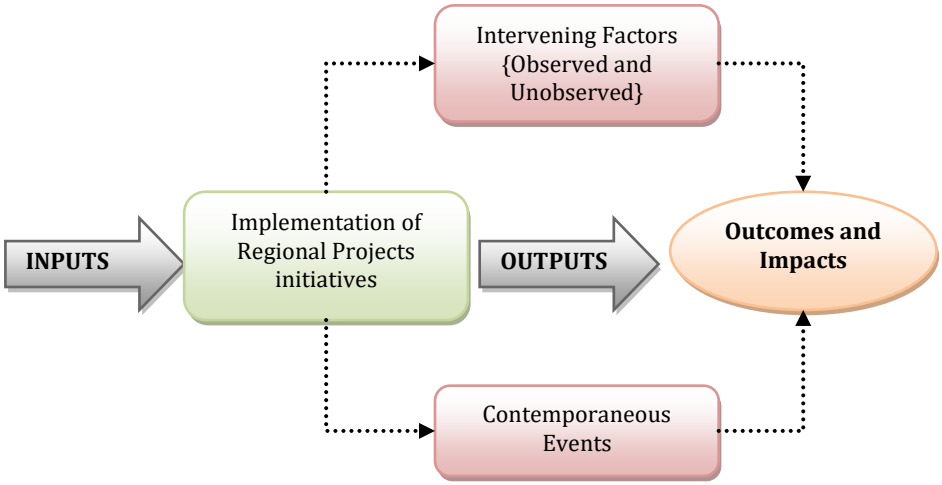
A combination of the two greatly influences the type of engagement that institutions and targeted communities could have. For instance, an interested and influential stakeholder is a key player.

### 3.2.2. The Results Chain

The study theorizes that since various organizations and associations took initiatives and implemented regional projects through National Agricultural Research Institutes (NARIs) using the available inputs such as agricultural development domains and

commodities as well as in making use of priority crops and staff, the expected outputs have been realized. The achievements of desired impacts of these regional projects are assumed to depend on some observed and unobserved intervening factors (such as enabling policy, regulations and legal frameworks, and conducive business environment), as well as to be influenced by some unpredictable contemporaneous events such as climate change, social and political support and stability, macroeconomic stability as well as infrastructure (see Figure 3).

**Figure 3:** Conceptual Results Chain




Source: Author's conceptualization

Both the intervening factors and contemporaneous events are further assumed to influence the type of outputs and outcomes generated from these regional projects. The desired impacts of these regional projects include: (i) new TIMPs generated and availed for uptake by the targeted (and even non-targeted) farmers; (ii) increased levels and rates of adoption of TIMPs; (iii) enhanced income generation; increased yields of selected commodities and areas under improved cultivars; (iv) enhanced policy analysis, harmonization and approval by various policymaking organs, including governments; (v) enhanced capacity development in terms of short- and long-term trainings, infrastructural development and establishment and/or strengthening of partnerships; (vi) enhanced development of knowledge products and associated delivery pathways; and (vii) willingness of stakeholders to adopt new TIMPs and new interventions with regional focus.

### 3.2.3. Impact Assessment Conceptual Framework

For the desired impacts of these regional projects to be realized, five inter-related, but non-linearly related external factors must be involved (Figure 4). These factors form part of the key attributes that contribute to the impact of regional projects.

First, there must be adequate agricultural infrastructure or potential to improve infrastructure. In this study, infrastructure is defined as facilities, structures, associated equipment, services (such as financial, markets and extension services), and institutional arrangements that facilitate the flow of agricultural goods, services and ideas. Mechanisms for integrated natural resource management must be availed, focusing on, among other key themes, integrated soil fertility management, climate change, and sustainable water management. It was anticipated that the regional projects contributed significantly to the advancement of market access, integrated water management, agro-processing and integrated soil fertility management. It was assumed that by linking farmers to markets, these regional projects were likely to have direct impact on increased marketed outputs, and thus incomes.

Second, strong and reliable partnerships and capacity development should be ensured (including involvement of scientists within the national agricultural research systems, government ministries, robust monitoring and evaluation systems, and user-friendly software). The governments are expected to influence agricultural infrastructure development. It is also expected that these regional projects created platforms for promotion of scientific research, creation of robust monitoring and evaluation (M&E) system, and interaction with governments and scientists.

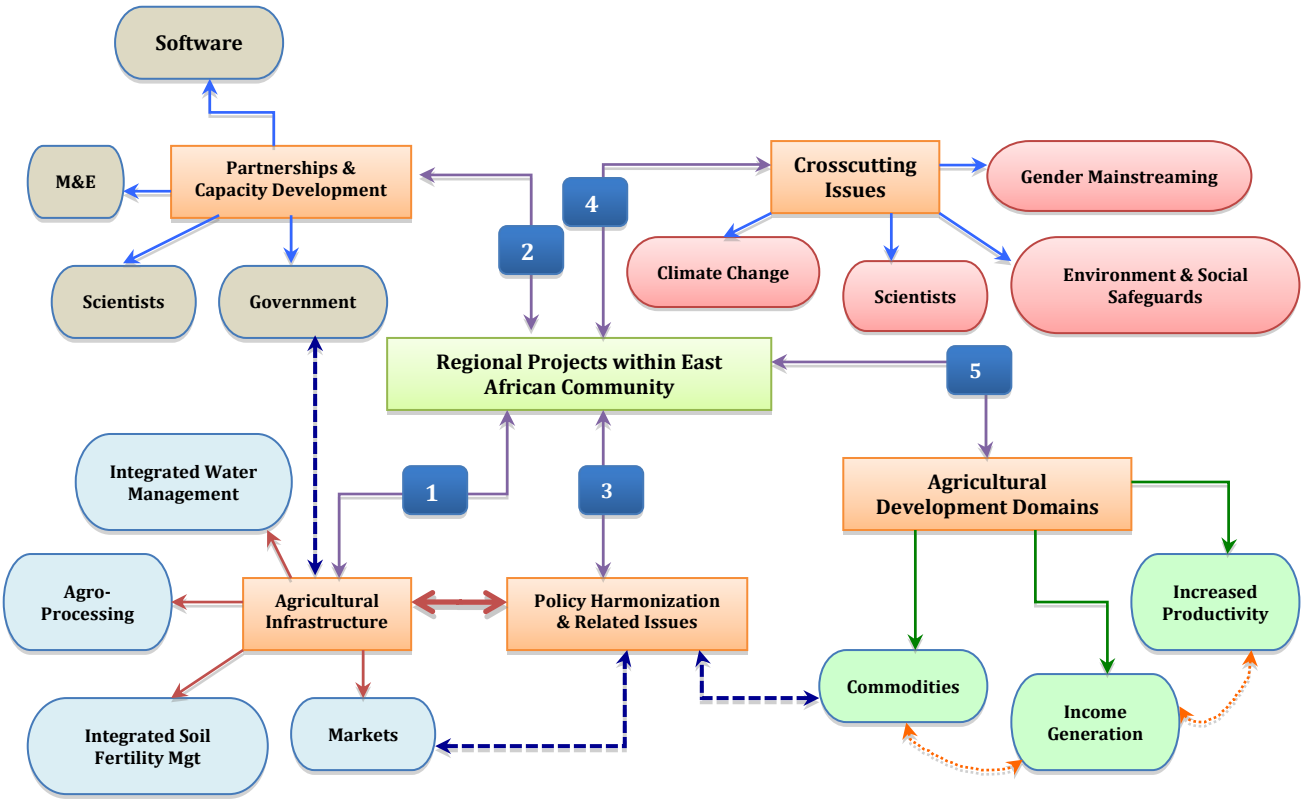
Third, appropriate policies that support agricultural development within all the selected domains (e.g. regional policy harmonization) should be ensured. These policies are therefore expected to influence choice of markets (some of which already exists), selection of commodities, as well as development of agricultural infrastructure. They should also contribute to the control of prices as well as create demand and supply equilibrium.

Fourth, crosscutting issues such as gender mainstreaming, environmental and social safeguards (ESS), knowledge generation, and climate change mitigation must be

taken into account since they are anticipated to influence the impacts of the targeted projects. The study anticipates determining the contribution of gender mainstreaming in adoption of TIMPs as well as effects of ESS on the choices of TIMPs.

Finally, all these factors must be supported within selected agricultural development domains. The main focus of interventions within the domains include: (i) anticipated increase in agricultural and livestock production and productivity; (ii) enhanced income generation among the targeted groups; and (iii) joint or coordinated selection of commodities. Selection of these commodities is assumed to be directly influenced by government policies (Step 3) and crosscutting themes (Step 4).

**Figure 4:** Impact Assessment Conceptual Framework



### 3.3. Background to Research Design

The research process is defined as a set of linked multi-stage procedures required for undertaking and completing a research project. The overall methodology followed Saunders et al. (2000) approach, whereby the stages of the research process were presented as layers (i.e. levels) of an "onion". In this case, the research process involved unfolding the layers of this onion one after the other, starting with the regional project philosophy, approach, strategy, time horizon, and data collection methods. Borrowing from Partington (2002) and Saunders et al. (2000), the research objectives were intended to guide many of the significant choices through the duration of the research.

According to Chisnall (1997), efficiency of research depends upon reliable and valid data collection. Similarly, Tull and Hawkins (1990) expounded on how primary data could be collected expressly to solve the current problem under assessment. In this study, data were collected using both qualitative and quantitative techniques. The information collection approach involved combining quantitative surveys with qualitative semi-structured key informant interviews and focus group discussions. This mixed approach of data collection was used to provide a rich databank and analytical power that would not be realized with any of the methods if used individually. Gender disaggregated data was collected as appropriate. The researcher engaged mixed methods approach, such as propensity score matching (PSM), double difference (difference-in-differences, DiD) as well as Likert Scale approach.

### 3.4. Location of the Study

#### 3.4.1. Introduction

The study was undertaken in the five countries of EAC, representing the regional intergovernmental organization of the Republics of Burundi, Kenya, Rwanda, Tanzania and Uganda, with its headquarters in Arusha, Tanzania. The Treaty for Establishment of the East African Community was signed on 30$^{th}$ November 1999 and entered into force on 7$^{th}$ July 2000 following its ratification by the Original 3 Partner States – Kenya, Uganda and Tanzania. The Republic of Rwanda and the Republic of Burundi acceded to the EAC Treaty on 18$^{th}$ June 2007 and became full Members of the Community with effect from 1$^{st}$ July 2007.

It has a population of 143.5 million, with an annual growth rate of 2.9% (Partner States, 2014). It has a Gross Domestic per capita of US$ 769and a combined GDP of US$ 50billion (EAC, 2014). The Community was set up to widen and deepen cooperation among the Partner States in, among others, political, economic and social fields for their mutual benefit. Agriculture is among the leading economic sectors in EAC. It provides a livelihood to about 80%of the population and accounts for about 35% to the GDP in Burundi, 28% in Kenya, 32% in Rwanda, 28% in Tanzania and 23% in Uganda (World Bank, 2012 and ADB, 2010).

The region has a total surface area of 1.82 million square kilometres, out of which over 100,000km$^2$ represent water bodies. Tanzania accounts for slightly over half (51.7%) of the surface area while Burundi and Rwanda account for equal share of the surface area at 1.5%. Kenya and Uganda account for 32.1 and 13.3%, respectively. The region has a total land area of 1,716.7 thousand square kilometres

Table 1: Economic Profile and Contribution of Agriculture to EAC Economy, 2011

| **Economic Indicator** | **Burundi** | **Kenya** | **Rwanda** | **Tanzania** | **Uganda** | **Average** |
|---|---|---|---|---|---|---|
| Population, total (million) | 9.4 | 41.8 | 10.9 | 46.2 | 35.4 | 143.5* |
| Population growth (annual %) | 2.4 | 1.3 | 2.2 | 2.7 | 3.6 | 2.9 |
| GDP (USD billion) | 2.7 | 4.4 | 74.5 | 33.3 | 22.8 | 22.1 |
| GDP growth (annual %) | 4.8 | 4.7 | 4.6 | 7.0 | 4.7 | 5.2 |
| GDP per capita (current US$) | 294.2 | 1,055 | 709.4 | 742.6 | 633.6 | 768.9 |
| Agricultural land (% of land area) | 86.4 | 48.2 | 77.8 | 42.1 | 70.4 | 46.0** |

*Total population; **% of total land cover of 1.82 million km$^2$.

Source: EAC Facts and Figures, 2014

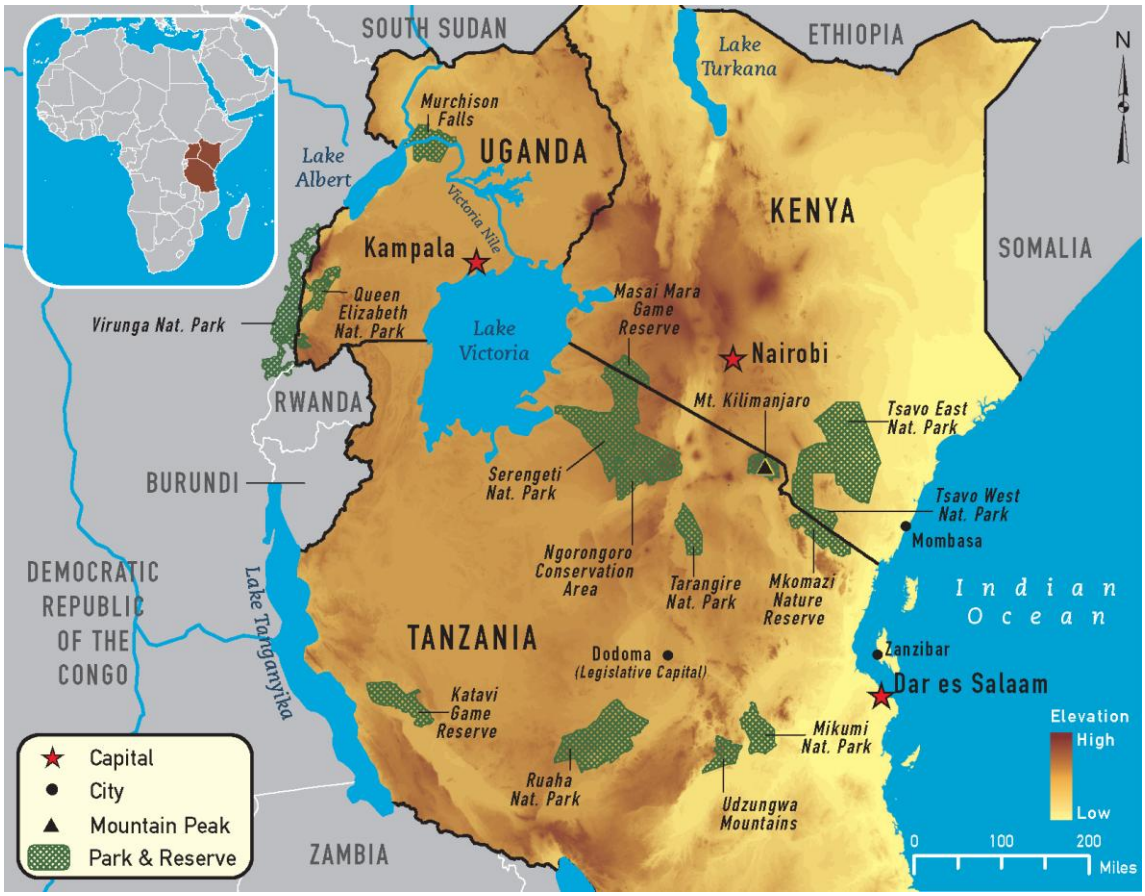
The region is also one of the leading producers of commodities such as bananas, sweet potatoes, peas, millet, and dry beans. Nearly all of these commodities are highly perishable and are grown by smallholder farmers. Given the low average land sizes dedicated to crop production among the smallholder farmers, challenges have been experienced in putting these agricultural products on the market. Since most of the smallholder farmers persistently experience food deficits, besides facing tight challenges in breaking-even in their farming engagements, they lease out their lands to private investors, or even to other farmers, thereby generating some meager

revenues for domestic purposes.

### 3.4.2. Geographical Location

The EAC region is located between $5^0$30`N $12^0$Sand $28^0$45`E $41^0$S 50`E (Figure 5).

**Figure 5:** East African Community countries




Source: Google maps, 2014

### 3.5. Target Population

As already indicated, the target group includes small-scale farmers as well as traders, processors and key players along the selected agricultural commodity value chains.

### 3.6. Sample Size Selection

A multi-stage sampling technique was used to select representative smallholder farming households and other targeted respondents for interview and data collection. Household surveys were conducted with 1,160 beneficiaries and non-beneficiaries in the targeted countries (out of the 1,260 originally planned), using a standardized questionnaire (Appendix 4). The study targeted 60% beneficiaries and 40% non-

beneficiaries, and eventually reached 60.5% and 39.5% of the targeted groups respectively. On the other hand, at least 40% of the targeted respondents were to be women. Both the beneficiaries and non-beneficiaries were randomly selected from the four different agricultural development domains. The regional projects implemented in at least three countries were selected for the study, as follows:

Stage 1: In this stage, convenience or purposive sampling technique was used to select four agricultural development domains, namely: HLL, HLH, HHH and LLL (out of the eight domains in the EAC sub-region, viz.: HHH, HHL, HLH, HLL, LHH, LHL, LLH, and LLL). The four domains were purposively selected because of their potential to support agriculture-based growth in the study area, as well as to provide wider scope for rapid agricultural development. In total, these selected domains cover over 70% of EAC croplands.

Stage 2: After selection of these four domains, only the projects implemented in at least three countries were identified. Given that there were over 90 regional projects already implemented within the EAC during this study, the researcher classified these projects according to the country combinations or clusters. Through this criterion, seven (out of the 16 clusters) were randomly selected (Table 2 and Appendix 1).

Table 2: Sampling Frame

| Cluster No. | Country Clusters | Selected Commodity | No. of Projects | Number of Respondents |
|---|---|---|---|---|
| | BKU* | Potato | 3 | 130 |
| | BRU | Beans | 2 | 140 |
| | KTU | Maize, Sorghum | 7 | 150 |
| | RTU | Livestock | 1 | 180 |
| | BKRU | Banana | 1 | 140 |
| | BKTU | Cassava | 3 | 210 |
| | All countries | Maize, livestock | 6 | 210 |
| | | | 23 | 1,160 |

* B = Burundi; K = Kenya; R = Rwanda; T = Tanzania; and U = Uganda

Stage 3: Within the selected domains and country clusters, seven priority crops for the region were selected, namely: maize, beans, cassava, sorghum, potatoes, bananas, and livestock (especially milk and forage). For instance, in Burundi, Rwanda and Uganda

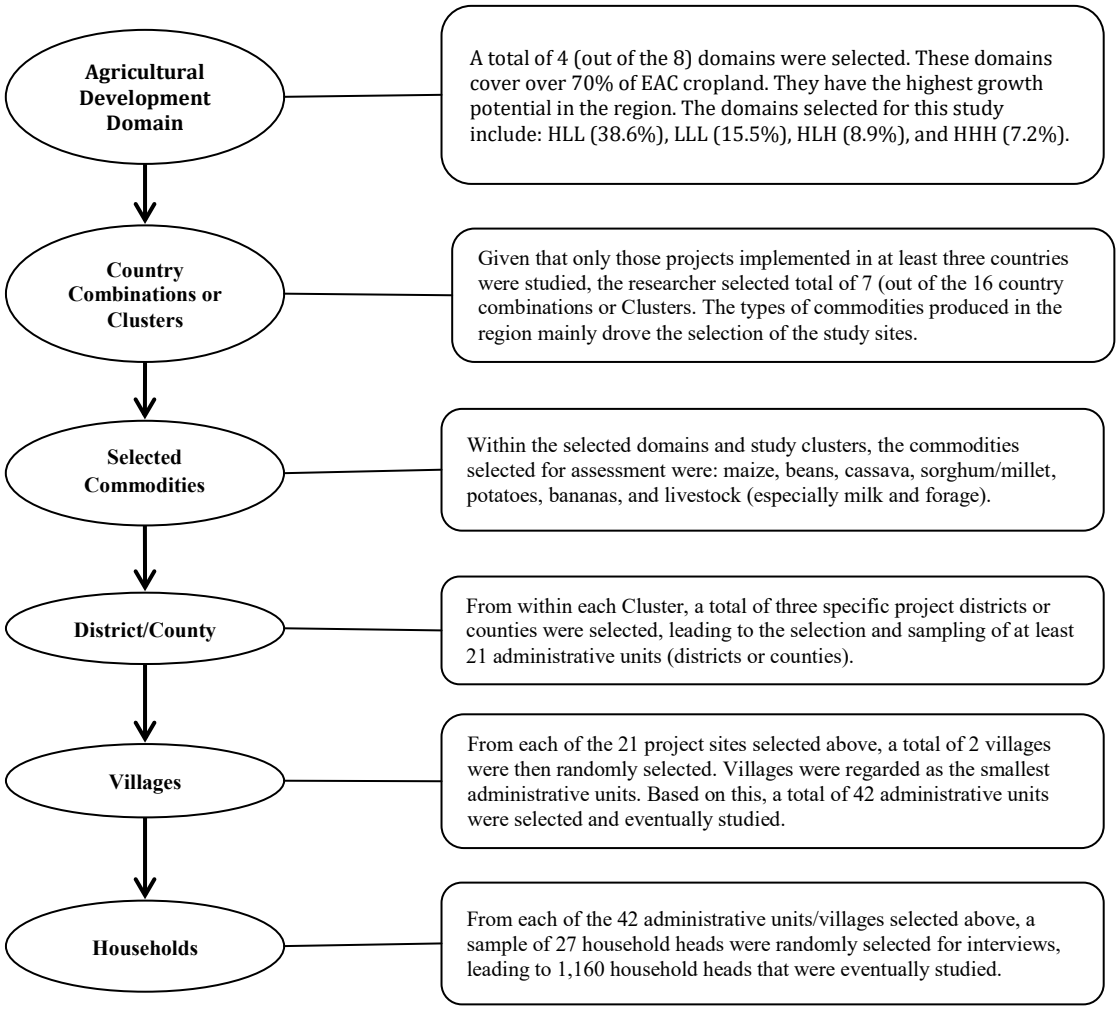
(BRU) cluster, the impact of bean technologies was assessed, while in Rwanda, Tanzania and Uganda (RTU), livestock were targeted.

Stage 4: In this stage, at least 3 project districts or counties were selected from within each cluster. These districts were within the project catchment areas where the (7) targeted commodities were supported. At least 21 administrative units were sampled.

Stage 5: In this study, the smallest unit is the household level. This stage therefore involved random selection of the smallest administrative unit where the projects were implemented. From each of the 21 project sites selected above, two villages were randomly selected (taking into account the control groups or non-project beneficiaries). Thus, a total of 42 administrative units were studied.

Stage 6: In this final stage, a representative sample of at least 30 household heads was selected from each of the 42 villages (whose populations are estimated to be 18,000). The minimum number of respondents that was earlier anticipated was 1,260. However, the final number of respondents selected was 1,160, and they comprised mainly the farming households, traders, processors, private sector investors, and other targeted stakeholders. The assessment took into account the different gender and socioeconomic differences and variability of the respondents within the EAC block. The above steps were schematically represented as shown in Figure 6.

**Figure 6:** Stepwise approach to sample size selection




Source: Author's conceptualization

## 3.7. Data Collection Methods

### 3.7.1. Introduction

Data is defined as: "*the facts that are presented to the researcher from the research environment. Data is characterized by its abstractness, verifiability, elusiveness and closeness to the issues being studied*" (Cooper and Schindler, 2003). Sekaran (2003) stated that data could be obtained from primary and secondary sources. Generally, primary data refers to the information obtained first hand by the researcher regarding the research variables.

Hox and Boeije (2005) argued that every time a social scientist collects primary data, a new contribution to the overall knowledge is made. This explains the significance of collecting primary data as it contributes to the novelty of research projects. On the

other hand, secondary data refers to information that the researcher collects from existing sources (Blumberg et al., 2008). In general, Saunders et al. (2000) recommended combining primary and secondary data in the same study.

### 3.7.2. Primary Data Collection Methods

Primary data was collected through targeted and focused interviews, administered questionnaires, observation, and focused group discussions, including farm and household surveys. Given that several groups of people were involved in priority setting (and eventual selection of the projects), data collection also targeted them, viz.: the science community at large; consumers' interest groups; rural development community; farming community, agro-industry, private sector; "public opinion" as well as CGIAR.

In the absence of baseline data, a Case Study Control approach was used to control for non-project impacts, involving random selection of at least 40% of non-project beneficiaries from the same agricultural development domains. It comprised socioeconomic and demographic characteristics of farmers such as age, sex, education level, household size, frequency of visits by extension agents, sources of household income, crops grown and TIMPs available for selection and utilization by the farmers.

Data on selected farmers' indicators were collected, such as: use of different TIMPs already availed to the farmers, source of TIMPs, annual change in yields per hectare, problems faced in using these TIMPs, access to markets, infrastructural support, and capacity development. Selection of variables was based on the probability of participating in the regional projects and with the outcomes of interest (Heckman and Navarro-Lozano, 2004).

### 3.7.3. Secondary Data Collection Methods

On the other hand, secondary data collection methods included collecting documentary data, such as archives, publications, annual reports, newspapers, and surveying the Internet (Hox and Boeije, 2005; Sekaran, 2003). Other targeted data were collected from government departments (especially in the Ministry of Agriculture and Livestock Development and Central Bureau of Statistics), maps, evaluation reports, FAO, IFPRI, World Bank and USAID statistics, aerial

photographs and satellite images.

In this study, mixed methods approach as suggested by Waters (2001), who recommended combining both quantitative and qualitative approaches in the same study in order to improve the decision-making process, was adopted. Bryman and Bell (2007) also argued that combining quantitative and qualitative data in the same study enables triangulation to be applied. Based on the above preposition, quantitative approach was used as the dominant approach, while qualitative method was used as the less-dominant approach, mainly to augment the quantitative data.

### 3.8. Research Instruments

Selected mixed methods approaches, namely the double difference and propensity score matching were used during data collection. Statistical tests for differences between the project participants and non-project participants were used to determine statistical significance. The following section provides brief description of each approach.

#### 3.8.1. Double Difference or Difference-in-Differences (DiD)

This method is used to estimate the effect of regional projects on selected indicators, including adoption of TIMPs, crop and livestock productivity, and income from agriculture. This approach is applied where the control or comparison groups are not perfectly comparable. Baseline survey data are used as well as evaluation surveys. In this study, the household historical data were collected from the recall of the respondents.

The main assumption for the validity of this method is that the difference between "before" and "after" in the comparison group is a good counterfactual for the treatment group. It accounts for potential sources of selection bias and to compare treatment and comparison groups in terms of outcome changes over time relative to the outcome observed for a pre-intervention baseline (Khandler et al., 2010).

The following equation is used to estimate the impact of the interventions:

$$Y_{it} = \alpha + \Upsilon_t + \delta T_{i1} t + \varepsilon_t \quad (1)$$

Where:

$Y_{it}$ = individual *i*'s benefits (in terms of income, yield or productivity) accrued from engagement in the projects at time *t*;

$Y_i$ = the regressor that controls for fixed average differences between beneficiaries and non-beneficiaries;

$T_{i1}t$ = engagement in intervention at time *t* (T = 1 if household engages in intervention, e.g. adoption of new TIMPs, and T = 0 if otherwise);

*t* = round of survey (t = 0 for baseline; t = 1 for follow up);

$\delta$ = impact of intervention (double difference). It represents the interaction between the post-project engagements ($T_{i1}$) and time (t = 1,…,T);

$\varepsilon_t$ = the error term.

### 3.8.2. Propensity Score Matching (PSM)

Non-parametric propensity score matching (PSM) methods was used to estimate the effects of the treatment, which here refers to participation in the regional projects. This technique, first introduced by Rosenbaum and Rubim (1983), involves pairing individuals between two groups, treatment and control, using a large set of information on those individuals. This technique is one of the preferred approaches in reducing bias in effect estimates (Khandler et al., 2010; Glazerman et al., 2003; Diaz and Handa, 2005; Cook et al., 2008; Henry and Yi, 2009).

The beneficiaries and comparable non-beneficiaries were matched using propensity score, which is the estimated probability of being included in the regional projects. Only the beneficiaries and non-beneficiaries with comparable propensity scores were used to determine the effect of these regional projects. The parameter of interest in this study is the average treatment effect of these regional projects ($ATT_j$). It is calculated as the mean difference in outcome across these two groups (Equation 2):

$$\mathbf{ATT_j = E[I_{1j} | RP_j = 1] - E[I_{0j} | RP_j = 0]} \quad (2)$$

Where,

$ATT_j$ = Impacts of the regional projects measured as the average treatment effect of the treated for each project;

$I_{1j}$ = Value of the outcome of farm household (or other participating entity) after participation in the program;

$I_{0j}$ = Value of the outcome of the same farm household j if he/she had not participated in the project (or participated in a similar national project);

$RP_j$ = Regional projects, where 1 indicates participation, and 0 otherwise

In this study, predicted values from the standard logit model were used to estimate the propensity score for each observation in the participant and the comparison-group samples. Using the estimated propensity scores, Ṕ(X), matched-pairs were constructed on the basis of how close the scores were across two samples. The nearest neighbor to the $i^{th}$ participant is hereby defined as the non-participant that minimizes $[p(X) - p(X_j)]^2$ over all $j$ in the set of non-participants, where $p(X_k)$ is the predicted odds ratio for observation $k$, i.e.

$$\boldsymbol{p(X_k) = \frac{\acute{P}(X_k)}{1-\acute{P}(X_k)}} \quad (3)$$

Letting $\Delta Y_j$ denote the benefits for the $j^{th}$ unit attributable to the regional projects, the PSM estimator of mean impact is estimated as follows:

$$\Delta\bar{Y} = \sum_{j=1}^{T} \omega_j [(Y_{j1} - X_j\hat{\beta}_0)] - \sum_{i=1}^{C} W_{ij} [(Y_{ij0} - X_i\hat{\beta}_0)] \quad (4)$$

Where

$Y_{j1}$ = post-intervention indicator of success;

$Y_{ij0}$ = outcome indicator of the $i^{th}$ non-treated matched to the $j^{th}$ treated;

$T$ = total number of treatments;

$C$ = total number of non-treated households;

$\omega_j$ = sampling weights used to construct the mean impact estimator;

$W_{ij}$ = weights applied in calculating the average benefits of the matched non-participants;

$\hat{\beta}_0$ = the OLS estimate for the comparison group sample

Through comparisons with experimental estimators, Heckman et al. (1997, 1998) showed that PSM provides reliable, low-bias estimates of program impacts provided that (i) the same data source is used for participants and non-participants, (ii) participants and non-participants have access to the same markets, and (iii) the data includes meaningful explanatory variables capable of identifying program participation.

### 3.9. Data Analysis

Given that this study assesses the impact of regional projects, thus demanding a reliable control group, the reflexive and randomized controls methods were adopted. In reflexive controls, participants who receive the interventions are compared to themselves before and after receiving the intervention. In the randomized controls, individuals are randomly placed into two groups: those that received the interventions and those that did not. Through this method, the impact of regional projects was determined by comparing the means of outcome variables. Based on the above, regression with both binary and continuous dependent variables was used. This is because of the assumption that the individuals, households, institutions and countries that participate in these regional projects/initiatives are self-selecting.

In addition, statistical data were analyzed using the Statistical Package for Social Sciences (SPSS) program for windows. Initial analysis was anticipated to generate descriptive statistics in form of means, modes and frequency distributions. These statistics were graphically presented in tables and charts. Chi-square tests were performed to test for independence in some parameters thought to be related. As is usually the case, the goodness of fit is determined on the basis of the Pearson's correlation coefficient ($R^2$) the F-values, and the level of significance of the independent variables. Relationships between each attitudinal scale and discreet categorical variables were investigated with the help of the Student's t-test for unpaired samples.

### 3.9.1. Data Analysis Procedures for Objective 1

#### 3.9.1.1. Measurement of Spillover Effects

In order to determine the effectiveness of the regional projects concept and its contribution to generation of regional public goods for end-users, the researcher measured, among other things, the across-location, across-commodity and price spillovers. Since the scientists in the research stations in the participating countries availed the jointly developed TIMPs for uptake and scaling out, assessment of across-location spillover effects were conducted. This joint collaboration in the implementation of the regional projects is assumed to have given room for the adoption and adaption of the new TIMPs availed at various locations. The potential or effects of spillovers of selected TIMPs generated and availed to the targeted stakeholders were estimated as follows:

$$S_{ij} = \frac{Y_{ij}}{Y_{jj}} \tag{5}$$

Where,

$S_{ij}$= the potential of the spillovers of the TIMPs

$Y_{ij}$= the yield of the variety *j* in environment *i*

$Y_{jj}$= the yield of variety *j* within the environment *j* for which this variety was initially developed, tested and made available to the farmers,

#### 3.9.1.2. Estimation of Land Productivity per Hectare

Value productivity of the land per hectare was estimated for each crop planted. Estimates of areas under each crop were recorded as cited by the crop farmer, as well as through observation. The harvest (farm-gate) prices were used for these estimates (and discounted to reflect the different time lines), and the following formula used in the estimation of value productivity for each crop.

$$C_j = \left[ \frac{\sum_{i=1}^{N} [A_i * Y_i * P_i]}{\sum_{i=1}^{N} A_i} \right] \tag{6}$$

Where,

$C_j$ = Value productivity per hectare for the $j^{th}$ crop;

$A_i$ = Area under the $i^{th}$ crop (hectares);

$Y_i$ = Yield per hectare of the $i^{th}$ crop (metric tons);

$P_i$ = Farm harvest price of the $i^{th}$ crop

Byerlee (1995) reported that the extent of spillover, i.e., the size of $S_{ij}$(Equation 5) depends on various factors, including: agro-ecological similarity between the originating and the receiving region, local food tastes and preferences, factor prices, institutional factors (land tenure and intellectual property rights), historical and cultural links between countries, geographical proximity, complexity of the problem, and other institutional factors (the research networks and the level of intellectual property rights).

Across commodity spillover effects were assessed by tracking the number and impacts of TIMPs whose development and scaling out had influenced applicability across other commodities. This is based on the premise that the spillover mechanisms for some TIMPs are not confined to a single commodity, and that resource- or input-based TIMPs may be relevant to several commodities. Similarly, the role of the regional projects in influencing price spillover effects was assessed. This is based on the assumption that the adoption, adaption and utilization of availed TIMPs at a specific location are likely to increase the supply, and thus change the price of that commodity in the same and/or other locations through trade.

#### 3.9.1.3. Farmers' Willingness to Pay for Agricultural Services

In the natural environment, a person's willingness to pay a price premium for any utility decreases as the price premium of that utility or commodity increases, as is regulated by the law of demand. Similarly, in the consumer behavior theory, consumers' choices are made in order to create equilibrium between the marginal utility and the marginal price of one unit of quality-food products.

In this study, willingness to pay (WTP) for specific services (e.g. extension or low toxicity pesticides) refers to the sacrifice of current income in order to sustain or increase agricultural productivity in the future. Selected approaches such as contingent valuation and shadow pricing are being used. It some scenarios, it is measured at nominal level as a dichotomous variable of Yes (1 point) and No (no point). From the list of stakeholders, farmers are asked to indicate services they are

willing to pay for, and how much (in local currency) they are willing to pay for such services. Descriptive statistics are used to analyze the socioeconomic features of the farmers, while the probit model is used to capture the factors determining farmers' willingness to pay for these services.

In this study, the minimum expenditure level required to achieve the initial utility level is given by

$$\boldsymbol{e(p, AU_0, P_0)} \tag{7}$$

Where

$p$ = the vectors associated with the prices of services

$AU_0$ = the current stakeholders' anticipated utility level

$P_0$= the set of previous or old agricultural services and farm characteristics.

Based on this model, the WTP in order to sustain the current levels of productivity are estimated as follows:

$$\boldsymbol{WTP = e(p, AU_0, P_0) - e(p, AU_0, P_1)} \tag{8}$$

Where,

$WTP$= the amount that still leaves the household indifferent between the expected marginal utility under the old set of TIMPs and the discount expected marginal utility of the anticipated change in income through use of new TIMPs;

$P_1$ = the new set of agricultural services and farm characteristics following use of new TIMPs.

Shadow pricing is used to quantify intangible outcomes and assign monetary values for non-market goods. This process, as outlined by Hares and Royle (1994; cited in Murphy and Simon, 2002) involves identifying outcomes, making outcomes measurable, predicting the benefits of each outcome level and evaluating the benefits of outcomes in cash flow terms. In this study, the list of all intangible outcomes was made, and a method of measuring these intangible outcomes (e.g., an index describing levels of utilization of availed TIMPs) developed. A survey and comparative study was undertaken to link each point on the measure with predicted benefits, before eventually valuing these benefits and turning them into cash flow terms.

The relationship between the probability of the willingness to pay $WTP_i$ and its determinants, φ is given as

$$WTP_i = \beta\varphi_i + \mu_i \quad \textbf{(9)}$$

Where:

$WTP_i = 1$ for $X_i \leq Z$; $i = 1, 2, \ldots\ldots, n$

$\varphi_i$ is a vector of explanatory variable

β is the vector of parameters

$\mu_i$ = the random error term.

The logit model computes the maximum likelihood estimator of β given the non-linear probability distribution of the random error ($\mu_i$). The dependent variable $WTP_i$ is a dichotomous variable which is 1 when a farmer is willing to pay, and 0 if otherwise.

The explanatory variables are:

$X_1$ = age in years

$X_2$ = dummy variable for gender (Male = 1; female = 0)

$X_3$ = dummy variable for educational level (at least 5 years of education = 1, less than 5 years of education = 0)

$X_4$ = dummy variable for marital status (married = 1; others = 0)

$X_5$ = farm size in hectares

$X_6$ = farming experience in years

$X_7$ = dummy variable for land tenure system (land owner = 1; others = 0)

$X_8$ = household size (number of persons)

$X_9$ = number of monthly contacts with agricultural service providers (extension)

$X_{10}$ = income (local currency)

$X_{11}$ =proportion of crop sold (percentages).

### 3.9.2. Data Analysis Procedures for Objective 2

The changes in outcome due to natural trend and all other events were computed as the difference before and after for the control group as follows:

$$\bar{y}_{C1} - \bar{y}_{C0} = \frac{1}{N_C}\sum_{j \in C} y_{j1} - y_{j0} \quad (10)$$

This was followed by the computation of the change in outcome due to natural trends and all other events and the program. This was computed as the difference before-after for the treatment group as follows:

$$\bar{y}_{T1} - \bar{y}_{T0} = \frac{1}{N_T}\sum_{i \in T} y_{i1} - y_{i0} \quad (11)$$

Therefore, the impact of the regional projects (RP) was estimated as follows:

$$RP = (\bar{y}_{T1} - \bar{y}_{T0}) - (\bar{y}_{C1} - \bar{y}_{C0}) \quad (12)$$

The result has been estimated using regression analysis. For each observation unit *i*,

$\delta_i$ = 0 if observation *i* is from the baseline, $\delta_i$ = 1 if it is from follow-up.

$T_i$ = 1 if in the treatment group, and $T_i$ = 0 if in the comparison group.

Regressing the outcome of the regional projects on δ, T, and the product δT leads to the following regression equation:

$$y_i = a + b\delta_i + cT_i + d\delta_i T_i + \epsilon_i \quad (13)$$

Where,

a = constant term

b = specific effect of the treatment group which accounts for average permanent difference between the treatment and control groups

c = time trend common to both the treatment and control groups

**d** = desired effect of the regional projects (treatment).

Thus,

$\bar{y}_{T1}$ = a + b + c + d; $\bar{y}_{T0}$ = a + c; $\bar{y}_{C1}$ = a + b; $\bar{y}_{C0}$ = a; $\epsilon$ = error term

Therefore, the impact (*RP*) = *d*. It determines the impact of the regional projects on crop and livestock productivity, as well as agricultural income, among other variables.

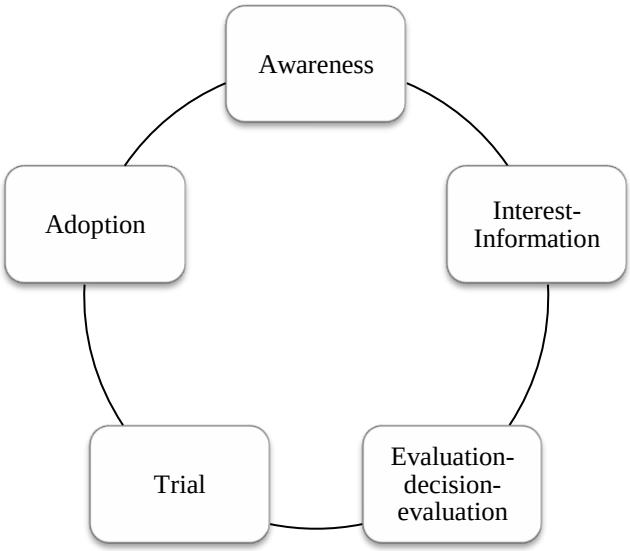
### 3.9.3. Data Analysis Procedures for Objective 3

There is always a time lag between the origin of a new idea and its complete adoption. In this study, diffusion and adoption processes that help bring new ideas about TIMPs from their source of initial development to acceptance by farmers were assessed. Assessment of diffusion process includes determination of the processes by which new farm practices or ideas are communicated from sources of origin (i.e. scientists) to the farmers.

#### 3.9.3.1. Adoption Stages

Technology adoption refers to the actual use of the technology at the individual farm level as well as at the aggregate population level. Generally, adoption as a process undergoes several stages, namely interest formation; evaluation-decision-evaluation of all the interests formed; trials as well as actual adoption (Figure 7).

**Figure 7:** Assorted Adoption Stages




Source: Author's conceptualization

In this thesis, the adoption process of TIMPs was determined by categorizing farmers into five specific groups, depending on the adoption stages, namely:

1) Awareness. This was aimed at critically assessing whether the farmer knew about the new idea or TIMPs (e.g. the name of the TIMPs), but lacked vital information about that idea or TIMPs;

2) Interest-information. This focused on determination of whether the farmer was interested in the idea already aware of, and the extent to which that farmer sought for more information about it (e.g. how it worked and what its potentialities are);

3) Evaluation-application-decision This stage involved assessment of whether the farmer made any mental application of the new idea to his/her present and anticipated future situation, and whether the farmer made any decisions either to try it or not;

4) Trial. This stage involved determination of whether the farmer used the new idea, applied the TIMPs, and/or practiced it on the farms to validate its workability; and

5) Adoption. This final stage included appraisal of whether the farmer actually used the new idea and TIMPs on a full scale, and also the extent to which the farmers incorporated these new TIMPs onto their agronomic practices.

In each of the stages in this process, the main sources of information on available TIMPs were documented. This involved the assessment of level of accessibility to the ideas and TIMPs, the main sources of vital information, the common delivery channels for the information, as well as accessibility to the various markets. The study focused on how the available information was packaged and disseminated to the relevant target groups through the regional projects.

#### 3.9.3.2. Analytical Model

To evaluate farmers' adoption decisions to adopt any TIMPs, a Logit model (Maddala, 1983) is used. For simplicity, let $P_i$ be the probability that a farmer adopts the availed TIMPs, and X, a vector of explanatory variables related to adoption. In this study, vector X has been assumed to be a function of three sets of factors: (a) land tenurial rights held by the farmer where the targeted TIMPs may be implemented; (b) socioeconomic characteristics of the targeted farmers; and (c) village-specific characteristics.

The probability of adopting a particular TIMPs by the farmer is specified as $P_i = f(X,$

ε), where ε is the error term with a logistic distribution. Logit model has been widely applied in adoption studies (Bagi, 1983; Polson and Spencer, 1991; Adesina and Sirajo, 1995).

Based on the above, the conceptual model is here defined as:

$$P(y = 1) = \frac{\exp(x\beta)}{1+\exp(x\beta)} \quad (14)$$

$$P(y = 0) = \frac{1}{1+\exp(x\beta)} \quad (15)$$

Where the dependent variable, *y*, takes the value of 1 if a particular TIMPs is adopted, and 0 otherwise; x is the vector of independent variables, which may include a constant; and β is the corresponding parameter vector. The larger the xβ, the higher is the probability of adoption of the TIMPs.

The implicit models of the probability of adoption of the targeted TIMPs is determined through the following logit model:

$$log\left\{\frac{P_i}{1-P_i}\right\} = \beta_0 + \beta_1 SEX_i + \beta_2 AGE_i + \beta_3 EDU_i + \beta_4 HHS_i + \beta_5 NTV_i + \beta_6 OFI_i +$$
$$\beta_7 FSZ_i + \beta_8 ACC_i + \beta_9 LBF_i + \beta_{10} EXT_i + \beta_{11} FO_i + \beta_{12} LTN_i + \varepsilon_i \quad (16)$$

Where

$P_i$ = the status of the adoption of specific TIMPs, *i* measured as a dummy (dichotomous) variable

SEX = gender of the respondent

AGE = age in years

EDU = education status

HHS = household size

NTV = nativity of the farmer

OFI = off-farm income

FSZ = farm size

ACC = access to TIMPs

LBF = labour force size

EXT = contact with extension staffs

FO = membership in farmer organizations

LTN = land tenure system

$\varepsilon_i$= a random error

*i* = the household.

### 3.9.3.3. Empirical Model

Explanatory variables in the empirical model and their justifications are as hereby described:

1) SEX is a dummy variable that indexes the gender of the adopter of the TIMPs. In this study, it was assigned a value of 1 for men and 0 for women. It was also hypothesized that SEX is positively related to adoption.

2) AGE measures the number of years of life of the farmer. Past studies have shown that young farmers have tendency to be more innovative due to their longer planning horizons and lower risk aversion (Bagi, 1983; Gould et al., 1989). For instance, Polson and Spencer (1991) found that younger farmers had greater likelihood of adopting cassava-improved varieties in southwest Nigeria. In this study, it was hypothesized that AGE is negatively related to adoption of the availed TIMPs.

3) EDU in this study measures the number of years of education of the targeted farmer. Actual number of years of schooling was collected. It is expected that education enhance capacity for creativity and innovation, such that the more educated farmers have been found to have greater likelihood of adopting soil conservation technologies (Ervin and Ervin, 1982). It was therefore hypothesized that EDU is positively related to adoption of selected TIMPs.

4) HHS measures the size of the household. Given that the adoption of some of the TIMPs is a highly labour intensive venture, and given that family labour is the major source of labour for farming households, larger families with more labour supply would be expected to adopt the TIMPs. On the other hand, large families are also more likely to face lower per-capita land availability and high dependency ratios for food requirements. In such cases, these families are very

likely to lease more land so as to extend cultivated area to meet food requirements rather than putting their land under other land use options to the detriment of food crop area. In this study, it is hypothesized that HHS is negatively related to adoption of selected TIMPs.

5) NTV is a dummy variable that takes the value of 1 if the farmer is a native of the village, and 0 if non-native. The utilization of selected TIMPs usually requires the availability of enough land at the disposal of the farmer, especially land under secure long-term control. In this case, migrants are more likely to face land constraints that may reduce the likelihood of their adoption of the TIMPs. It is therefore hypothesized that NTV is positively related to adoption of availed TIMPs.

6) OFI is a dummy variable that measures if the farmer has non-agricultural (off-farm) incomes. It is anticipated that having non-agricultural incomes is likely to empower the farmers to meet their capital costs for implementation of the TIMPs. Studies have shown that non-farm income positively influence adoption of new TIMPs (Savadogo et al., 1994; Adesina, 1996). It is therefore hypothesized that OFI is positively linked to adoption of TIMPs.

7) FSZ refers to the size of the farm (in hectares) owned by the farmer, and on which the TIMPs may be implemented. It is hypothesized that the larger the farm size owned, the higher the probability of adopting the TIMPs.

8) ACC is a dummy variable that measures if the farmer has full access to the existing TIMPs. This is a composite variable that captures the farmer's ease of getting the TIMPs; right to use the TIMPs on the farm; and rights to dispose the TIMPs. It is hypothesized that if farmers have access to TIMPs, the likelihood of adopting them increases.

9) LBF refers to the number of persons within the family that could be engaged in the farmlands. It is hypothesized that if farmers have enough labour force, the likelihood of adopting the TIMPs increases.

10) EXT is hereby regarded as a dummy variable that takes the value of 1 if the farmer had contact with agricultural extension agents within the past 3 years preceding the study, and 0 otherwise. It is anticipated that contact with extension services allows farmers to have access to relevant information and knowledge products on various TIMPs. It is therefore hypothesized that EXT is positively related to adoption of availed TIMPs.

11) FO is a dummy variable that indicates if the farmer is a member of a group farm or farmers' association. Several research and development efforts to promote adoption of relevant TIMPs have focused on farmers' groups or communities (Atta-Krah and Francis, 1987; Koudokpon et al., 1995). This approach is premised on the fact that community or farmer groups allow increasing returns to scale in information dissemination, besides providing economies of scope for extension agencies as they can reach a large number of farmers with different sets of TIMPs per time. It is also assumed that farmers that join these associations comprise those more receptive to new innovations or interventions in the community. In this study, membership in farmers' groups is therefore hypothesized to positively influence the adoption of TIMPs.

12) LTN is dummy variable that indexes the security of land rights. It takes the value of 1 if the farmer has secure tenurial rights, and 0 otherwise. Secure land rights emanate from direct purchase, divided inheritance or gift. It is thus hypothesized that LTN is positively related to adoption of TIMPs.

The description, measurement and *a priori* expectations of the study (as stated above) are summarized in Table 3.

**Table 3:** Description of Selected Variables

| Variable | Description | Measurement | Expected Sign |
|---|---|---|---|
| Dependent Variable | | | |
| $P_i$ | Probability of adopting TIMPs | Dummy (1 = adopter; 0 = non-adopter) | 0 to 1 |
| Independent Variables | | | |
| SEX | Gender of the farmer | Dichotomous (1 = male; 0 = female) | + |
| AGE | Age of the farmer | Years | - |
| EDU | Level of education | Years | + |
| HHS | Household size | Number of people | - |
| NTV | Total income per person | US $ equivalent | + |
| OFI | Household size | Number of people living under same roof | + |
| FSZ | Farm size | Hectares | + |
| ACC | Access to TIMPs | Dichotomous (1 = Yes; 0 = No) | + |
| LBF | Labour force | Number of people | + |
| EXT | Contact with extension agents | Dichotomous (1 = Yes; 0 = No) | + |
| FO | Member of farmer organization | Dichotomous (1 = Yes; 0 = No) | + |
| LTN | Land tenure | Dichotomous (1 = Yes; 0 = No) | |

### 3.9.1. Data Analysis Procedures for Objective 4

The level of stakeholder satisfaction with the assorted products and services from the regional projects, including delivery of TIMPs and knowledge products was tracked using the Likert scale. The central idea behind using this scaling theory is based on the fact that the unknown position of a person on a latent mental attribute (e.g.: a disposition, an attitude, an opinion, a notion, an impression, an intention, a view, a conception, a judgment), is estimated by his/her agreement or disagreement with statements that are relevant and valid for this latent attribute.

In this study, this scale was used to measure complex concepts, like attitudes, styles of TIMPs use, satisfaction for products and services, among others. It is used to combine a battery of variables into a single index to measure the level of stakeholder satisfaction and perceptions. Devellis (2003) found that the number of questions asked affects the reliability of the number of choices that should be used in creating a survey using Likert-type scale. Based on this, the researcher assigned the number of choices arbitrarily according to personal taste and past convention in order to quantify results and obtain shades of perceptions.

The choices (or categories of responses) are set to range from strongly disagree to strongly agree. As the categories move from one level to the next, the value increases by one unit. In this study, five alternatives were used, and values assigned from one (strongly disagrees) to five (strongly agrees), with three assigned to the undecided position. These five-point statements yield a distribution resembling a normal distribution (Likert, 1932).

# CHAPTER 4
# DESCRIPTION OF THE SOCIOECONOMIC SETTING OF THE RESPONDENTS

## 4.1. Summary

This chapter presents the background of the study area, as well as the detailed characteristics of the socioeconomic environment of the respondents. It is categorized into three main sections. It provides an overview of smallholder-centred approaches to agricultural research for development in the region, and especially within East Africa. It further elucidates the principles of the Framework for African Agricultural Productivity (FAAP) that guide agricultural research for development in Africa. It concludes by introducing the agricultural development domains, and their relevance to agricultural development in the study area. It delineates the key findings and discussions on the socioeconomic synopsis of the respondents, and focuses on the diversity of household types within the study area, the respondents' levels of education, age, years engaged in farming, as well as the role played by farm labour inputs in enhancing agricultural productivity. It also tackles the observed farm characteristics of the respondents, especially the variations in land holdings, land use options, tenurial systems, as well as land sizes across the gender categories.

## 4.2. Introduction

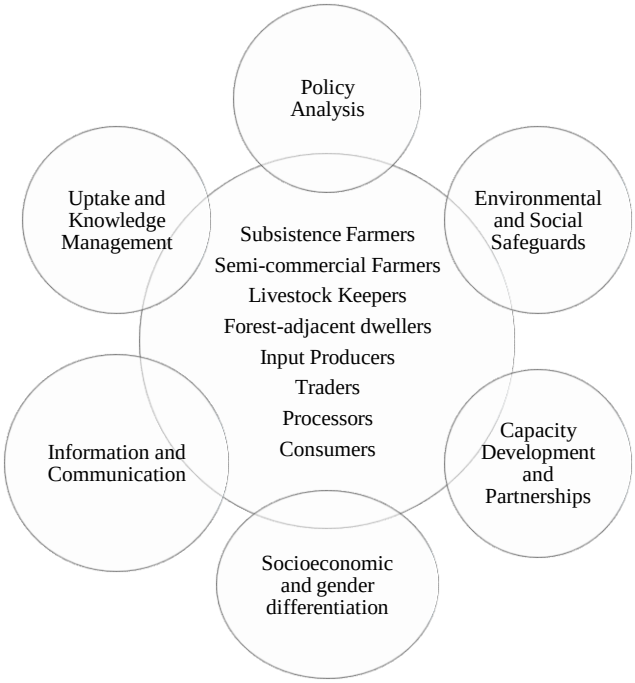
### 4.2.1. Smallholder-centred Approach to AR4D

In this research, the term 'smallholder farmer' refers to a general expression that encapsulates diverse types of farms within an assortment of farming systems. It includes farmers engaged in the production of crop products and livestock solely for sale in local markets, as well as those engaged in agriculture either to achieve food security or to supplement their livelihoods. These farmers also include individuals on employment, small-scale businesses, or petty trades, in addition to farming.

From the findings of previous reviews and assessments, it is evident that the most appropriate approaches to enhance the generation of optimal benefits to smallholder farmers calls for an integration of closely related and intertwined approaches. The most effective mechanisms include: (i) enhanced promotion of agricultural enabling environment through analysis of policies, regulations, and administrative procedures;

(ii) adherence to the environmental and social safeguards, especially when adopting the TIMPs; (iii) enhanced capacity strengthening of the farmers to cope with emerging challenges, including climate change, and diseases and pest management; (iv) increased use of new information and communications technologies, especially the Open Data Kits (ODKs), short message services (sms), mobile telephony, among others. These approaches (see Figure 8), if closely implemented are likely to create conducive and enabling environment for more engagement in farming.

**Figure 8:** Potential smallholder-central mechanism to AR4D




Source: Author's conceptualization

As already indicated in Chapter One, NEPAD intends to advance food security, rural livelihoods and improved national economies through its implementing arm, the CAADP. It operates on a theory of change that is captured under its four main pillars of intervention, namely: (i) Extending the area under sustainable land management (Pillar 1); (ii) Improving rural infrastructure and trade-related capacities for market access (Pillar 2); (iii) Increasing food supply and reducing hunger (Pillar 3); and agricultural research, technology dissemination and adoption (Pillar 4). Pillar four in particular focuses on improving delivery systems to farmers, especially smallholders

and agri-business (AUC, 2014). This is likely to be achieved when the rural knowledge centres are turned into information delivery pathways.

Based on the above, the role of information and learning is evident. The availability of these are very likely to ensure informed, effective, and appropriate decision-making regarding adoption of TIMPs, scaling up of best TIMPs, as well as accessing new markets. In order to effectively implement the regionally coordinated projects, and to ensure its sustainability, investments in documentation of best practices and lessons learned, as well as ensuring participatory monitoring and evaluation are inevitable. Indicators of change must be selected and tracked, targets set, and systems for continual and process evaluations ensured.

Development of strategic alliances and linkages with other stakeholders (such as private sector; international agricultural research institutions; NGOs; governmental organizations; communities) are mandatory. These alliances and linkages act as conduits through which scaling out of TIMPs pass, thereby reducing costs of developing individual pathways. Within the regional organizations (such as ASARECA), these linkages have been strengthened, and where none exists, formed, thus expanding and strengthening linkages amongst institutions. Alongside building linkages, advances in policy dialogue are also vital in ensuring stakeholder-centred approaches to research and development. Through engagement in dialogue with policymakers, the enhanced approval of TIMPs, standards, and policies is likely to cause significant changes in scaling out of best TIMPs, since most of the barriers and hindrances will have been handled.

### 4.2.2. The Framework for African Agricultural Productivity (FAAP) Principles

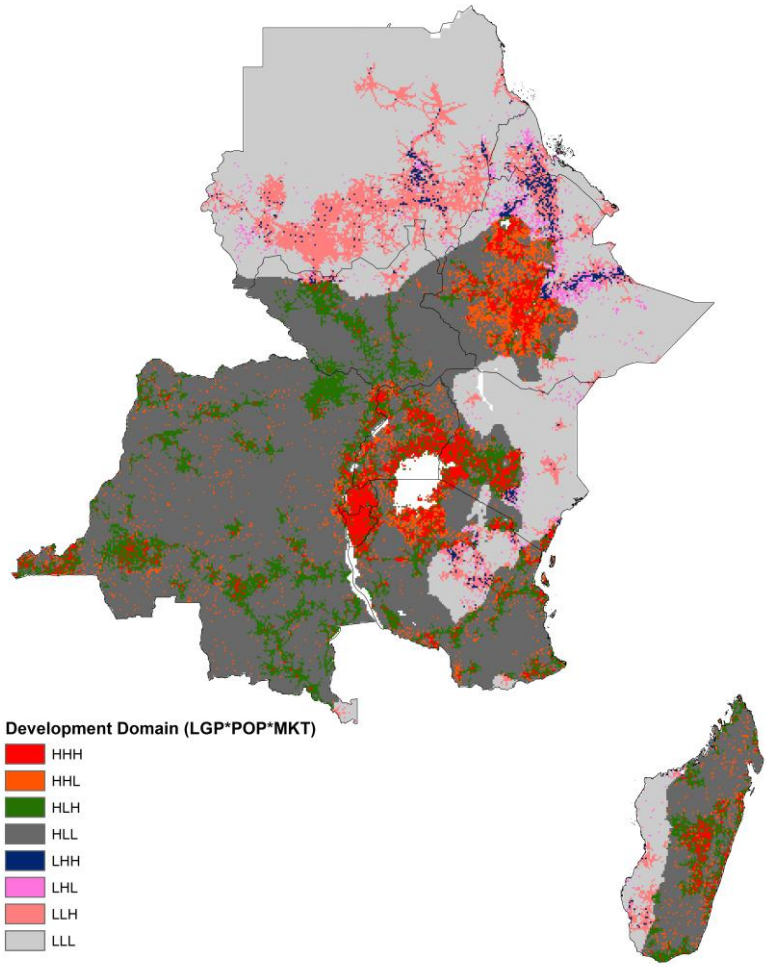
Among the key features of the regionally implemented projects include adherence to the Framework for African Agricultural Productivity (FAAP) principles. Under this framework, it is believed that in order for Africa's agricultural productivity efforts to be successful, all the regionally-implemented projects should reflect the following principles: (i) Empowerment of end-users; (ii) Planned subsidiarity; (iii) Pluralism in the delivery of agricultural research, extension, and training services; (iv) Evidence-based approaches of impacts; (v) Integration of agricultural research with extension services, the private sector, training, capacity building, and education programmes;

(vi) Explicit incorporation of sustainability criteria; (vii) Introduction of cost sharing with end users; (viii) Systematic utilization of improved management information systems (MIS) and M&E; (ix) integration of gender considerations at all levels.

### 4.2.3. Development Domains

The development domains within Eastern and Central Africa, and from which the selected countries for study were made are presented in Figure 9. As already indicated, the targeted countries hosted projects that articulated prioritized opportunities and were characterized by problems experienced in more than three countries. Results confirmed that the regional projects contributed to significant benefits for small-scale farmers and other stakeholder groups.

**Figure 9:** Development Domains in Eastern and Central Africa




Source: Omamo et al. (2006), IFPRI and ASARECA

## 4.3. Results and Discussion

### 4.3.1. Socioeconomic Synopsis of the Respondents

Every social research embraces the role played by socioeconomic factors, especially in predicting outcomes from human behavior. In this study, socioeconomic characteristics encompass targeted household's assets, sources of income, access to available TIMPs, level of education, age, category of smallholder farmers (i.e., whether beneficiary or non-beneficiary), nativity of the farmer (i.e., whether the farmer is a native of the study area, or is not), and social position.

Besides these, the researcher discusses other critical factors, including farmers' willingness to adopt certain TIMPs, variations in returns to investments (especially on-farm and non-farm incomes), farmers' access to training services and credit facilities, including their access to market information. The choice of these socioeconomic characteristics is prompted by their perceived significant influence, not only to agronomic practices and cropping patterns, but also in the eventual access, utilization and adoption of availed agricultural TIMPs that have been proven to enhance production and productivity.

#### 4.3.1.1. Diversity of Household Types

Diverse types of households were encountered, including nuclear families, polygamous homesteads, extended family homesteads, as well as single female-headed households. In order to standardize working definitions, the study further categorized female-headed households as either de jure or de facto female-headed households. The former refers to a situation whereby the female head of the household is single or widowed (18.1%). The latter refers to a situation whereby the female head of the household takes the responsibilities of the day-to-day management of the household, especially when the male partner does not permanently reside in the home. This category accounts for nearly 55% of the respondents.

The descriptive analysis of the data collected in this study clearly shows that the beneficiaries of the regional projects were slightly older than the non-beneficiaries by an average of 1.7 years. Similarly, the beneficiaries had an average of 1.8 years more education than the non-beneficiaries. This was shown to have direct influence on the type of TIMPs selected as well as the adoption levels among the various respondents.

With regards to on-farm incomes, all the beneficiaries received an average of US$ 152 above the non-beneficiaries. However, the trend changes with respect to average amount of off-farm incomes, such that the non-beneficiaries earned an average of US$ 188 above the beneficiaries. This huge difference is accounted for in terms of the sources of revenue, given that most of the non-beneficiaries were not only salaried employees, but were also engaged in other income-generating activities. Other observed variations are presented in Table 4.

**Table 4:** Socioeconomic Characteristics of the Targeted Stakeholders

| Variable | Overall mean | | Beneficiaries | | Non-beneficiaries | |
|---|---|---|---|---|---|---|
| | Beneficiary | Non-Beneficiary | Male | Female | Male | Female |
| Age (mean years) | 43.46 | 41.76 | 44.45 | 42.45 | 42.12 | 41.39 |
| Education level (years) | 8.9 | 7.1 | 8.98 | 8.77 | 7.15 | 7.00 |
| Household size (mean) | 6.53 | 5.9 | 6.62 | 6.43 | 6.10 | 5.70 |
| Farm size (mean Ha) | 2.81 | 2.06 | 3.17 | 2.37 | 2.33 | 1.78 |
| Farm income (mean US$) | 858 | 706 | 835 | 885 | 738 | 673 |
| Off-farm income (mean US$) | 1,401 | 1,893 | 1,245 | 1,592 | 2,201 | 1,589 |
| Years of farming (mean) | 11.75 | 11.58 | 12.34 | 11.05 | 11.20 | 11.45 |

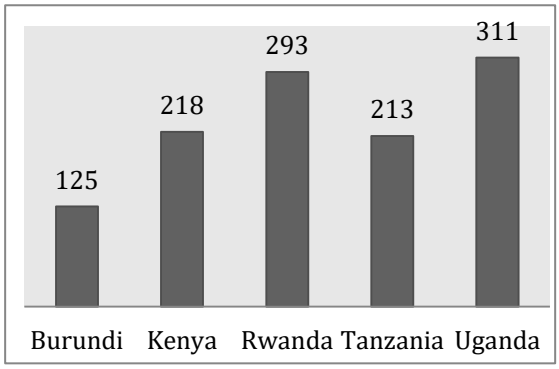
Source: Survey Data, 2014

#### 4.3.1.2. Distribution of Respondents

A total of 1,160 respondents, comprising 613 males (52.8%) and 547 females (47.2%), all drawn from five countries of the East African Community were identified and eventually interviewed (Figure 10 and Table 5). Out of these, over 60% (comprising 32.9% male and 27.6% female) were direct beneficiaries, and were especially actively engaged in the regionally implemented projects. The rest of the respondents (comprising 19.9% male and 19.6% female) were either engaged in nationally funded or coordinated projects or no project at all.

The respondents planting the targeted crops, especially maize, potatoes, beans, sorghum, millet, bananas, or cassava were selected. This was done to ensure accurate comparative analysis of socioeconomic status of the adopters of these TIMPs before and after engagement in the regional projects.

**Figure 10:** Number of respondents in household surveys




Source: Survey Data, 2014

**Table 5:** Types of Respondents

| | | Country | | | | | |
|---|---|---|---|---|---|---|---|
| | | Kenya | Rwanda | Tanzania | Uganda | Burundi | Total |
| Male | Beneficiary | 101 | 83 | 67 | 80 | 51 | 382 |
| | Non-beneficiary | 30 | 62 | 52 | 69 | 18 | 231 |
| | Total | 131 | 145 | 119 | 149 | 69 | 613 |
| Female | Beneficiary | 48 | 91 | 50 | 100 | 31 | 320 |
| | Non-beneficiary | 39 | 57 | 44 | 62 | 25 | 227 |
| | Total | 87 | 148 | 94 | 162 | 56 | 547 |
| TOTAL | Beneficiary | 149 | 174 | 117 | 180 | 82 | 702 |
| | Non-beneficiary | 69 | 119 | 96 | 131 | 43 | 458 |
| | Grand Total | 218 | 293 | 213 | 311 | 125 | 1160 |

Source: Survey Data, 2014

With regards to marital status of the respondents, out of the 1,160 respondents interviewed, 81.9% were married, 7.6% single, while the rest (10.5%) were widowed. Notwithstanding these marital compositions, it was observed that major decisions regarding participation in agricultural production stages were jointly undertaken. For instance, decisions on choice of crops for cultivation and the marketing decisions, including selling of the commodities, transportation to markets, and price negotiations were jointly made, apart from where the head of the household is widowed, or in the case of de facto female-headed households (i.e., households where male partners do not permanently reside in the homestead, and while he can still influence larger decisions, he is not altogether involved in day-to-day decisions and activities).

#### 4.3.1.3. Level of Education

There was a significant correlation (P≤.05) between the respondents' levels of education and their engagement in regional projects. Smallholder farmer education was measured by asking the respondent to state the number of years spent in school. This was then further categorized as either nil, if the respondent had not attended any formal or informal schooling. The average level of education among the respondents was 8.9 years, with Burundi recording the highest (11.6) and lowest levels (5.16) in terms of numbers of years of schooling for beneficiaries and non-beneficiaries, respectively. Other details are as shown in Table 6.

**Table 6:** Level of Education of Respondents

| Level | Beneficiary | | Sub- | Non-Beneficiary | | Sub- | TOTAL |
|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | |
| NIL | 25 | 27 | 52 | 37 | 44 | 81 | 133 |
| Lower Primary (up to 4 years) | 50 | 43 | 93 | 44 | 34 | 78 | 171 |
| Upper primary (up to 7 or 8 years) | 149 | 115 | 264 | 90 | 90 | 180 | 444 |
| Secondary (up to 12 years) | 119 | 110 | 229 | 49 | 48 | 97 | 326 |
| Tertiary (<12 years) | 39 | 25 | 64 | 60 | 59 | 22 | 86 |
| TOTAL | 382 | 320 | 702 | 231 | 227 | 458 | 1,160 |

Source: Survey Data, 2014

A total of 35.3% of the regional project beneficiaries had an average of primary level education of up to seven or eight years (depending on the education system of the country). This was 6.1 percentage points above the respondents who were not part of the regional project model. This gives the beneficiaries an advantage over the non-beneficiaries in that farmer education increases the probability of adopting new agricultural technologies (Feder et al., 1985). A large body of prior research has shown that highly educated workers tend to adopt new technologies faster than those with less education (Welch, 1970, 1973; Wozniak, 1984, 1987; Krueger, 1993; Lleras-Muney and Lichtenberg, 2002).

The above statistics is in agreement with Feder et al. (1985); Nelson and Phelps (1966); and Cotlear (1986) who observed a direct relationship between level of education and engagement in regional and international projects, programs, and

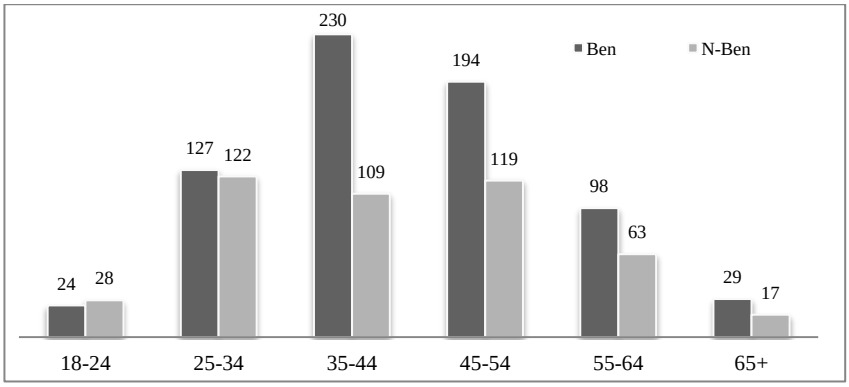
policy reform agenda. This observation is also explained by the fact that the regional projects often demand relatively higher level of education and expertise than the other non-regional interventions. The results prove this fact in that the proportion of beneficiaries with a minimum of secondary level of education was twice as much as the non-beneficiaries (i.e., 25.2% compared to 10.3%, respectively).

The research confirmed the works of Cotlear (1986) that classified three types of farmer education: formal, non-formal, and informal. In this case, beneficiaries of formal education consisted mainly of participation in conventional schooling, where participants were restricted to classroom environment. Similarly, in cases where non-formal education was reported, learning incorporated various types of mentoring, and involved approaches such as involvement of extension officers, as well as engagement of participants in adult literacy training, and organized apprenticeships. The study also identified the third class of education beneficiaries – those involved in informal education. In this case, the participants were regarded as having learned new concepts when they were able to learn-by-doing and observing.

#### 4.3.1.4. Age Distribution of the Respondents

As part of enhancing analysis, the age group of the targeted smallholder farmers was divided into six categories (Figure 11). The first two categories focus on stakeholders regarded as the youths (aged up to 34 years), while the third category focuses on the middle-aged respondents (up to 44 years). The rest of the categories look at the individuals considered as mature adults (aged at least 45 years).

**Figure 11:** Age Group of the Respondents (n = 1,160)




Source: Survey Data, 2014

From the figure, it is observable that the youths of up to 35 years constituted one-third of the sampled respondents. This supports earlier research that indicate significant role played by the youths in enhancing rural agricultural activities. Further analysis revealed that less than half of these youths (47.4%) were direct beneficiaries of the regionally implemented projects – an indication that they are not optimally accessing, utilizing and benefiting from the availed and proven agricultural TIMPs.

By still using the conventional TIMPs, these youths have not generated significant benefits from improved agricultural practices. This further confirms their diminishing willingness to engage in agriculture-related ventures. The study showed a significant relationship between the age of the respondents and the total non-farm income ($P \leq .05$).For instance, over 52% of the youths preferred to engage in non-farm income-generating activities, including petty trades, even though the overall net returns were lower than from on-farm ventures. This is a clear indication that the youths need more incentives to lure them back into agricultural activities, including ensuring increased access and control of their own land.

On the other hand, a myriad of development groups have been formed within the region, including youth clubs, forums and polytechnics. These groups were initiated to tackle specific challenges, and enhance targeted developmental agenda, including attracting the youths to engage in improved agricultural practices. Results indicate a minimum of seven youth clubs in each of the countries. On average, these clubs comprised youths from different disciplines, and thus were set up to address crosscutting challenges such as water management issues, to promote integrated soil fertility management, to enhance promotion of tree planting, besides mobilizing other youths to motivate their peers to engage in assorted resource management activities.

#### 4.3.1.5. Years of Farming

Results from the study indicate that the overall average number of years of farming by the respondents was 11.58 years. A significant difference between the respondents in terms of gender, country, or whether they were beneficiaries of the interventions or not, was observed (Table 7 and Table 48). Similarly, the beneficiaries of the regional projects had practiced farming for slightly longer duration (11.75 years) than their

counterparts who were not part of the projects (11.32 years).

The targeted male beneficiaries had practiced farming for an average period of 12.34 years, compared to their female counterparts' 11.05 years. The main reason for this difference could be attributed to the fact that when the women were married into the husbands' homesteads, the latter were already engaged in farming their traditional or customary lands. This is further supported by the fact that within the research area, the patriarchal systems of land ownership (as opposed to matriarchal) predominate.

**Table 7:** Years of Farming (Average)

| | Beneficiaries | | Non-Beneficiaries | |
|---|---|---|---|---|
| Country | Male | Female | Male | Female |
| Kenya | 14.94 | 13.17 | 12.77 | 11.46 |
| Rwanda | 11.94 | 10.45 | 10.52 | 10.89 |
| Tanzania | 11.90 | 10.18 | 10.48 | 11.00 |
| Uganda | 9.45 | 10.22 | 10.09 | 10.05 |
| Burundi | 12.94 | 13.61 | 17.28 | 16.96 |
| Average(Sex) | 12.34 | 11.05 | 11.20 | 11.45 |
| Average (Type of HH) | 11.75 (P≤0.05) | | 11.32 (P≤0.05) | |
| Average (Overall) | 11.58 (P≤0.05) | | | |

Source: Survey Data, 2014

#### 4.3.1.6. Use of Hired Labour

The use of labourers on the farms and homesteads was observed, with nearly 42% of the respondents hiring both short- and long-term labourers. There was a significant difference in the use of labourers by the beneficiaries (P≤0.05), as opposed to the non-beneficiaries (P≤0.05). This difference was attributed to the fact that the beneficiaries needed more labour to handle the new TIMPs and to work on expanded farmlands. The study also showed that the farmers continually made decisions on the type and number of labourers to engage. This decision depended on the number of years the targeted farmer had practiced farming (P≤0.05).

Most of the hired labourers were the unemployed male youths, who were paid an annual average of US$ 117.40 and US$ 131.12 in 2010 and 2014 respectively. This

low level of incentive further contributes to the low engagement of the youth in smallholder farming practices. On average, labourers engaged in regional projects in Tanzania received almost double what their counterparts in Burundi earned. This trend is likely to encourage more youths into agriculture, not only as casual labourers, but also as agricultural entrepreneurs, also engaging other youths. However, the Chi-Square test indicates that there was no significant difference between the amount of labour charges paid to the workers on the farms and the duration the farmer has engaged in the activity. This indicates that every farmer hired labourers based on the prevailing market rates, or depending on mutually agreed terms. The correlation between use of labour and other parameters are presented in Table 8.

**Table 8:** Correlations of labour related parameters

| Parameters | Ben P-value | Non-ben P-value |
|---|---|---|
| Hires labourers * Years of farming * Type of HH | .000 | .099 |
| Hires labourers * Amount paid in 2010 * Type of HH | .000 | .000 |
| Hires labourers * Amount paid in 2014 * Type of HH | .000 | .000 |
| Hires labourers * Total land area (Ha) in 2010 * Type of household | .020 | .666 |
| Hires labourers * Total land area (Ha) in 2014 * Type of household | .026 | .692 |
| Hires labourers * Cattle quantity - 2014 * Type of household | .030 | .844 |
| Hires labourers * Who applies pesticides * Type of household | .037 | .763 |
| Hires labourers * Household Size * Type of household | .061 | .072 |
| Hires labourers * Country * Type of household | .064 | .982 |
| Hires labourers * 2010 Total Income * Type of household | .313 | .411 |
| Hires labourers * Total Non-Farm income * Type of household | .420 | .271 |
| Hires labourers * TNFarm2014 * Type of household | .461 | .345 |
| Hires labourers * 2014 Total Income * Type of HH | .545 | .382 |
| Hires labourers * Cattle quantity - 2010 * Type of HH | .876 | .497 |

Source: Survey Data, 2014

Table 9 summarizes the average bi-annual wages (in US$) earned by the labourers engaged in agricultural activities. It clearly shows that the regional projects have greater potential in generating income for the beneficiaries than for the non-beneficiaries.

**Table 9:** Average Bi-annual Wages (US$) Earned by Labourers in Cropping Seasons

| Type of Household | Sex | Country | | | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Kenya | | Rwanda | | Tanzania | | Uganda | | Burundi | | | |
| | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| | Male | 72.77 | 79.10 | 110.95 | 123.65 | 122.17 | 127.34 | 64.16 | 74.04 | 60.10 | 67.35 | 86.24 | 94.61 |
| Beneficiary | Female | 75.10 | 84.58 | 90.34 | 97.51 | 109.18 | 119.49 | 58.66 | 72.00 | 61.45 | 70.32 | 78.30 | 88.40 |
| | Total | 73.52 | 80.87 | 100.17 | 109.98 | 116.62 | 123.98 | 61.11 | 72.91 | 60.61 | 68.48 | 82.62 | 91.78 |
| | Male | 23.33 | 26.33 | 27.44 | 30.13 | 17.79 | 15.40 | 17.68 | 24.32 | 10.56 | 10.83 | 20.50 | 23.08 |
| Non-Beneficiary | Female | 27.13 | 17.89 | 15.61 | 17.89 | 45.23 | 54.00 | 14.32 | 18.21 | 21.20 | 20.80 | 23.59 | 27.69 |
| | Total | 25.48 | 29.42 | 21.77 | 24.27 | 30.36 | 33.09 | 16.09 | 21.43 | 16.74 | 16.63 | 22.03 | 25.36 |
| | Average Male | 61.45 | 67.02 | 75.24 | 83.66 | 76.56 | 78.43 | 42.64 | 51.01 | 47.17 | 52.61 | 61.47 | 67.66 |
| | Average Female | 53.60 | 60.92 | 61.56 | 66.85 | 79.24 | 88.83 | 41.69 | 51.41 | 43.48 | 48.21 | 55.60 | 63.20 |
| | Overall AVERAGE | 58.32 | 64.58 | 68.33 | 75.17 | 77.75 | 83.02 | 42.14 | 51.22 | 45.52 | 50.64 | 58.70 | 65.56 |

Source: Survey Data, 2014

#### 4.3.1.7. Critical Decision Making

Over the years, critical decision-making within the homestead has always been an integral determinant of the overall direction of family development. In most cases, the head of the household has always been the sole decision maker on critical issues. Regarding this study, the results show similar trends in the effects of different familial decision making roles. Significant differences in decision-making between beneficiary and non-beneficiary households were observed, especially with regards to the choice of crops as well as decisions over crop marketing.

Wide variations on the choices made within the surveyed countries between 2010 and 2014 were also observed ($P \leq 0.05$). For instance, in 2010, women were unlikely to participate in decisions on the choice of crops to be planted than those in non-project households ($P \leq 0.05$). Unfortunately, this trend remained unchanged even four years later (in 2014), resulting into non-significant likelihood of women solely making such decisions ($P \leq 0.05$), unless they were single or widowed.

Based on the study findings, it could be concluded that leadership of household enhances the selection, access, utilization, adoption and spread of new TIMPs, including ensuring optimization of benefits. The study involved quantitative data collected on the household head to provide a key factor in assessing the stakeholders' behaviors and decisions (both beneficiaries and non-beneficiaries). Through this approach, the study revealed that both female and male household heads were reliable conduits for increasing and scaling out the dissemination of the TIMPs among their community members.

Table 10 summarizes the mean area (in hectares) under different crops. There is a significant difference ($P \leq 0.05$) between the land areas dedicated to crops by the beneficiaries and non-beneficiaries. It is also clear that there has been a steady increase in the amount of land allocated to crops by the beneficiaries. This is mainly due to the increase of demand for staples crops by the ever-increasing human population.

**Table 10:** Mean Cropland Areas (Ha)

| Country | Status | Maize | | Sorghum | | Millet | | Beans | | Sweet Potato | | Cassava | | Banana | | Irish Potato | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| | Beneficiary | 1.29 | 1.26 | 0.94 | 1.03 | 0.56 | 0.68 | 1.09 | 1.14 | 0.57 | 0.62 | 0.67 | 0.64 | 4.22 | 1.57 | 47.70 | 6.81 |
| Kenya | Non-Beneficiary | .83 | .83 | .55 | .52 | .66 | .60 | .64 | .76 | .20 | .65 | .43 | .61 | 2.67 | 2.94 | .61 | 12.05 |
| | Mean | 1.15 | 1.13 | 0.88 | 0.95 | 0.58 | 0.66 | 0.95 | 1.02 | 0.52 | 0.62 | 0.63 | 0.63 | 3.59 | 2.13 | 38.28 | 8.12 |
| | Beneficiary | .78 | .87 | .39 | .49 | .24 | .30 | .49 | .59 | .74 | .67 | 1.35 | 1.87 | .81 | .90 | .55 | .54 |
| Rwanda | Non-Beneficiary | .50 | .55 | .21 | .24 | .44 | .48 | .62 | .66 | 1.04 | .98 | .24 | .29 | .35 | .41 | .64 | .66 |
| | Mean | .67 | .74 | .32 | .38 | .32 | .38 | .54 | .62 | .81 | .75 | .94 | 1.24 | .61 | .69 | .57 | .57 |
| | Beneficiary | 1.12 | 1.26 | 0.67 | 0.69 | 0.40 | 0.44 | 0.85 | 1.00 | 0.58 | 0.54 | 0.34 | 0.39 | 0.62 | 1.06 | 1.21 | 1.21 |
| Tanzania | Non-Beneficiary | .78 | .89 | .74 | .63 | .51 | .51 | .73 | .81 | .55 | .67 | .30 | .33 | 2.84 | 3.12 | 18.52 | |
| | Mean | .96 | 1.09 | .70 | .66 | .42 | .45 | .79 | .91 | .57 | .58 | .32 | .37 | 1.83 | 2.14 | 12.75 | 1.21 |
| | Beneficiary | 1.70 | 1.67 | 1.39 | 1.47 | 0.39 | 0.39 | 1.09 | 1.13 | 0.78 | 0.79 | 0.95 | 0.90 | 0.88 | 0.96 | 1.91 | 3.20 |
| Uganda | Non-Beneficiary | .94 | 1.05 | .57 | 1.31 | .53 | .55 | .68 | .78 | .69 | .66 | 1.08 | .78 | 2.50 | 1.24 | .50 | .59 |
| | Mean | 1.37 | 1.40 | 1.25 | 1.44 | 0.44 | 0.44 | 0.92 | 0.98 | 0.75 | 0.76 | 1.00 | 0.85 | 1.59 | 1.08 | 1.20 | 1.93 |
| | Beneficiary | .93 | .96 | .67 | .57 | .64 | .68 | .89 | .90 | .76 | .79 | .51 | .51 | .60 | .63 | | |
| Burundi | Non-Beneficiary | .67 | .70 | .46 | .49 | .47 | .47 | .65 | .69 | .42 | .44 | .33 | .35 | | | | |
| | Mean | .84 | .87 | .61 | .55 | .58 | .60 | .81 | .83 | .66 | .69 | .47 | .48 | .60 | .63 | | |
| | GRAND MEAN | 1.00 | 1.05 | .67 | .72 | .52 | .57 | .79 | .85 | .70 | .70 | .78 | .83 | 1.56 | 1.22 | 3.08 | 1.41 |

Source: Survey Data, 2014

#### 4.3.1.8. Crop-Livestock Production Environment

During the period of the study, the average number of livestock, especially cattle owned by the respondents increased by 32% in four years (from 2.94 in 2010 to 3.89). Critical tests for correlation showed that a significant difference ($P \leq 0.05$) occurred between the participants in regional projects, and those who never participated. These differences were also observed within and outside each of the countries. The processing of livestock into value added products (especially from cattle, goats and pigs) were limited in the study region. This low value addition was attributed to the poor conditions of the local abattoirs from which most of the slaughtering was done. The processing of beef and meat from the other small ruminants was conducted close to the areas of consumption in rural trading centres.

Notwithstanding the fact that slaughtering was undertaken within the local abattoirs situated closer to the small towns and market centres, where the demand was higher and the costs of production lower, the overall potential benefits from value addition using improved technologies was lost. Studies have supported this observation. For instance, despite the low production of meat, the meat processing capacity of over 870,000 MT/year in the region is far from being achieved, while the average utilization capacity of dairy plants stands out at less than 30% (Kilimo Trust, 2011). These indicate the huge potential of demand for livestock and livestock products.

The global importation of both processed and branded secondary and tertiary products, especially of meats, beans, cassava, dairy milk, and sorghum has been on the increase. However, comparison of the importation trends between the global averages and the EAC block indicated that region has clear comparative advantages (Kilimo Trust, 2011). This comparative advantage provides opportunities for the region to expand its agricultural sector so as to meet the ever increasing, but un-met global demands for agro-processed products. This is further supported by the fact that the EAC block is among the top 20 producers in the world for most of the aforementioned commodities.

### 4.4.Conclusion

On average, the beneficiaries of the regional projects were slightly older than the non-beneficiaries (by 1.7 years), and had more years of education (1.8 years), thus directly

influencing selection and adoption of TIMPs. On average, these beneficiaries had practiced farming for slightly longer duration (11.75 years) than their counterparts (11.32 years), hence influencing their choices, such as whether to join agriculture-based groups, or to adopt the availed TIMPs.

The number of respondents with an average of between two and ten hectares of farm sizes increased by over 1.4 percentage points, an indication that more smallholders wanted to increase the production of selected commodities and incomes. Through engagement in regional projects, the respondents' average number of improved cattle breeds increased by 32%. Nearly 42% of the respondents hired both short- and long-term labourers to handle the new TIMPs and to work on expanded farmlands. Most of these labourers were the unemployed male youths, who were paid an average of US$ 66 per season. It can be concluded that the socioeconomic characteristics and prevailing environment of the respondents greatly influenced participation in regional projects.

The following chapter focuses on the findings of the evaluation of the effectiveness of the implemented regional projects in the five countries under study. The chapter further elaborates the impacts of regional projects, as well as the factors that influence the rate of uptake of TIMPs and best practices generated from these regional projects by smallholder farmers.

# CHAPTER FIVE
# EVALUATION OF THE EFFECTIVENESS OF REGIONAL PROJECTS IN GENERATING PUBLIC GOODS

## 5.1. Summary

As a follow up from the previous chapter that focused on the overall characteristics of the socioeconomic environment of the respondents, this chapter presents detailed findings of the evaluation of the effectiveness of the implemented regional projects in the five countries under study. These findings are further compared to those generated from the respondents not engaged in the regional projects. These latter groups are regarded as non-beneficiaries.

This chapter focuses on the results generated from the survey; provides detailed discussion of the findings; shows the benefits of the regional projects; discusses the dynamics of farm income generation; and seeks to articulate the current advances made in enhancing agricultural policy environment. It provides comparative assessment of respondents' anticipated versus actually accrued benefits from the regional projects, quantifies the value added from the regionally implemented interventions, besides focusing on the role played by the various TIMPs generated and availed for uptake by the farmers. The chapter further assesses the awareness that the farmers have on these TIMPs; their levels of satisfaction with these TIMPs; as well as assessment of the status of value productivity of assorted commodities. It concludes by providing a brief discussion of assorted capacity building initiatives undertaken as well as the summary of main challenges faced in the implementation of these regional projects.

## 5.2. Introduction

It is general knowledge and appreciation that agro-ecological zones, domains and environments overlap national boundaries. As a result, the products of research and developmental opportunities also exist, and have the potential of overlapping into other nations. In other words, a myriad of benefits, including agricultural TIMPs, knowledge and knowledge products, as well as capacity strengthening initiatives that exist in one country can spill over to the next. Studies have shown that national research systems, if undertaken individually, and without the involvement of other

national systems generally face limitations. These limitations include reduced spillover effects, cross-border disease and pest controls, reduced exchange of essential germplasm, as well as sharing of vital information, knowledge, and skills.

As already indicated in Chapter One, regional projects have been regarded to provide some quick solutions to the emerging regional challenges, some of which are also mentioned above. Generally, regional projects are regarded as those projects and programs that possess cross-national character (also known as internationality). The internationality of any given research or intervention was used in the ranking of those projects and programs to qualify for financial and other associated support.

As a measure of internationality of projects, the Simpson Index of Diversity, $I_k$, was used (Simpson, 1949), and is hereby defined as follows:

$$\boldsymbol{I_k = \sum_m \left[\frac{S_{km}}{100}\right]^2} \tag{17}$$

In this equation, $S_{km}$ is the share of economic returns to the research intervention, *k*, realized by all the partners engaged in the intervention, *m*. In order to standardize measurements, a variable $(I - I_k)$ was introduced to measure the magnitude of these expected returns. As a result, a higher value generated from this variable is a clear indication of greater internationality. All the selected projects that were implemented in the five countries had greater index of diversity, and were therefore expected to generate tangible gains. An assortment of the gains from these regional projects is presented in this section.

The study revealed that these regional projects yielded benefits in both absolute and percentage terms, across all agro-ecologies and gender categories. These benefits include, but not limited to:

a) Enhanced policy enabling environment for agricultural research, development and extension services;

b) Improved research tools that are adapted to national research needs, including

generation of demand-driven gender-responsive agricultural TIMPs;

c) Improved national human resources for development, especially through capacity building initiatives such as short- and long-term trainings on emerging international and national challenges and themes;

d) Strengthened national institutions for research, through provision of assorted infrastructure and equipment;

e) Improved national and local institutions for development, especially through establishment and strengthening of local technology and innovation platforms;

f) Enhanced crop yields and livestock production through adoption of better regionally implementable TIMPs, among others.

## 5.3. Results and Discussion

### 5.3.1. Benefits of Regional Projects

The effectiveness of the regional projects was determined through assessment of the levels of access, utilization and adoption of the availed land-based TIMPs. Some of these TIMPs were still under confined (2%) and open (8%) field testing (pending adoption), while over 90% had been field-tested, evaluated by the national variety selection and release committees, released and adopted by respondents.

The TIMPs evaluated in this research (selected through the application of the Simpson Index of Diversity) included also those that increase production, enhance nutritional balance, and address climate change adaptation and mitigation. They were broadly categorized as follows: (i) Crop genetics, such as improved and/or certified seed that are higher yielding, higher in nutritional content (e.g., through biofortification, such as vitamin A-rich sweet potatoes and QPM) as well as more resilient to climate impacts; (ii) Pest management, such as Integrated Pest Management and appropriate application of insecticides and pesticides; (iii) TIMPs for disease management, including appropriate application of fungicides;(iv) TIMPs addressing soil-related fertility and conservation, including integrated soil fertility management as well as specific soil management practices that enhance biotic activity and soil organic matter

levels, besides acting as erosion control systems; (v) Very specific TIMPs that focus on irrigation, including drip, surface, and sprinkler irrigation approaches; and (vi) promotion of TIMPs that focus on water management, such as runoff water harvesting and retention dams.

#### 5.3.1.1. Dynamics of Income from Farming

There was an overall increase in the income generated by the stakeholders. The project beneficiaries recorded 19.5% increase in income generated (above the non-beneficiaries) from both on-farm and off-farm activities. This represents an average annual income of US$ 1,258 generated by every household (Table 11 and Table 49). On the other hand, the non-beneficiaries recorded slightly higher increase in income in percentage points (26% compared to beneficiaries' 25%), and not in real terms, thereby representing an average income of US$ 1,197 for the non-beneficiaries. Most of these incomes are generated from salaries, remittances, and assorted business ventures.

**Table 11:** Summary of Income Generated (US$)

| Status | | Farm income | | Non-Farm income | | Total Income | |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| Beneficiary | Mean | 718 | 861 | 1,108 | 1,401 | 1,016 | 1,258 |
| | Sum | 475,246 | 580,573 | 228,014 | 292,7689 | 699,119 | 873,343 |
| Non-Beneficiary | Mean | 598 | 711 | 1,372 | 1,893 | 950 | 1,197 |
| | Sum | 244,569 | 294,362 | 183,825 | 244,157 | 428,393 | 538,519 |
| Overall | Mean | 672 | 804 | 1,213 | 1,589 | 990 | 1,234 |
| | Sum | 719,815 | 874,935 | 407,698 | 536,926 | 1,127,512 | 1,411,861 |
| DiD | | US$ 55,534 | | US$ 8,564 | | US$ 64,098 | |

Source: Survey Data, 2014

In general, the beneficiaries of the regional projects recorded a net increase in revenues of US$ 174,224 compared to non-beneficiaries' US$ 110,126 (representing net advantage of over 37% for participation in regional projects). The results also indicate that farm-active beneficiaries of regional projects generated an average of US$ 259 above their non-beneficiary partners engaged off-farm.

Based on the difference-in-differences (DiD) method, the impact estimates from the

regional projects showed similar findings, in that the beneficiaries engaged in farm activities were better off than their non-beneficiary counterparts. Their engagement in on-farm projects generated over US$ 55,000 above what the non-beneficiaries also engaged in farming received during the period of study. The case is slightly different for the beneficiaries engaged in only off-farm activities. Their income strength was US$ 8,564 above their non-beneficiary counterparts also engaged in non-farm related activities. Detailed distribution of mean household incomes is illustrated in Table 12.

**Table 12:** Details of Mean Household Incomes (US$)

| Type of household | Sex | Country | Farm Income | | Non-Farm Income | | Total Income | |
|---|---|---|---|---|---|---|---|---|
| | | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| Beneficiary | Male | Kenya | 613 | 839 | 617 | 749 | 940 | 1,280 |
| | | Rwanda | 1,015 | 1,119 | 1,045 | 1,295 | 1,042 | 1,152 |
| | | Tanzania | 708 | 784 | 1,905 | 2,344 | 1,445 | 1,672 |
| | | Uganda | 677 | 766 | 861 | 1,264 | 772 | 891 |
| | | Burundi | 499 | 540 | 1,265 | 1,354 | 935 | 1,007 |
| | | Total | 714 | 835 | 1,061 | 1,245 | 2,030 | 2,405 |
| | Female | Kenya | 658 | 810 | 1,128 | 1,761 | 1,140 | 1,582 |
| | | Rwanda | 996 | 1,095 | 719 | 826 | 1,027 | 1,132 |
| | | Tanzania | 757 | 1,079 | 2,345 | 2,853 | 1,728 | 2,376 |
| | | Uganda | 553 | 779 | 650 | 967 | 701 | 1,037 |
| | | Burundi | 494 | 524 | 451 | 532 | 659 | 719 |
| | | Total | 722 | 885 | 1,189 | 1,592 | 2,061 | 2,650 |
| | Total | Kenya | 626 | 831 | 763 | 1,020 | 1,003 | 1,375 |
| | | Rwanda | 1,005 | 1,106 | 808 | 953 | 1,034 | 1,141 |
| | | Tanzania | 729 | 902 | 2,102 | 2,599 | 1,568 | 1,976 |
| | | Uganda | 607 | 773 | 709 | 1,039 | 732 | 972 |
| | | Burundi | 497 | 534 | 956 | 1,042 | 833 | 900 |
| | | Total | 718 | 861 | 1,108 | 1,401 | 1,016 | 1,258 |
| Non-Beneficiary | Male | Kenya | 640 | 564 | 514 | 1,231 | 942 | 1,440 |
| | | Rwanda | 667 | 724 | 1,267 | 1,391 | 771 | 839 |
| | | Tanzania | 590 | 767 | 3,173 | 4,441 | 1,853 | 2,472 |
| | | Uganda | 715 | 963 | 758 | 827 | 753 | 977 |
| | | Burundi | 218 | 226 | 645 | 798 | 504 | 581 |
| | | Total | 623 | 738 | 1,503 | 2,201 | 2,028 | 2,624 |
| | Female | Kenya | 494 | 492 | 861 | 1,149 | 869 | 941 |
| | | Rwanda | 746 | 833 | 1,535 | 1,616 | 829 | 917 |
| | | Tanzania | 519 | 592 | 1,381 | 2,004 | 1,185 | 1,663 |
| | | Uganda | 642 | 900 | 1,895 | 1,883 | 988 | 1,223 |
| | | Burundi | 206 | 207 | 190 | 223 | 273 | 245 |
| | | Total | 573 | 673 | 1,240 | 1,589 | 1,770 | 2,161 |
| | Total | Kenya | 558 | 523 | 684 | 1,195 | 900 | 1,157 |
| | | Rwanda | 704 | 775 | 1,389 | 1,493 | 799 | 877 |
| | | Tanzania | 558 | 687 | 2,257 | 3,116 | 1,551 | 2,101 |
| | | Uganda | 680 | 933 | 1,430 | 1,514 | 865 | 1,095 |
| | | Burundi | 211 | 215 | 470 | 577 | 351 | 389 |
| | | Total | 598 | 711 | 1,372 | 1,893 | 950 | 1,197 |
| | | Overall Mean | 672 | 804 | 1,213 | 1,589 | 990 | 1,234 |

Source: Survey Data, 2014

The research determined that the farmers with higher income, whether from on-farm or off-farm, had a positive perception about new technologies, and were more capable

of purchasing required inputs for implementing the availed TIMPs. It was revealed from this study that on-farm income was a vital indicator of farmers' overall assets, and significantly influenced the farmers' adoption decisions on various TIMPs ($P \leq 0.05$), especially the choices made by the beneficiaries. This is also supported by previous studies conducted by Hossain and Crouch (1992); Lapar and Ehui (2004); Negatu and Parikh (1999). In their studies on smallholder farmers in Madagascar, Moser and Barrett (2003) and Wadsworth (1995) discovered that lack of income was a major factor that hindered the farmers from applying new innovations across different planting seasons.

However, this study revealed that allocation of resources for enhancing good agricultural practices was not always a priority. Instead, acquisition of food, medical services, shelter and clothing were always prioritized, preferably in that order. The use of improved crop varieties, as well as animal breeds were never regarded as key in ensuring household income and food and nutrition security, and instead most of the farmers opted to recycling their seeds, thus leading to the overall low yields.

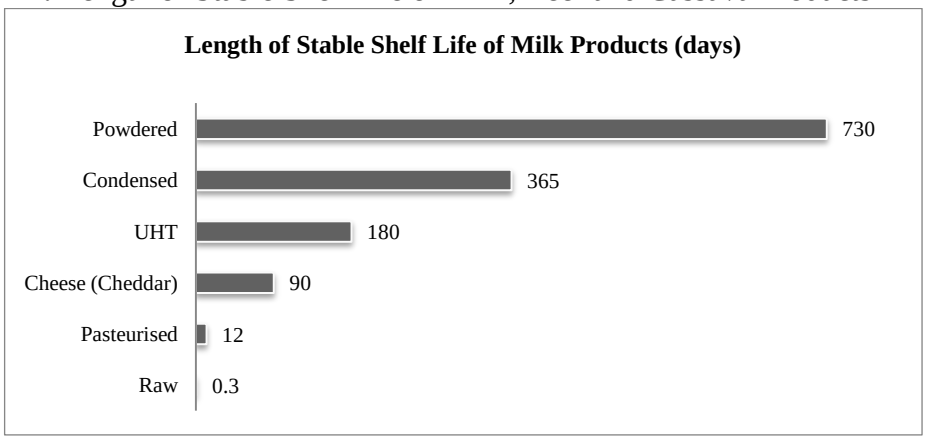
#### 5.3.1.2. Effects of Value Addition on Incomes

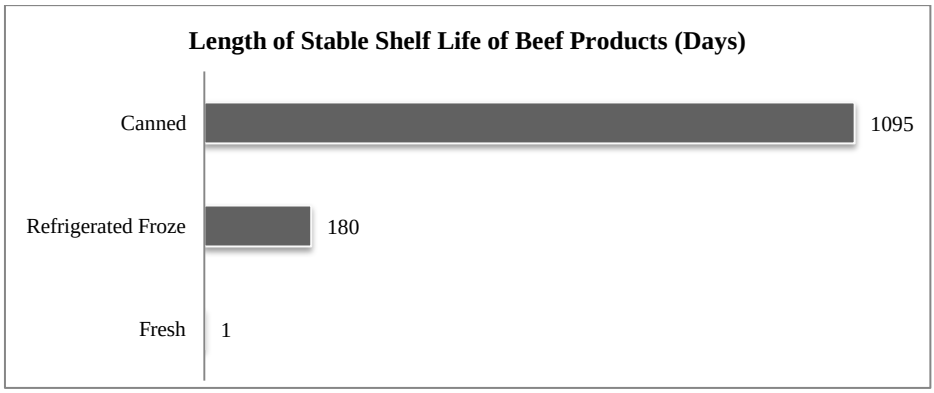
It was further noted that income from farming was directly affected by inadequate post-harvest handling processes, including processing to extend the length of stable shelf life, especially of perishable food commodities such as starchy crops, vegetables and fruits, as well as of livestock products. Following estimated post-harvest losses of up to 30%, the study indicated that the region was still susceptible to perpetual hunger and malnutrition that is already rampant in the region. On the other hand, the variations in the length of stable shelf life of priority commodities posed another challenge to farmers, traders, as well as transporters.

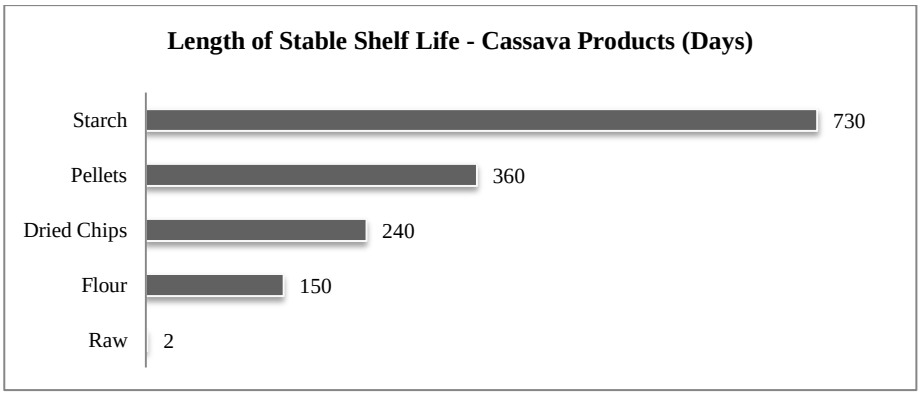
In support of these observations, previous reports (FAO, 2011), indicate that milk, beef, and cassava, among other common commodities within the EAC block have a short shelf life, such that the absence of processing, storage, and transport facilities pose greater susceptibility of the producers to huge post-harvest losses. Both UNIDO and FAO (2011) also indicated that over 40% of the food losses within the EAC block are attributed to post-harvesting and processing. They further stated that a meager 28% of the agricultural produce registered within the national statistics was processed,

notwithstanding the fact that processing of the same commodities had the potential of increasing their shelf life to at least two years (Figure12).

**Figure 12:** Length of Stable Shelf-life of Milk, Beef and Cassava Products




Source: FAO, 2011

Hatibu et al. (2011) concluded in his paper that processing commodities had the potential of enhancing reduction of non-tariff and tariff barriers to trade, thereby increasing revenues from agriculture. They observed that the current standards to export meat products required the host region for the farmed animals to be disease free. Based on this, the processed products are free from infections.

As an example, they observed that cow milk did not contain infectious quantities of the protein that causes BSE (mad cow disease), even if the milk was obtained from infected cows. On the other hand, the matured and deboned beef from which major lymph nodes had been removed also presented minimal risk of transmitting foot and mouth disease, BSE and many other infections. The implementation of these standard procedures has already started producing results. Both intra- and inter-national and regional trade has been more liberalized, while border checks are undergoing harmonization so as to reduce time taken to clear the goods.

The research also showed that value addition to the primary agricultural commodities, especially for export was rarely undertaken, thus contributing to low returns from such commodities. Studies have shown that agricultural value added contributes more than 80% of the total manufacturing in the region, while food processing accounts for 40% of the value added by agro-industries. On the other hand, only about 28% of the agricultural produce in the region is processed (Kilimo Trust, 2011), a fact proved during the study. Based on this, the observed minimal value addition is known to contribute to low demand for the targeted commodities within the regional markets. This further influences the rate of production, besides dictating the magnitude of engagement in other factors of production, especially land and labour.

The study revealed that 97% of the smallholder farmers were affected by fluctuations of the prevailing weather conditions. This further affected their income, not only from farming, but also from other climate-related income-generating activities. Analysis showed that over 84% were affected by droughts and experienced at least an average of 2.48 and 2.10 months of food unavailability in 2010 and 2014 respectively. As a means of coping with shocks emanating from reduced household incomes, and eventual food shortages, the respondents also had other assets such as livestock. For example, 12.2% was engaged in other businesses such as selling of second-hand clothes, operating small kiosks, employed in transport services, among others, while 8.4% received salaries.

On the other hand, 4.8% of the respondents were engaged as casual labourers, especially on the farms, while 5.1%engaged in petty trade, such as sale of handicrafts

in nearby markets. The research showed that these other income sources provided the smallholder farmers with alternative means of sustenance, especially during droughts or in periods of crop failures or disease incidences.

The low utilization of the available labour on various smallholder farms was observed, caused mainly by: (i) prevalent land fragmentation, leading to the scatter of the small quantities produced by each smallholder farmer; (ii) unreliable supply of good quality raw materials and inputs; (iii) long distance between the farms (i.e., areas of production) and the markets (i.e., agro-industries and other regional markets); and (iv) high opportunity costs for farming (compared to other off-farm activities), especially among the youths. Low levels of incentives from farm-related activities contributed to this high opportunity cost of farming.

#### 5.3.1.3. Benefits Associated with Advances in Agricultural Policy Environment

In addition, review of secondary information shows that significant progress has been made in advancing policy analysis and advocacy of agricultural research for development. For instance, within one such regional organization (ASARECA), a total of 100 different policies, laws, regulations and procedures were analyzed within the research period.

The analysis mainly focused on the factors hindering the free movement and trade of essential agricultural commodities, as well as the assessment of trends in food price transmissions. It was noted that, despite being a common market that is also linked to other trading blocs like COMESA and SADC, the EAC block still faces serious non-tariff barriers that makes it challenging to transact trade even within one country. The reduced intra- and inter-country and regional trade was observed to contribute to the farmers' willingness to expand their cropping lands, besides adopting productivity-enhancing TIMPs.

Notwithstanding the aforementioned barriers, analysts, comprising mainly policy analysis experts and policy-makers, made significant changes in enhancing the policy-enabling environment, including the development of roadmaps to be used in addressing the drivers of food price volatility. This included critical analysis of agricultural enabling environment policy options including reforms, regulations and

administrative procedures in the area of agricultural resources, food, market standards and regulations; natural resources management; agricultural resources; integrated soil and water management; climate change adaptation/mitigation that implemented new or revised policies by relevant authorities; as well as potential public investment plans. Based on this, at least 90 assorted policies, laws, regulations and management procedures were formally presented before legislators through meetings, workshops, seminars, conferences, and forums. At least 50 of these policy documents were approved, and implementation begun.

One significant breakthrough in engaging in the regional projects involved the development of a food price-forecasting model. This model was customized to inform early warning and response systems in the region. All the five countries under research benefited from this intervention, and can easily use the model to advice policy-makers on the price trends, and how to regulate movement of essential commodities within and across the borders.

Besides policy analysis, selected regional projects were implemented to address the persistent challenges hinging on the harmonization of standards for quality products, handling of pest and disease risks; streamlining border procedures and paperwork; and advocating with policy-makers to improve the overall enabling environment for regional trade and market access. Significant breakthrough, mainly regarding harmonization of policies and regulations to de-bottleneck trade in the targeted priority crops has been achieved. Some of these standards are currently under implementation and enforcement at the national levels.

In collaboration with actors in COMESA, the EAC, and the national governments of the five states, ASARECA coordinated the processes leading to the approval of essential agricultural enabling environment policies, regulations, and administrative procedures. These policies focused on agricultural resource, food and nutrition security, market standards, as well as specific regulations. Top on the list included the approval of the 11 harmonized standards for cassava (7) and potatoes (4). The East African Standards Committee (EASC), following successful presentation of the same for legislation and dialogue approved these standards (see Appendix 4 for list of the Standards). These standards are currently in force in the EAC.

Harmonization of these standards, not only contributed to enhanced farm-level production, but also led to intra- and inter-regional trade. Meta-evaluation of targeted organizational performance reports (including the monitoring and evaluation reports), indicate that the harmonization of cassava standards has boosted trade among smallholder farmers (WB, 2014).

It was further noted from the study that the use of farm inputs, especially fertilizers, farm implements, and seed subsidies have not fully involved the private sector partners, whose participation has been shown to enhance agricultural input marketing. In some instances, farmers reported that irregular bans on exports of certain commodities greatly impacted their economic returns. For instance, the bans imposed on maize by the Tanzanian government in 2013 caused some of the respondents to reduce their engagement in maize production.

#### 5.3.1.4. Evaluation of Anticipated versus Actual Benefits from Regional Projects

The study revealed that regionally implemented projects, and those interventions coordinated jointly led to economies of scale and spillovers among the participating farmers. Participants in these regional projects reported benefits ranging from regional integration, to collective action against common challenges. Participants from Kenya, Uganda, Tanzania, and Rwanda reported that the regional coordination in tackling the maize lethal necrotic disease had led to not only their awareness on how to deal with the disease, but also on mechanisms of collaboration across the boundaries to reduce the spread of the disease.

Farmers engaged in the regionally coordinated projects recorded an increase in the farm expenditure by up to 33.7%, as compared to the non-beneficiaries whose expenditure increased by 45.3% (from US$ 93,939 in 2010 to US$ 125,632 in 2014 for beneficiaries, compared to an increase from US$ 27,325 in 2010 to US$ 39,697 in 2014 for non-beneficiaries). It is worth noting that the latter's expenditures seem low because of the low magnitude of their engagements in national and local projects. This is in contrast to the regional projects that cover wider areas within the defined agricultural development domains. This finding further reinforces the role of

organizations promoting regional projects, i.e., to identify, catalyze, and coordinate regional activities and networks.

Evidence from the research indicated that some of the organizations within the five countries under study still opted to individually confront the same agricultural problems, instead of teaming up with others within the region. However, the trend has started shifting, and collaborative partnership has been fostered. This has been made possible since most of the project locations share the same climatic and edaphic conditions. As already indicated, and based on previous researches (Walton, 1994; Gijsbers and Contant, 1996; Eponou, 1998), putting together resources for joint research has been proven to increase the effectiveness of handling diseases, pests, and other challenges at hand.

Among the organizations that recorded success in the regional implementation of their projects, programs and interventions, their effectiveness was realized through enhanced collaboration in the identification and financing of the common problems and strategies, development and definition of clear and transparent coordination modalities, and efficient and equitable cost-sharing mechanisms among the targeted groups.

The use of knowledge and information products and pathways (e.g., telephone, publications, fax, e-mail, Internet), have also led to significant cost reductions in the implementation of these regional collaborations. Among the different types of regional collaborations already formed and operational include: regional associations, networks, forums, as well as professional associations (Table 13).

**Table 13:** Types of Regional Collaboration in Agriculture

| Types of collaboration | Main Activities | Specific Benefits | Associated Risks | Main Examples |
|---|---|---|---|---|
| • Regional collaboration organizations | • Various programmes shared between partners<br>• Multi-disciplinary and multi-institutional projects | • Solid programmes, regional presence<br>• Broad participation<br>• Focus on specific problems | • Mobilization of partners' resources<br>• Coordination costs<br>• Political process<br>• Weak commitments between partners<br>• Lack of identity | African Highland Initiative; AFAAS; Farm Concern International; Seed companies (e.g. KEPHIS) |
| • Regional agricultural research institutions | • Implementation of research programmes | • Knowledge and information exchange<br>• Market and market linkages<br>• High quality, sustainable programmes | • Low regional identification | ILRI; CIMMYT; CIAT; IITA |
| • Regional associations | • Exchange of experiences and results<br>• Capacity building of less-resourced NARS | • Stable NARS with resources to run programs<br>• Mutual support and problem recognition | • Focus on national projects at the expense of regional challenges<br>• Political influence<br>• Lack of research | ASARECA; AFRII; CORAF; CCARDESA |
| • Regional networks and for a | • Exchange of perspectives<br>• Precise programme between partners | • Open character and contacts<br>• Solid programme and directed exchange | • Lack of action and commitment<br>• Distance from national problems<br>• Low political support | CABI – Africa; FARA; CIALCA; CARITAS; FAO |
| • Professional associations | | • Disciplinary contacts | • Lack of sustainability | National University of Rwanda; Kenyatta University (Kenya); Sokoine University of Agriculture (Tanzania); Moi University; Nairobi University |

Source: Survey Data (2014)

Formation of consortia among selected organizations also helped bring together diverse institutional partners. These partners drafted agreements (in form of memorandum of understanding (MoU) and letters of agreement (LoA), among others) around common problems and emerging themes. Besides these consortia, the partners also convened and facilitated scientific workshops and conferences, where they engaged in development of common approaches of tackling emerging challenges in the region, as well as within individual countries.

The approach of collaborative problem solving has contributed to a better understanding of the problem by the collaborators. It has also enabled participating parties to clearly define and articulate their objectives, goals, and responsibilities, leading to enhanced project, program and intervention management and evaluation. These confirm similar issues raised by researchers such as Fiore et al. (2010), Mayer (1998), and Funke (2010) that most of the collaborations end the moment the common problem is addressed, thus risking sustainable management of the projects. However, in order to avoid this, the research revealed that some of the partners have resorted to the development of longer-term agreements. For example, ASARECA has such longer-term agreements with the International Food Policy Research Institute (IFPRI), COMESA, and IITA, besides participation in the Consultative Group of International Agricultural Research Programs (CRPs).

Researchers like Funke (2010), Glaser et al. (1997), Mayer (1998), Hacker et al. (2009), and O'Neil (1999) have generally agreed that collaborative problem solving is an inherently complex mechanism that incorporates the components of cognition found in individual problem solving in addition to the components of collaboration.

Within the approach of regional project implementation within the five countries of East Africa, it is evident that the cognitive components of individual problem solving include understanding and representing the problem content, applying problem solving strategies, and applying self-regulation and meta-cognitive processes to monitor progress toward the goal. In countries where this approach has been embraced, significant collaboration impacts have been witnessed. However, Dillenbourg (1999) and Fiore et al. (2010) observed that engaging other group members in a collaborative task requires additional cognitive and social skills to allow shared understanding, knowledge and information flow, to create and understand an appropriate team organization, and to perform coordinated actions to solve the problem.

The research proved that the above concepts and principles hold. For instance, in the adoption of QPM and Bean Innovation TIMPs, some farmers, especially the beneficiaries of regionally implemented projects in Rwanda and Tanzania employed this approach of collaborative problem solving. They identified the existing problems,

brainstormed on a myriad of options to engage to provide them with affordable access to nutritive foods. Such collaborative needs assessment culminated in the identification of priority crops, QPM and bean innovation being among them. These groups of farmers formalized their groups into Farmer Organizations, thereby giving them more clout than when they act individually. The process has empowered the members of such groups with cognitive skills, development and behavior, thus making them better able to access facilities (such as credits) as well as a stronger negotiating body. The negotiators have easily bargained with traders, private sector partners, and the local governments, better than their counterparts who opt to operate otherwise.

#### 5.3.1.5. Benefits Associated with Value Addition in Regional Projects

As indicated in the methodology section, the contribution of regional projects towards strategic priorities was undertaken by measuring value added in agricultural activities. The steps involved letting the subscript *i* represent a household, whether for the beneficiary or non-beneficiary. The data for both 2010 and 2014 periods were used in fitting the model. The model for determining the value added ($VA_a$) in agriculture is represented as follows:

$$\boldsymbol{VA_a = \sum_i y_{a,i}^{SE} + \sum_i y_{a,i}^{L} + \sum_i y_{a,i}^{K}} \quad (18)$$

Where

$VA_a$ =Value added in the a$^{th}$ agricultural activity

$y_{a,i}^{SE}$ = Self-employed agricultural income of $i^{th}$ household

$y_{a,i}^{L}$ = Agricultural labour income of $i^{th}$ household

$y_{a,i}^{K}$ = Agricultural capital income of $i^{th}$ household

Based on the above equation, the value of all outputs produced through the self-employed agricultural income for the targeted household, net any costs was determined as follows:

$$\boldsymbol{y_{a,i}^{SE} = P_j(\sum_j^J x_{i,j}^{Home} + \sum_j^J x_{i,j}^{Market} + \sum_j^J x_{i,j}^{Investment}) - COSTS_{a,i}} \quad (19)$$

Where

$P_j$ = Farm-gate price of good $j$. In this case, $j$ indexes all the targeted agricultural commodities in this study, namely: maize, sorghum, millet, beans, sweet potato, cassava, and bananas

$x_{i,j}$ = Quantities of good $j$ used at home, sold at the market, and invested for revenue generation.

On the other hand, the agricultural labour income ($\sum_i y_{a,i}^L$) is hereby defined as all the income paid in currency or in-kind for labour services rendered by any member of the household in the agriculture sector. Wage income is measured at the individual level and then aggregated to the household level. In this study, the amount of wages received, or earned was determined through the assessment of how much money was received as casual labourer or what was spent on hiring labour.

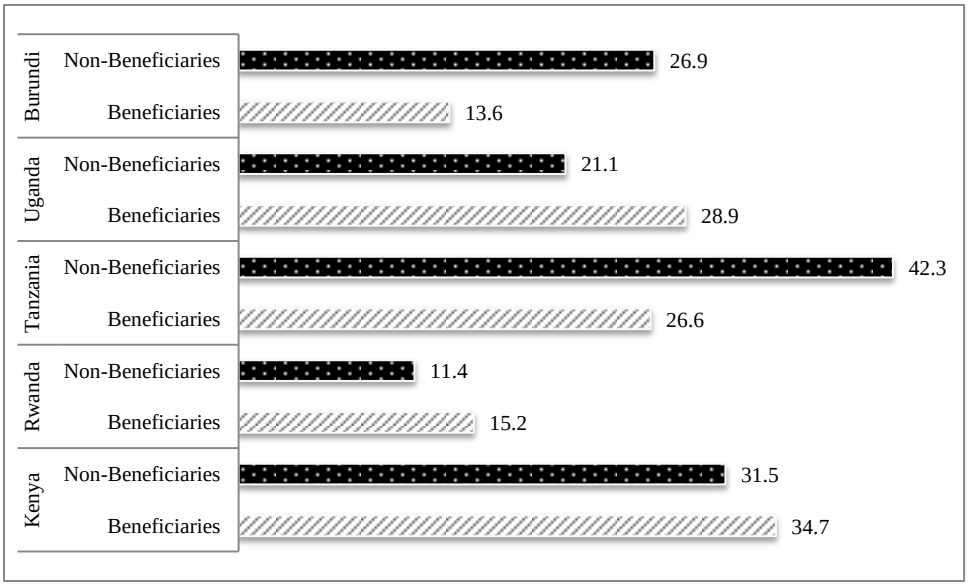
Similarly, agricultural income ($\sum_i y_{a,i}^K$) is computed as all forms of income earned in cash or in-kind for assorted activities ranging from agriculture-related salaries, to remittances, pension, as well as agro-businesses or trade. It is measured directly at the household level. It is also hereby assumed that all capital income earned by agricultural households is agricultural, and all capital income earned by non-agricultural households is non-agricultural.

Based on the models above, an increase of 26.5% in net revenue was recorded (up from US$ 5.24 million in 2010 to 6.63 million in 2014). There was a significant difference between the respondents, such that the beneficiaries recorded an increase of US$ 808,768 between 2010 and 2014 (25.1% increase), while the non-beneficiaries recorded a slightly higher net increase of US$ 581,075 (28.7%) within the same period. However, it is worth noting that in as much as the non-beneficiaries recorded a higher percentage increase, the absolute values of net returns were lower, such that the net difference between the beneficiaries and non-beneficiaries was US$ 228,000.

Results further showed that there were variations in the percentage change in the amount of value added. Kenya, Rwanda and Uganda recorded larger increment among the beneficiaries than non-beneficiaries (in terms of both the percentage

change and monetary differences). On the other hand, more percentage increments were noted for Tanzania and Burundi. However, as already indicated above, increased percentage change in value added does not automatically mean the same thing in terms of actual monetary increments (apart from the case of Tanzania). For instance, in Burundi, the 26.9% increase in value added among the non-beneficiaries translated to US$ 17,196. On the other hand, the 13.6% increase registered by the beneficiaries was equivalent to US$ 41,607 (Figure 13).

**Figure 13:** Percent Change in Value Added



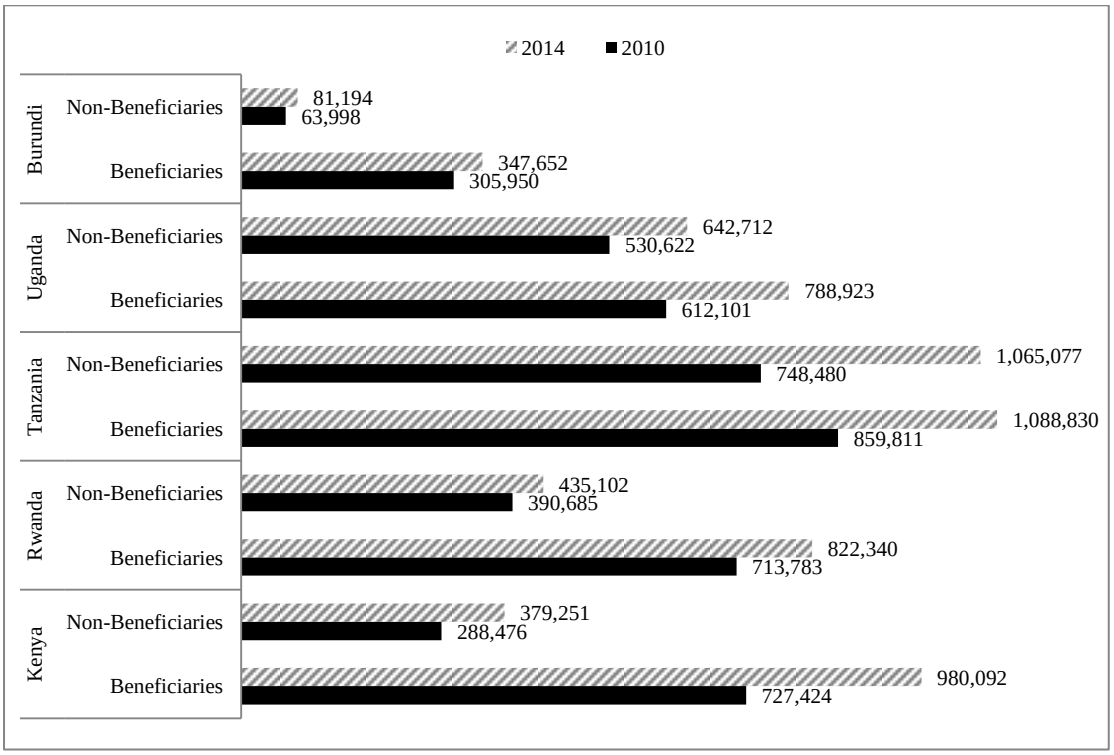

Value addition for crop commodities ranged from adoption of TIMPs that enhance quality and safety during processing to storage. Commodities such as cassava and banana were value added, thus improving shelf life and revenue generation. Cassava's value addition included adoption of efficient chippers and cleaners, thereby reducing wastes associated with over-peeling. Where this technology was applied, beneficiaries fetched up to 38% increase in sales. Value addition for banana involved packaging of pre-peeled bananas into airtight bags. These processed bananas fetched almost double the price, besides reducing transport and storage costs.

As part of enhancing value addition, the study revealed that some of the beneficiaries have signed contracts with agro-based companies. For instance, the Afribanana Products, a banana value chain incubator in Uganda, and the COAFGA in Rwanda, are contributing to the development of the banana sub-sector. Through this

partnership, the beneficiaries are engaged in not only selling banana, but also making biodegradable bags, banana fabrics, banana juice, banana wine, charcoal briquettes, and tissue culture planting materials.

The results further indicate that there were specific differences in the actual amount of value added. Empirical findings reveal that the total value added on the commodities were dependent on factors such as project coverage, type of TIMPs adopted, accessibility to markets, as well as farmland size. These factors coalesce to influence the amount generated from value addition (Figure 14).

**Figure 14:** Total Value Added among Respondents




Further computations show that the beneficiaries received net revenue of nearly US$ 1.2 million above their counterparts. This shows that each of the 702 beneficiaries was US$ 1,705 higher than the non-beneficiary. Similarly, the beneficiaries generated extra revenue of US$ 1.42 million in 2014, leading to net revenue of US 2,029 for each of the targeted beneficiaries. By the end of the research, the beneficiaries had an average of US$ 324 above the non-participants in the regional projects. This further provides some evidence that the respondents engaged in regional projects have comparative advantage over the respondents engaged elsewhere.

Results even further illustrate that the unit prices of specific commodities were generally lower for the non-participants of regional projects. This may be attributed to the fact that the participants in these regional projects were also registered in other organizations. This registration was noted to provide the members with benefits that the non-members could not access. For instance, the members enjoyed collective bargaining of their commodities; thereby enabling them to negotiate with the middlemen and other traders for better prices. An example of this can be seen where the unit price of a cow was US$ 185 and US$ 195 in 2010 and 2014, respectively for the beneficiaries, as opposed to US$ 127 and US$ 182 in 2010 and 2014, respectively for the non-beneficiary (Table 14).

**Table 14:** Details of Value Added to Respondents (US$)

| Country | Status | $\sum_i y_{a,i}^L$ | | $\sum_i y_{a,i}^K$ | | $\sum_j^J x_{i,j}^{Home}$ | | $\sum_j^J x_{i,j}^{Market}$ | | $\sum_j^J x_{i,j}^{Investment}$ | | $COSTS_{a,i}$ | | $VA_a$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| Kenya | Beneficiaries | 468,820 | 642,603 | 29,545 | 40,232 | 58,718 | 83,675 | 146,425 | 200,790 | 46,016 | 40,087 | 22,100 | 27,295 | 727,424 | 980,092 |
| | Non-Beneficiaries | 191,770 | 244,265 | 8,178 | 11,766 | 29,395 | 46,615 | 61,197 | 77,500 | 4,282 | 7,303 | 6,346 | 8,198 | 288,476 | 379,251 |
| Rwanda | Beneficiaries | 538,339 | 607,500 | 8,012 | 15,096 | 8,891 | 10,488 | 176,776 | 197,468 | 10,276 | 31,014 | 28,511 | 39,226 | 713,783 | 822,340 |
| | Non-Beneficiaries | 280,326 | 309,025 | 2,172 | 3,943 | 15,277 | 16,423 | 92,718 | 101,694 | 7,853 | 14,648 | 7,661 | 10,631 | 390,685 | 435,102 |
| Tanzania | Beneficiaries | 566,397 | 708,232 | 17,820 | 20,745 | 103,007 | 129,931 | 180,318 | 229,164 | 10,342 | 24,311 | 18,073 | 23,553 | 859,811 | 1,088,830 |
| | Non-Beneficiaries | 449,479 | 614,937 | 7,543 | 9,814 | 101,576 | 143,347 | 147,312 | 201,708 | 48,102 | 103,029 | 5,532 | 7,758 | 748,480 | 1,065,077 |
| Uganda | Beneficiaries | 430,320 | 555,031 | 41,162 | 36,080 | 25,521 | 38,454 | 128,120 | 172,984 | 2,129 | 10,486 | 15,151 | 24,112 | 612,101 | 788,923 |
| | Non-Beneficiaries | 364,098 | 451,861 | 26,880 | 27,986 | 31,467 | 30,272 | 112,406 | 141,292 | | 562 | 4,229 | 9,261 | 530,622 | 642,712 |
| Burundi | Beneficiaries | 208,817 | 232,737 | 6,374 | 13,926 | 27,736 | 30,222 | 67,481 | 72,937 | 5,657 | 9,275 | 10,115 | 11,445 | 305,950 | 347,652 |
| | Non-Beneficiaries | 44,960 | 53,268 | 680 | 4,290 | 6,110 | 7,501 | 14,760 | 16,326 | 1,046 | 3,658 | 3,558 | 3,849 | 63,998 | 81,194 |
| TOTAL | Beneficiaries | 2,212,693 | 2,746,103 | 102,912 | 126,080 | 223,873 | 292,769 | 699,119 | 873,343 | 78,770 | 117,363 | 93,939 | 125,632 | 3,219,069 | 4,027,837 |
| | Non-Beneficiaries | 1,330,633 | 1,673,356 | 45,454 | 57,800 | 183,825 | 244,157 | 428,393 | 538,519 | 56,934 | 127,010 | 27,325 | 39,697 | 2,022,261 | 2,603,336 |

Source: Survey Data (2014)

With respect to livestock management, the value added in regional projects included: (i) improvement of animal health; (ii) application of genomics and the conservation and use of genetic resources; (iii) improvement of feed utilization and animal nutrition; (iv) sustainable improvement of production systems, including improved livestock productivity and natural resources management; (v) integrated systems analysis, including livestock policy analysis and enhanced surveillance systems for nomadic groups; and (vi) enhanced capacity building, including strengthening of partnerships and knowledge and information management.

The significant difference ($P \leq 0.05$) between the benefits accrued to the participants in these regional projects, vis-à-vis non-participants is a clear indication of the benefits forgone when projects are implemented by individual countries (as national projects) and not handled regionally. Significant differences ($P \leq 0.05$) were observed between respondents with respect to the actual benefits received from some of the regionally generated and disseminated TIMPs, especially QPM, quality seed potato, and bean innovation.

For instance, through the adoption of wooden stakes in enhancing productivity of climbing beans in Rwanda, Uganda and Kenya, the beneficiaries realized increased yields, ranging from the usual 1 ton/ha to 4.5 tons/ha. These beneficiaries also received higher economic returns of up to US$ 950/ha above the non-beneficiaries. As an alternative to the wooden stakes, beneficiaries in Rwanda and Tanzania adopted the use of sisal strings, thereby leading to increased productivity from the usual 0.8 tons/ha to an average of 3,5 tons/ha, as well as economic returns of up to US$ 1,300 above the non-beneficiaries.

New partnerships were formed, and the already existing ones were strengthened. For example, in Tanzania, a total of 13 partnerships for Banana Xanthomonas Wilt (BXW) control were established between the Maruku Agricultural Research and Development Institute with the Local Governments (Bukoba, Missenyi and Karagwe district councils), World Vision – Kagera Zone, SC Vi- Agro-forestry, Karagwe Development Relief Services (KADERES), CHEMA, MAVUNO MEMA, Tanzania Christian Relief Services (TCRS), Kagera Development Trust Fund (KADETFU), MAYAJA (Technology transfer), Kolping Society of Tanzania and Evangelical

Lutheran Church – Tanzania.

On the other hand, Uganda strengthened its partnerships with the District Farmers Associations of the Kumi, Katakwi, Soroti and Abim districts, as well as the Uganda National Farmers' Federation; East African Farmers' Federation; District Agricultural Offices; Sub-County Local Governments; and Grow More Seeds Company, besides other players. This led to increased quantity of sales of seeds by over 23% over the research period.

The key partners engaged in the implementation of the regional projects included: International Livestock Research Institute (ILRI); International Centre for Insect Physiology and Entomology (ICIPE); International Potato Centre (CIP); World Agro forestry Centre (ICRAF); International Institute of Tropical Agriculture (IITA); International Maize and Wheat Improvement Centre (CIMMYT); and International Crops Research Institute for Semi-Arid Tropics (ICRISAT), among others.

#### 5.3.1.6. Benefits accrued from assorted TIMPs

In general, the regional projects generated assorted benefits to the respondents. Significant correlation was observed between the type of availed and utilized TIMPs and the actual benefits accruing to the targeted stakeholders (Table 15). Benefits were mainly recorded among the farmers who utilized and adopted quality protein maize (QPM), quality seed potato (QSP), bean innovations (including the adoption of both climbing and bush beans), integration of sorghum and legume varieties, Striga-resistant maize and sorghum varieties, integrated water management (IWM), and integrated soil fertility management (ISFM).

**Table 15:** Benefits from Various TIMPs

| TIMPs | Number benefiting | p-value |
|---|---|---|
| Quality Protein Maize | 173 | .021 |
| Quality Seed Potato | 217 | .000 |
| Orange-Fleshed Sweet Potato | 65 | .546 |
| Bean Innovation | 269 | .000 |
| Sorghum-Legume varieties | 80 | .039 |
| Crop-Livestock Integration | 111 | .280 |
| Striga-resistant Maize Variety | 20 | .049 |
| Striga-resistant Sorghum Variety | 37 | .014 |
| Banana Varieties | 65 | .928 |
| Cassava Varieties | 32 | .043 |
| Soil Erosion Control Structures | 49 | .214 |
| Post-Harvest Handling | 17 | .506 |
| Integrated Water Management | 260 | .003 |
| Integrated Soil Fertility Management | 150 | .004 |

Source: Survey Data (2014)

The following section provides a brief description of the benefits generated from the adoption of assorted TIMPs.

In some of the regional organizations (such as ASARECA), sorghum is ranked as the third most important crop after maize and beans, and the fifth most important cereal after wheat, rice, maize, and barley in the world (FAO, 2013). Notwithstanding the development of substantial numbers of improved cultivars, very low levels of technology uptake have been experienced, while the expected increases in yields on farmers' fields have been very minimal.

In order to help bridge this gap, a minimum of five regional projects were initiated and implemented during, and before the research period. These projects were jointly implemented with universities (e.g., National University of Rwanda, Nairobi, Sokoine University of Agriculture and Makerere); advanced research institutions, such as the International Sorghum and Millet Collaborative Research Support Programme (INSORMIL); the International Centre of Insect Physiology and Ecology (ICIPE); and international agricultural research centres including the International Crop Research Institute for Semi Arid Tropics (ICRISAT).

Results from the research indicate that the research projects were mainly implemented to address major constraints, such as soil fertility; insect pests and diseases, as well as quality seed production and distribution. With regards to soil fertility management, the sorghum-legume technology was implemented in regions deficient in nitrogen (N), phosphorous (P) and potassium (K). Through this project, the results indicate increases in sorghum-legume productivity. For instance, the research showed an increase of over 100% in sorghum productivity (up from 0.26 tones per hectare in 2010, to over 0.51 tons per hectare in 2014). These results were further confirmed by the scientists' findings, thus further indicating that the implementation of these regional projects has helped, not only to increase soil nitrogen, but also to enhance crop yields and farm productivity.

Striga tops the list of the most dangerous parasitic weeds that attack most of the cereals in the region. Studies by CIMMYT (2004) have shown that losses caused by this parasite ranges between 15 to 50%, thus rendering most of the poor smallholder farmers susceptible to recurrent hunger and food insecurity. Based on the foregoing information, the regional organizations developed projects to tackle this menace. Among the main tasks of these projects were to develop striga-resistant maize varieties that could be easily accessed and adapted to the smallholder farmers' environments.

Amongst the strategies that the respondents adapted to control this disease included crop rotation with other cereals and legumes (such as climbing, bush and soy beans, as well as cow peas and green grams); soil fertility management, such as application of organic and inorganic fertilizers; introduction and promotion of resistant varieties; and habitat management, especially through the use of management practices such as push-pull strategy that combines Napier grass and *Desmodium uncinatum* intercropped with maize. These approaches were also proved to be effective during researches conducted by Odongo et al. (1999); Khan et al. (1999); and Berner et al. (1995). In addition to these approaches, Kanampiu et al. (2003) developed an affordable approach to manage striga infestation through seed coating herbicide-resistant maize with low doses of imazapyr (30 g/ha), prior to planting.

Besides the sorghum-legume varieties, the regional projects also included interventions that focused on the development, promotion and adoption of striga-resistant sorghum varieties. These varieties were developed to be adapted in drought-prone area, particularly within the hot, semi-arid tropical environments that experience between 400 to 600 mm of rainfall, where most of the cereals cannot be supported. As part of generating regional benefits, the implementers of the regional projects focused on enhancing integrated water management in Kenya, Rwanda and Burundi through formulating integrated water management plans that combined such measures as promoting afforestation and improved operations of dams, controlling man-induced flooding in the middle sections of rivers and constructing flood control channels to protect downstream portions of the arid and semi-arid areas within the catchments.

In addition, the research showed that the respondents, especially the participants in the regional projects focused on enhancing integrated water resource management with emphasis on enhancing water productivity at farm and watershed levels; linking farm level gains made on agricultural productivity to the market through the value chain; promoting soil fertility and conservation enhancement approaches through the application of various concepts; watershed management using innovative approaches including carbon markets, payment for environmental services schemes, and enhancing smallholders' adaptive capacity under varying climatic conditions.

The respondents engaged in IWM also made use of "green water." Green water refers to the rainwater harvesting and management, especially in the drylands where water that becomes available directly as raindrops, falls and returns to the hydrological cycle in the form of vapor. As opposed to conventional irrigation that makes use of "blue water" by virtue that these waters are diverted from streams and aquifers (Rockström, 2001), the respondents that used the "green water" reported increased productivity on their farms.

For instance, farmers in Kenya's arid and semi-arid lands (ASALs) of Machakos adopted the Tumbukiza pits to recover crusted lands, capture rain and run-off water, protect seeds and organic matter, and increase yields. Through the use of this technology, farm productivity of up to 3.2 tons/ha of maize production was recorded

in these pits, as opposed to the productivity of 0.5 tons/ha in the fields without these technologies.

The study also focused on approaches of enhancing integrated soil fertility management (ISFM).This refers to the application of soil fertility management practices, and the knowledge to adapt these to local conditions, which maximize fertilizer and organic resource use efficiency and crop productivity (Sanginga and Woomer 2009). These practices necessarily include appropriate fertilizer and organic input management in combination with the utilization of improved germplasm.

On the other hand, specific TIMPs such as orange-fleshed sweet potato (OFSP), crop-livestock integration (CLI), some banana varieties, management practices focusing on soil erosion, as well as technologies on post-harvest handling (PHH) were not significant ($P \leq 0.05$). This non-significance may be accounted for by the predominance of confounders between targeted beneficiaries and non-beneficiaries. This confounding scenario mainly arises when the non-intended groups are allowed to freely mix with other beneficiaries within the study area. This interaction was observed, and in some cases it led to increased income in the previously non-targeted groups.

Besides the above, there was also a positive correlation between the respondents and the type of benefits received within the countries. Benefits from the adoption of technologies such as the bean innovation, sorghum-legume varieties, striga-resistant maize varieties, and the integrated water management (IWM) were all significantly different among the countries ($P \leq 0.05$). The above observations are also supported by the Chi-square tests of independence (with Yates Continuity Correction) indicating a significant association between observed characteristics (e.g., countries, sex and type of respondents (beneficiary or non-beneficiary), farm size, years of farming, among others).

#### 5.3.1.7. Benefits Associated with Membership in other Organizations

The research showed that over 96% of the respondents belonged to some form of organization or association (Table 16). Out of the over 300 organizations recorded during the survey, majority of them (over 80%) were local (e.g., women groups;

community- and faith-based); while the rest were nationally and regionally coordinated (e.g., CARE and CIP respectively). A significant correlation between the respondents was observed (P≤0.05).

**Table 16:** Membership Distribution

| | Type of household | | Total |
|---|---|---|---|
| Belongs to any organization | Beneficiary | Non-Beneficiary | |
| Yes | 501 | 110 | 611 |
| (%) | (44.7) | (9.8) | (54.5) |
| No | 179 | 331 | 510 |
| (%) | (35.1) | (64.9) | (45.5) |
| TOTAL | 681 | 441 | 1122 |
| | (60.7) | (39.3) | (100.0) |

Source: Survey Data (2014)

The regionally supported and coordinated organizations accounted for over 48% of all the memberships. In as much as these projects were coordinated from the Secretariat of the organizations supporting the projects, there were principal investigators, or their deputies at the national level to coordinate field-based activities.

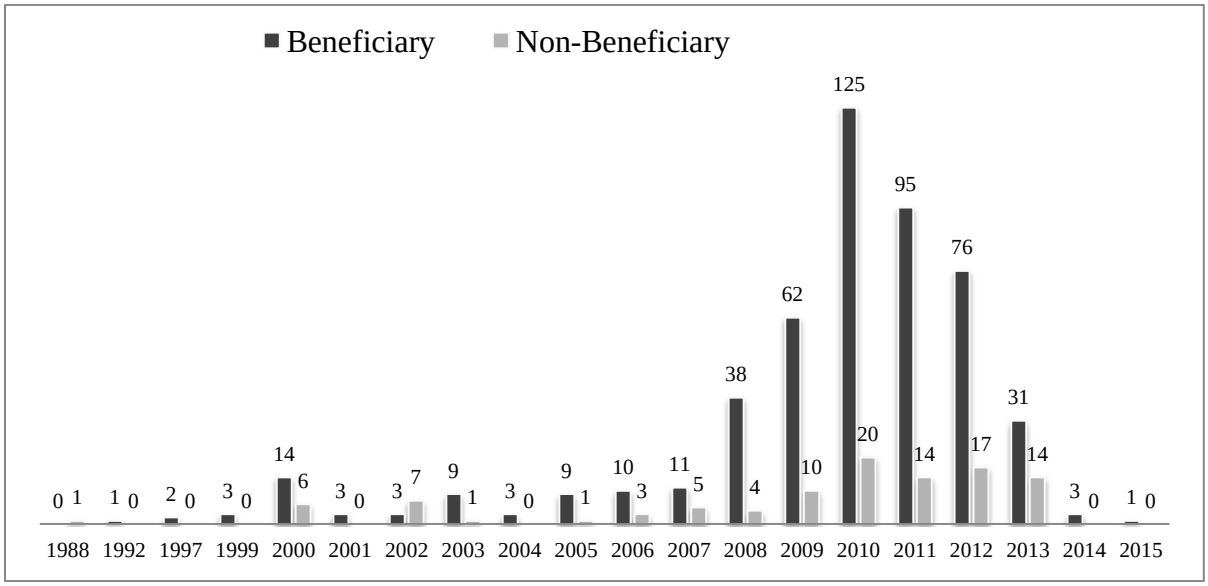
Some of the organizations have been registered, while the local ones (e.g., women groups and self-help associations) operate informally, but on trust among the registered members. They have their own guiding constitutions and byelaws, and certificates of memberships. In most cases, members of these groups have used these certificates to access credits from the banks, or from the small-and medium micro-credit firms.

Among the key organizations where the respondents had registered in, or collaborated with included regional and international organizations (e.g., CIP, CARE, USAID, ADRA, World Vision, and ASARECA); national organizations (e.g., Cotitamu and Urugaga Imbataga) as well as local institutions, cooperatives, self-help and women groups (e.g., Akamila Eyiye; Abahuruju; Mugambi; Agro-Farmer SHG; Vikoba). There was a significant difference (P≤0.05) among the

respondents with respect to the years they joined the organizations as partners.

As can be seen in Figure 15 (figures shown refer to the number of respondents), majority of the beneficiaries began serious partnerships with the organizations, cooperative societies, women groups, community-based organizations, and other self-help groups in 2008, and this continued till 2013. This is the period that most of the regional projects implemented their operational and strategic plans.

**Figure 15:** Year of Respondents' First Membership in various Organizations




Source: Survey Data (2014)

### 5.3.2. Influencers to join Development Group

Unfortunately, there was no significant difference ($P \leq 0.05$) between the respondents and their influencers. This is an indication that most of the members of these groups either did not adequately create awareness, or in some case, they just did not want to expand their membership. From these results, it is clear that over 36% of the beneficiaries joined the organizations by themselves, without anyone inviting them or telling them about the benefits of being members thereof, apart from nearly 11% who joined after being asked by the community leaders. This is also contrary to the researcher's expectations that more respondents, especially those already in the regional projects, would create awareness and ask more members to join (Table 17). More surprising is the fact that the respondents who joined by themselves were more than those who were invited by existing members. This trend can also help explain

why adoption of some TIMPs may be slower than expected.

**Table 17:** Influencers of Respondents to join Organizations

| | Type of household | | Total |
|---|---|---|---|
| | Beneficiary | Non-Beneficiary | |
| Joined myself freely | 219 (36.7%) | 47 (7.9%) | 266 (44.6%) |
| Existing member | 210 (35.2% | 47 (7.9%) | 257 (43.0%) |
| Community Leader | 64 (10.7%) | 6 (1.0%) | 70 (11.7%) |
| Others | 3 (0.5%) | 1 (0.2%) | 4 (0.7%) |
| TOTAL | 496 (83.1%) | 101 (16.9%) | 597 (100.0%) |

Source: Survey Data (2014)

The research showed that unlike the non-beneficiaries, the majority of the respondents who were enrolled in the regional projects also participated in groups' activities, such as meetings, enterprise selection, variety selection, on-farm trials, as well as specialized short-term trainings. In order to determine the factors that contribute to the decision of members to join any organization or group, the following logistic model was fitted:

$$\mathcal{M}_i = \alpha + \beta \mathbf{X}_i + \epsilon_i \quad \textbf{(20)}$$

Where:

$\mathcal{M}_i$ = Membership in any organization or group; $\beta \mathrm{X}_i$ = Vector of explanatory variables for the respondent i, including education, age, farming experience, gender, $\epsilon_i$ = the error term

The whole model with all predictor variables was statistically significant ($P \leq 0.05$). This shows that the model can distinguish the members of the organizations along whether they are beneficiaries of regional projects or not. Based on the model, it can be concluded that the model as a whole is capable of explaining between 25.7% (Cox and Snell R-Square) and 34.4% (Nagelkerke R-squared) of the variance in membership. It also correctly classified 74.1% of the cases. Following regression

iterations, eight of the independent variables generated unique statistically significant contribution to the model. These included: The total number of years of active farming; the type of household (i.e., whether beneficiary or not); the age of respondent; cost of labourer; the total farm income; whether respondent hires labour or not; level of education (years); and whether respondent holds a bank account, thus saves money (Table 18).

The results showed that the strongest predictor of the respondents' membership in any organization was the type of respondents, since it recorded an odds ratio of 7.5. This shows that the beneficiaries of the regional projects were 7.5 times more likely to be members of the organizations than non-beneficiaries (controlling for all other factors in the model). Similarly, in as much as there was no significant relationship between membership and account holding ($P \leq 0.05$), the respondents who operated savings accounts were over 2.4 times more likely to be members than those without such savings accounts. This illustrates the fact that some of the groups insist that members must open bank accounts as preconditions for membership. On the other hand, the level of income, gender, and nativity of the respondents were not considered important factors in meeting the requirements for membership.

**Table 18:** Logistic Regression Predicting Enrolment as Members in Organizations

| | **B** | **S.E.** | **Wald** | **df** | **Sig.** | **Odd-Ratio** |
|---|---|---|---|---|---|---|
| Years of farming | .073 | .020 | 12.803** | 1 | .000 | 1.076 |
| Type of Household | 2.016 | .180 | 125.299** | 1 | .000 | 7.509 |
| Age of respondent | -.036 | .010 | 13.386** | 1 | .000 | .965 |
| Cost of labourer | -.007 | .002 | 15.658** | 1 | .000 | .993 |
| Farm income | .000 | .000 | 5.667** | 1 | .017 | 1.000 |
| Hires labour? | .550 | .302 | 3.308* | 1 | .069 | 1.733 |
| Level of Education | -.033 | .018 | 3.252* | 1 | .071 | .968 |
| Saves income | .879 | .621 | 2.008 | 1 | .156 | 2.410 |
| Account holder? | | | 6.680* | 3 | .083 | |
| Occasionally saves | -.959 | .667 | 2.066 | 1 | .151 | .383 |
| Regularly saves | -1.040 | .643 | 2.613 | 1 | .106 | .354 |
| Always saves | -.625 | .672 | .865 | 1 | .352 | .535 |
| Sex of respondent | -.201 | .147 | 1.877 | 1 | .171 | .818 |
| Nativity | .378 | .307 | 1.510 | 1 | .219 | 1.459 |
| Total income | .000 | .000 | .007 | 1 | .933 | 1.000 |
| Constant | .164 | .537 | .094 | 1 | .760 | 1.179 |

** Significant at $P \leq 0.05$; * Significant at $P \leq 0.1$

Source: Survey Data (2014)

#### 5.3.2.1. Satisfaction with Membership in Organizations

Results on the respondents' levels of satisfaction with the benefits of being a member of the organization were assessed. Nearly 82% of the beneficiary respondents expressed satisfaction with the benefits they have gained by being members. This is further proven by the high level of statistical significance ($P \leq 0.05$) between the two groups of respondents. However, delays in addressing some of the issues within the groups and association are likely to cause some level of dissatisfaction (as represented by the dissatisfied group that comprise 1.7%).

The study revealed that up to 15% of the non-beneficiaries were satisfied with their membership. This group represents those that interacted with the beneficiaries, thereby acquiring new skills. Some of these groups of respondents were observed to adopt the TIMPs that were availed to the target groups, thus showing some multiplier effects in the diffusion of skills, TIMPs, and knowledge and information products (Table 19).

**Table 19:** Level of Satisfaction with Membership in Organizations

| | **Type of household** | | **Total** |
|---|---|---|---|
| | **Beneficiary** | **Non-Beneficiary** | |
| Very satisfied | 72 (14.0%) | 3 (0.6%) | **75** *(14.5%)* |
| Satisfied | 350 (67.8%) | 74 (14.3%) | **424** *(82.2%)* |
| Indifferent | 6 (1.2%) | 4 (0.8%) | **10** *(1.9%)* |
| Unsatisfied | 7 (1.4%) | - (-) | **7** *(1.4%)* |
| **TOTAL** | **435** *(84.3%)* | **81** *(15.7%)* | **516** *(100.0%)* |

Source: Survey Data (2014)

### 5.3.3. Awareness of and Satisfaction with TIMPs

The study investigated the stakeholders' awareness of the various TIMPs, whether they have ever used these TIMPs, the year when they had their first contact with the TIMPs and whether there are still using them. The researcher examined the responses from the participants regarding the adoption of the availed TIMPs in order to determine their sustainable use in the project areas.

In order to determine the level of awareness, the researcher applied the summated rating scale, more commonly known as the Likert scale. This was based on the assumption that each of the statements and items being examined on the sale had equal attitudinal value, importance, or weight. A five-point categorical scale, ranging from strongly satisfied to strongly dissatisfied was applied, and the respondents were asked to rate their levels of satisfaction with the TIMPs based on the scales.

Results indicate that there was a general and overall high level of satisfaction among the beneficiary respondents (1.8) and slightly satisfied non-beneficiaries (2.7). There was also highly significant difference between the beneficiaries and non-beneficiaries. This may be attributed to the fact that all the beneficiary respondents had more interest in accessing and utilizing the best TIMPs from whichever source. In one of the observations and analysis, the non-beneficiaries were more satisfied with the striga-resistant maize variety than their counterparts. This was validated in areas where the non-targeted groups had had some opportunity to interact with the targeted groups – a form of informal extension service provision and awareness creation among the farmers. This approach contributed more to the confounding effects observed within some of the areas targeted for the research.

In some cases, the non-beneficiaries were rather indifferent to the TIMPs availed to their counterparts. This included TIMPs such as striga-resistant sorghum, banana and cassava varieties, soil erosion management practices, post-harvest handling as well as integrated soil fertility management practices. In such cases, these same respondents also reported more frequent incidences of pests and diseases, coupled with reduction in crop yields. The figures shown in Table 20 represent the number of cases scoring different levels of satisfaction.

**Table 20:** Level of Satisfaction with TIMPs

| | Very satisfied 1 | | Satisfied 2 | | Indifferent 3 | | Dissatisfied 4 | | Very unsatisfied 5 | | Overall level of Satisfaction | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Ben** | **No-Ben** | **Ben** | **No-Ben** | **Ben** | **No-Ben** | **Ben** | **No-Ben** | **Ben** | **Non-Ben** | **Ben** | **Non-Ben** |
| Quality Protein Maize | 52 | 10 | 102 | 54 | 16 | 16 | | 10 | | | **1.8** | **2.3** |
| Quality Seed Potato | 86 | 11 | 163 | 39 | 8 | 25 | | 9 | | | **1.7** | **2.4** |
| Orange-fleshed sweet potato | 29 | 3 | 100 | 26 | 10 | 15 | | 1 | 1 | | **1.9** | **2.3** |
| Bean Innovation | 109 | 43 | 115 | 33 | 4 | 29 | 1 | 8 | 1 | | **1.6** | **2.0** |
| Sorghum-Legume | 46 | 8 | 74 | 45 | 10 | 8 | 1 | 6 | 1 | 2 | **1.8** | **2.3** |
| Crop-Livestock Integration | 67 | 20 | 80 | 38 | 13 | 10 | 5 | 6 | 5 | | **1.8** | **2.0** |
| Striga-resistant Maize | 13 | 21 | 75 | 38 | 7 | 8 | 8 | 6 | 3 | 4 | **2.2** | **2.1** |
| Striga-resistant Sorghum | 19 | 11 | 21 | 13 | 10 | 25 | 6 | 21 | 1 | 17 | **2.1** | **3.2** |
| Banana Varieties | 30 | 15 | 24 | 10 | 7 | 21 | 6 | 21 | 1 | 17 | **1.9** | **3.2** |
| Cassava Variety | 33 | 15 | 29 | 19 | 3 | 21 | 6 | 21 | 1 | 17 | **1.8** | **3.1** |
| Soil Erosion Management | 36 | 13 | 32 | 13 | 2 | 20 | 6 | 21 | 1 | 17 | **1.8** | **3.2** |
| Post-harvest handling | 27 | 12 | 17 | 14 | 10 | 21 | 6 | 21 | 1 | 17 | **2.0** | **3.2** |
| Integrated Water Management | 117 | 21 | 129 | 19 | 14 | 19 | 5 | 25 | 2 | 19 | **1.7** | **3.0** |
| Integrated Soil Fertility Mgt. | 99 | 18 | 65 | 11 | 2 | 21 | 6 | 21 | | 18 | **1.5** | **3.1** |

Source: Survey Data (2014)

### 5.3.4. Level of Confidence for Project Management

In addition to being aware and satisfied with the TIMPs, it is vital that regional project implementers gain the confidence to undertake the projects alone and not heavily rely on external support whenever any need arises. Based on this fact, the researcher set out to determine the level of stakeholders' confidence.

In this study, it was recognized that the levels of confidence of the respondents were varied, with the beneficiaries stating that they were confident (an average of 2.1) to handle any regional project activities, and to effectively deliver on the project development objectives. On the other hand, the non-beneficiaries of the projects expressed some level of indifference in handling projects of regional nature (Table 21). In some cases, this category of respondents stated that they could not handle banana varieties as well as soil erosion management. In as much as this category of respondents was not part of the regional project, it is worth noting that a persistence of this trend is very likely to exacerbate food and nutrition insecurity.

It is observable that the average level of confidence by the beneficiaries of regional projects was not strong enough to warrant or guarantee project sustainability. This calls for strategic designing of the regional projects so as to equip the implementers in, not only project management, but also exit and sustainability strategies.

**Table 21:** Level of Confidence with continued Project Management

| | Very satisfied 1 | | Satisfied 2 | | Indifferent 3 | | Dissatisfied 4 | | Very unsatisfied 5 | | Overall level of Satisfaction | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ben | No-Ben | Ben | No-Ben | Ben | No-Ben | Ben | No-Ben | Ben | Non-Ben | Ben | Non-Ben |
| Quality Protein Maize | 50 | 21 | 90 | 38 | 24 | 24 | 5 | 7 | | | 1.9 | 2.2 |
| Quality Seed Potato | 74 | 15 | 166 | 27 | 14 | 22 | 3 | 20 | | | 1.8 | 2.6 |
| Orange-fleshed sweet potato | 46 | 2 | 64 | 14 | 28 | 22 | 2 | 6 | 1 | 1 | 1.9 | 2.8 |
| Bean Innovation | 99 | 31 | 109 | 41 | 17 | 21 | 4 | 18 | 1 | 2 | 1.7 | 2.3 |
| Sorghum-Legume | 53 | 9 | 66 | 16 | 10 | 26 | 1 | 9 | 2 | 9 | 1.7 | 2.9 |
| Crop-Livestock Integration | 57 | 3 | 96 | 36 | 9 | 11 | 1 | 15 | 5 | 10 | 1.8 | 2.9 |
| Striga-resistant Maize | 25 | 7 | 52 | 36 | 17 | 17 | 10 | 7 | 2 | 8 | 2.2 | 2.6 |
| Striga-resistant Sorghum | 9 | 5 | 23 | 16 | 13 | 21 | 7 | 28 | 5 | 17 | 2.6 | 3.4 |
| Banana Varieties | 27 | 6 | 24 | 4 | 1 | 0 | 0 | 9 | 12 | 24 | 2.2 | 4.0 |
| Cassava Variety | 13 | 4 | 22 | 15 | 26 | 22 | 4 | 19 | 7 | 33 | 2.6 | 3.7 |
| Soil Erosion Management | 19 | 1 | 32 | 6 | 18 | 17 | 3 | 27 | 5 | 33 | 2.3 | 4.0 |
| Post-harvest handling | 6 | 1 | 13 | 12 | 29 | 21 | 3 | 19 | 3 | 32 | 2.7 | 3.8 |
| Integrated Water Management | 102 | 16 | 130 | 16 | 19 | 16 | 7 | 20 | 13 | 35 | 1.9 | 3.4 |
| Integrated Soil Fertility Mgt. | 65 | 7 | 92 | 14 | 6 | 16 | 3 | 19 | 11 | 33 | 1.9 | 3.6 |

Source: Survey Data (2014)

### 5.3.5. Value Productivity

As already indicated in Chapter three (section 3.9.1.2), the research set out to estimate the value productivity of the targeted lands. This assessment focuses on the crops planted, as well as on the land areas under each crop. In this study, the average net value of crops produced by beneficiaries and non-beneficiaries was estimated using farmer estimates and records of commodities. The harvest prices were determined using the prevailing market process or at time the prices traded by the middlemen, especially the farm-gate prices. Where necessary, the unit prices of the various commodities were discounted to reflect the different time lines.

The following formula was used in the estimation of value productivity for each crop.

$$C_j = \left[ \frac{\sum_{i=1}^{N} [A_i * Y_i * P_i]}{\sum_{i=1}^{N} A_i} \right] \quad (21)$$

Where,

$C_j$ = Value productivity per hectare for each crop

$A_i$ = Area under the $i^{th}$ crop (hectares)

$Y_i$ = Yield per hectare of the $i^{th}$ crop (metric tons)

$P_i$ = Farm harvest price of the $i^{th}$ crop

Results showed that the value productivity per hectare varied significantly within the countries and when compared among the commodities. The high variations in the yields were mainly attributed the high dependence of respondents on rainfed agriculture as well as differences in the agro-ecological domains. Weather-related changes as well as emergence and outbreaks of pests and diseases contributed to the varied yields.

The yields of the various commodities were observed to greatly affect the prices at the various local markets (Table 22). Statistical tests show that the average unit prices depended on the quantity of the commodity produced ($P \leq 0.05$), the sex of the respondent ($P \leq 0.05$), as well as the native country of the respondent ($P \leq 0.05$). Further analysis indicated that variations were significant in Kenya and Rwanda ($P \leq 0.05$),

slightly significant in Uganda (P≤0.05). A non-significant difference was realized between the unit prices and maize production among the beneficiaries and non-beneficiaries in Tanzania (P≤0.05) and Burundi (P≤0.05), mainly because of national regulations in commodity prices; low production rates per hectare, thereby leading to low demand for the commodities; as well as low adoption of available TIMPs.

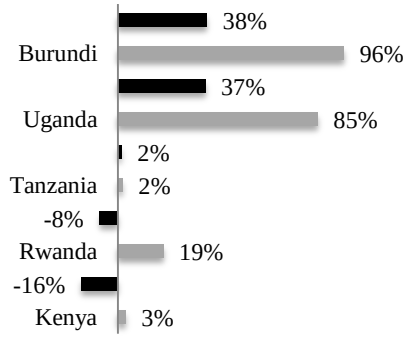
Other key factors responsible for the low productivity included: very limited use of improved varieties, fertilizers, and other inputs; very limited access to credit and finance; high post-harvest losses; and risky and uncertainty in availability of local markets for the farm produce.

Based on the information gathered from Tables 22 and 23, the values therein were then consolidated and computed to generate the value productivity per hectare (Table 24). It was evident that the value productivity per hectare varied with commodities, the type of respondent and among the countries. Beneficiaries of regional projects generally experienced increases in value productivity (see grey bars for each commodity in Figure 16).

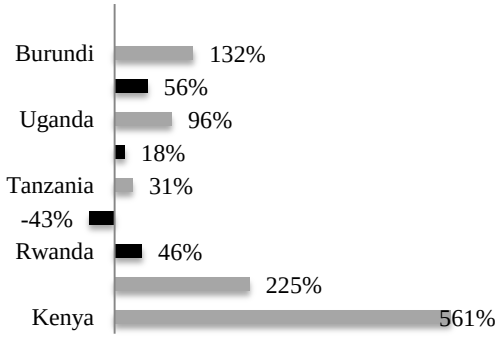
Cassava had the least value productivity per hectare. In most of the observed cases, negative value productivity was recorded. The main cause of this was the fear among the targeted beneficiaries that the cassava mosaic disease (CMD) was re-emerging in the area. Other participants of the regional projects recorded negative increases in value productivity because of poor adoption of the availed TIMPs, reduced market prices for the commodity, as well as difficulties in preserving, transporting and storing clean planting materials.

**Figure 16:** Value productivity/ha

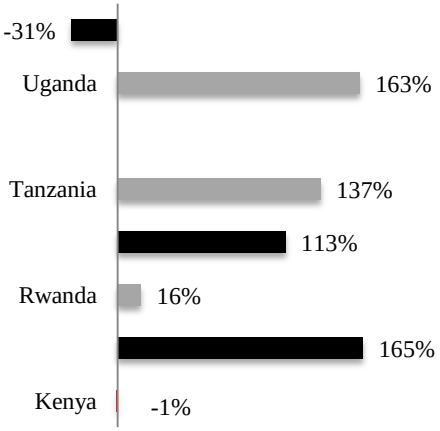
**Maize**



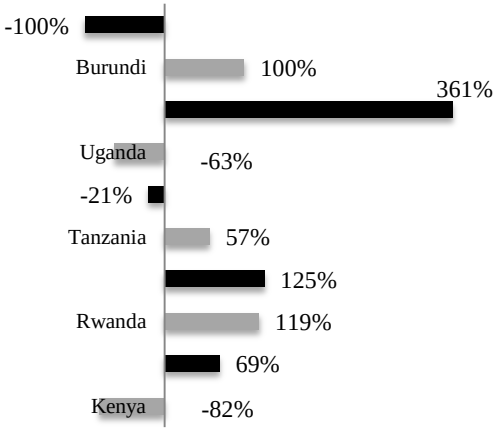

**Sorghum**



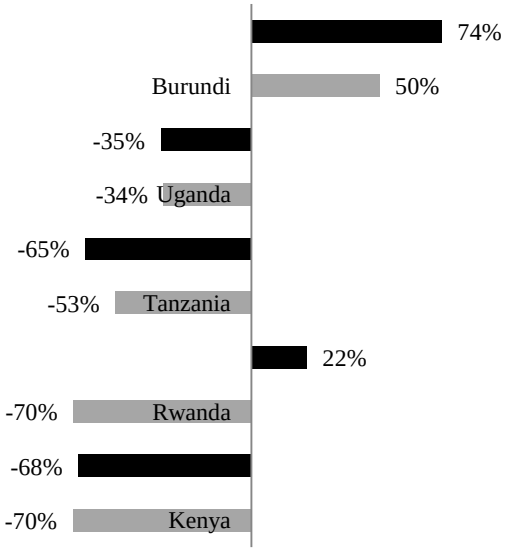

**Beans**



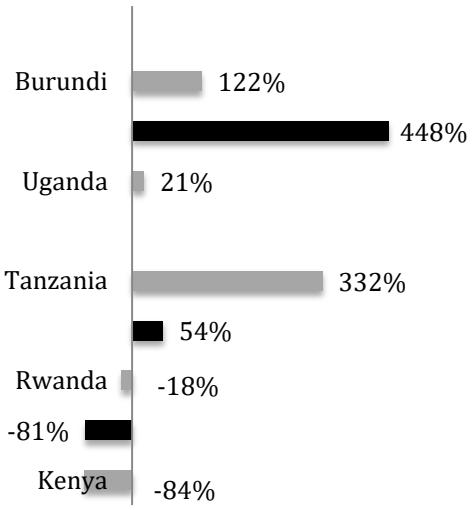

**Millet**




**Cassava**




**Banana**




**Key:** Grey – beneficiaries; Black – non-beneficiaries

Source: Survey Data, 2014

**Table 22:** Estimated Land Productivity (tons per hectare/year)

| Country | Status | Maize | | Sorghum | | Millet | | Beans | | Sweet Potato | | Cassava | | Banana | | Irish Potato | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| Kenya | Beneficiary | 0.54 | 0.63 | 0.26 | 0.51 | 0.48 | 0.75 | 0.29 | 0.50 | 0.86 | 1.37 | 0.78 | 0.99 | 0.19 | 0.60 | 0.00 | 0.02 |
| | Non-Ben | 0.64 | 0.68 | 0.28 | 0.63 | 0.35 | 0.58 | 0.40 | 0.55 | 2.04 | 0.87 | 0.92 | 0.70 | 0.11 | 0.07 | 0.00 | 0.00 |
| Rwanda | Beneficiary | 0.60 | 0.71 | 1.01 | 0.87 | 1.23 | 1.96 | 1.14 | 1.06 | 1.50 | 3.22 | 0.73 | 0.40 | 1.40 | 1.23 | 0.00 | 3.06 |
| | Non-Ben | 1.04 | 0.93 | 6.32 | 1.65 | 0.41 | 1.02 | 0.72 | 0.79 | 0.67 | 1.50 | 2.53 | 5.46 | 2.77 | 6.54 | 0.00 | 1.43 |
| Tanzania | Beneficiary | 1.76 | 1.37 | 1.78 | 1.83 | 0.96 | 1.26 | 0.51 | 0.67 | 1.78 | 2.07 | 1.33 | 1.00 | 0.43 | 0.79 | 0.00 | 0.75 |
| | Non-Ben | 1.02 | 0.91 | 0.81 | 1.01 | 1.14 | 1.18 | 1.43 | 1.43 | 0.77 | 0.87 | 1.92 | 1.20 | 0.00 | 0.18 | 0.00 | |
| Uganda | Beneficiary | 0.30 | 0.48 | 0.26 | 0.33 | 0.80 | 1.65 | 0.26 | 0.42 | 0.95 | 1.39 | 0.46 | 0.54 | 0.79 | 0.96 | 0.00 | 0.91 |
| | Non-Ben | 0.54 | 0.51 | 0.54 | 0.27 | 0.55 | 1.18 | 0.33 | 0.37 | 0.49 | 0.37 | 0.18 | 0.26 | 0.24 | 0.59 | 0.00 | 1.24 |
| Burundi | Beneficiary | 0.21 | 0.44 | 0.28 | 0.61 | 0.25 | 0.55 | 0.19 | 0.45 | 0.38 | 0.77 | 0.56 | 0.98 | 0.50 | 1.21 | | |
| | Non-Ben | 0.21 | 0.33 | 0.33 | 0.49 | 0.27 | 0.46 | 0.19 | 0.30 | 0.42 | 0.80 | 0.42 | 0.89 | | | | |
| Average | Beneficiary | 0.68 | 0.73 | 0.72 | 0.83 | 0.74 | 1.23 | 0.48 | 0.62 | 1.09 | 1.76 | 0.77 | 0.78 | 0.66 | 0.96 | 0.00 | 0.95 |
| | Non-Ben | 0.69 | 0.67 | 1.66 | 0.81 | 0.54 | 0.88 | 0.61 | 0.69 | 0.88 | 0.88 | 1.19 | 1.70 | 0.62 | 1.48 | 0.00 | 0.53 |

Source: Survey Data, 2014

**Table 23:** Unit Price (US$/kg/year)

| Country | Status | Maize | | Sorghum | | Millet | | Beans | | Sweet Potato | | Cassava | | Banana | | Irish Potato | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| | Beneficiary | .31 | .28 | .31 | .94 | 2.80 | .26 | 1.02 | .55 | .27 | 1.26 | 1.09 | .27 | 1.32 | .18 | | .10 |
| Kenya | Non-Beneficiary | .35 | .28 | .33 | .51 | .25 | .28 | .20 | .33 | .26 | .65 | .66 | .20 | .54 | .15 | | |
| | Mean | .32 | .28 | .32 | .86 | 2.63 | .27 | .88 | .50 | .27 | 1.13 | .99 | .26 | 1.20 | .17 | | .10 |
| | Beneficiary | .30 | .27 | .32 | .43 | .20 | .22 | .32 | .33 | .31 | .37 | .53 | .21 | .25 | .21 | | .27 |
| Rwanda | Non-Beneficiary | .30 | .28 | .22 | .42 | .35 | .29 | .17 | .31 | .32 | .23 | .45 | .21 | .27 | .15 | | .19 |
| | Mean | .30 | .27 | .31 | .42 | .23 | .24 | .27 | .33 | .31 | .30 | .50 | .21 | .25 | .19 | | .25 |
| | Beneficiary | .31 | .36 | .34 | .42 | .24 | .26 | .20 | .31 | .34 | .29 | .46 | .25 | .14 | .19 | | .18 |
| Tanzania | Non-Beneficiary | .32 | .32 | .36 | .40 | .26 | .20 | | .33 | .29 | .30 | .41 | .21 | .29 | .30 | | |
| | Mean | .31 | .34 | .35 | .41 | .25 | .24 | .20 | .32 | .33 | .29 | .43 | .24 | .24 | .22 | | .18 |
| | Beneficiary | .29 | .34 | .33 | .48 | 1.38 | .25 | .20 | .32 | .32 | 36.60 | .51 | .30 | .24 | .22 | | 3.21 |
| Uganda | Non-Beneficiary | .33 | .43 | .32 | .43 | .27 | .56 | .65 | .35 | .33 | .27 | .48 | .30 | .18 | .80 | | .27 |
| | Mean | .31 | .35 | .33 | .46 | 1.12 | .32 | .39 | .33 | .32 | 33.57 | .50 | .30 | .23 | .34 | | 1.53 |
| | Beneficiary | .26 | .23 | .22 | .27 | .23 | .20 | | .26 | .22 | 1.05 | .28 | .24 | .23 | .20 | | |
| Burundi | Non-Beneficiary | .26 | .22 | | .39 | .22 | | | .26 | .22 | .21 | .28 | .22 | .21 | .20 | | |
| | Mean | .26 | .23 | .22 | .28 | .23 | .20 | | .26 | .22 | .84 | .28 | .23 | .22 | .20 | | |
| Overall Mean | | .30 | .29 | .30 | .51 | .78 | .25 | .35 | .35 | .28 | 4.50 | .56 | .25 | .56 | .24 | | .66 |

Source: Survey Data, 2014

**Table 24:** Value Productivity per Hectare of Commodities (US$/ha/year)

| Country | Status | Maize | | Sorghum | | Millet | | Beans | | Sweet Potato | | Cassava | | Banana | | Irish Potato | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| Kenya | Beneficiary | 216 | 223 | 75 | 496 | 745 | 133 | 319 | 316 | 133 | 1068 | 568 | 172 | 1055 | 171 | | 13 |
| | Non-Beneficiary | 187 | 158 | 51 | 166 | 58 | 98 | 52 | 138 | 106 | 366 | 262 | 85 | 162 | 30 | | |
| Rwanda | Beneficiary | 140 | 167 | 126 | 184 | 59 | 129 | 178 | 206 | 343 | 798 | 522 | 159 | 283 | 232 | | 446 |
| | Non-Beneficiary | 156 | 144 | 292 | 167 | 63 | 142 | 76 | 162 | 224 | 339 | 273 | 332 | 261 | 402 | | 179 |
| Tanzania | Beneficiary | 611 | 623 | 406 | 530 | 92 | 144 | 87 | 206 | 351 | 325 | 207 | 97 | 37 | 160 | | 163 |
| | Non-Beneficiary | 256 | 260 | 217 | 255 | 151 | 120 | | 382 | 122 | 176 | 236 | 83 | | 165 | | |
| Uganda | Beneficiary | 146 | 270 | 120 | 235 | 431 | 161 | 57 | 150 | 237 | 40297 | 222 | 146 | 168 | 203 | | 9303 |
| | Non-Beneficiary | 167 | 229 | 99 | 154 | 79 | 364 | 145 | 100 | 112 | 65 | 96 | 62 | 106 | 581 | | 197 |
| Burundi | Beneficiary | 50 | 98 | 41 | 95 | 37 | 74 | | 105 | 63 | 642 | 80 | 120 | 69 | 153 | | |
| | Non-Beneficiary | 37 | 51 | | 94 | 28 | | | 53 | 39 | 74 | 39 | 68 | | 80 | | |

Source: Survey Data, 2014

The results of the analysis further indicate that some of the respondents experienced periods of hungers. These periods ranged from an average of 2.48 months in 2010 and a mean of 2.10 months in 2014. In as much as there was a general drop (by 11.4 days) in the average number of months that the respondents had insufficient food, this drop may not be sufficient to keep the respondents food secure in the next five years and beyond. On the other hand, given all the availed TIMPs as well as assorted and proven agronomic and climate change (adaptation and mitigation) related practices, there seems to be very slow action towards ensuring food security in the areas targeted for the study. The details of the frequency of food insufficient months (Table 25) clearly show the trend.

**Table 25:** Frequency of Months with Food Insufficiency

| | Beneficiaries | | Non-Beneficiaries | |
|---|---|---|---|---|
| | 2010 | 2014 | 2010 | 2014 |
| Kenya | 2.70 | 1.71 | 3.24 | 2.59 |
| Rwanda | 2.35 | 2.22 | 2.72 | 2.37 |
| Tanzania | 2.19 | 2.02 | 2.17 | 2.03 |
| Uganda | 2.57 | 2.16 | 2.39 | 1.98 |
| Burundi | 2.71 | 1.71 | 2.67 | 2.22 |
| Average | 2.46 | 2.05 | 2.50 | 2.18 |
| | 2.48 | | 2.10 | |

Source: Survey Data (2014)

On comparison between 2010 and 2014 regarding the number of months that respondents had insufficient food, very high significant differences were observed ($P \leq 0.05$). This implies that there was some improvement among the respondents with respect to their frequency of accessing food, especially during the dry seasons. Further analysis showed that the respondents were also significantly different ($P \leq 0.05$) between those periods. This is a clear indication that there are chances that as many more community members or target groups access the availed TIMPs and also participate in regional projects, the frequency of months without insufficient food will be reduce.

### 5.3.6. Capacity Building

#### 5.3.6.1. Background

Previous studies have explored the role of capacity strengthening, especially with respect to enhancing agricultural research for development. For example, Wettasinha et al. (2014) stated that scaling up or institutionalizing farmer-led research involves building the capacity of different stakeholders and their organizations to apply the approach as part of their regular work.

On the other hand, FAO's renewed corporate approach to capacity development that was launched in 2010 recommended that the following functional capacities should be enhanced (complementing technical capacity strengthening) to enable countries and regions to plan, lead, manage and sustain change initiatives. These themes included:

a) **Implementation capacity**. In this case, the main thrust is to seek to implement and deliver programmes and projects, from planning to monitoring and evaluation. It includes training stakeholders and equipping them with skills such as setting of goals and strategies; financial and people management; project management; as well as organizational management.

b) **Partnering capacity** involves active engagement of the targeted stakeholders in networks, alliance and partnerships, that are mostly connected with active memoranda of understanding. It also encompasses enhancement of skills to engage stakeholders in negotiations; transparent decision-making processes (including budgets and plans); and accountable procedures for stakeholder consultation and empowerment. It encompasses application of inclusiveness in planning, implementation, and creation and sustenance of conducive regulations.

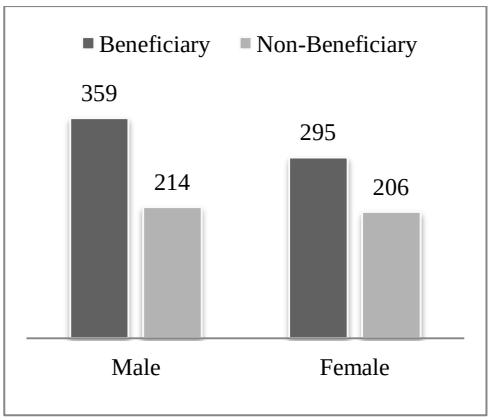
c) **Knowledge capacity** focuses on strategies of increasing access, generation, management and exchange of relevant information and knowledge. It involves arousing the desire of the respondents to keep learning and attending targeted trainings, inculcation of relevant skills for knowledge sharing and management, as well as enhanced observance of procedures for continuous performance review. Information, knowledge exchange and learning form the fulcrum of capacity development.

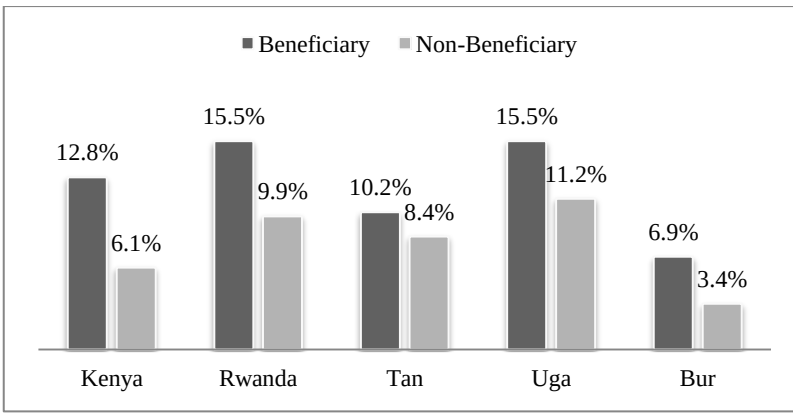
d) **Policy and normative capacity**. This emphasizes acquisition of skills and expertise in the formulation and implementation of policies, laws, and management procedures, as well as implementation of the approved policy reforms. It also involves skills in meaningfully engaging policymakers in agriculture-related policy and planning processes, as well as ability to personally formulate and implement policies, and to lead in the policy reforms.

e) **Technical capacity** ensures attainment of appropriate knowledge and skills mix, such as agronomic, environmental, engineering, economic, social, legal, financial, as well as institutional knowledge. It involves acquisition of knowledge on investment procedures; policy analysis; critical review of knowledge and information products and delivery pathways; as well as allocation of adequate resources for assorted agricultural practices.

In conformance to these observations, this study indicated that there was significant willingness by the farmers to participate in assorted capacity strengthening initiatives. Out of the 1,074 respondents who accessed and benefited from assorted trainings, 61% engaged in regional projects (33.4% male and 27.5% female). The selection of respondents for the short-term (as well as long-term) trainings was proportionally done (see Figure 17 and Table 51 (in appendix 2). There was a significant difference ($P \leq 0.05$) between the respondents accessing the training, and whether they were engaged in the mega-projects or not.

**Figure 17: Number** of Respondents Trained (disaggregated by %)




Source: Survey Data, 2014

#### 5.3.6.2. Main Training Themes

Results indicated a significant difference between the type of respondents and the training needs addressed ($P \leq 0.05$). Among the top training themes handled included a combination of crop management and agronomy; crop management coupled with artificial insemination for the livestock keepers; as well as crop management and pest and disease control. In some cases, farmers requested specific trainings on livestock management as well as monitoring and evaluation.

The main service providers included international, national and local organizations and agencies such as: ASARECA, CARE, USAID, and the International Potato Centre (CIP). The mode of training involved face-to-face instructions based on already prepared manuals, handouts and curriculum. Prior to these trainings, the trainers conducted pre-training assessments in order to determine the core areas that needed to be addressed. Based on these pre-training assessment and findings, relevant training materials were then prepared, including training curricula, teaching aid, contacting and finalizing contract signing with the trainers (if externally commissioned). In most cases, the trainings covered a period of three to five days. Most of the trainings were found to take place on individual day sessions, multi-day workshops or through a series of inter-related trainings or workshops.

As a means of standardizing procedures, the researcher adopted the characteristics that help distinguish between the short- and long-term trainings. For instance, the researcher described short-term training as those capacity-building initiatives that total no fewer than eight contact hours and no more than three contact months in duration. On the other hand, long-term training is hereby defined as capacity strengthening initiative that lasts more than three contact months. The knowledge and skills gained through technical assistance activities and visits to demonstration or experimentation sites were also included as means of acquisition of relevant skills. It was also revealed that the individuals attending more than one training course were counted as the same individual, but disaggregation was done based on the different courses undertaken.

The study revealed that the capacity building activities undertaken for the beneficiaries followed five guiding principles. These trainings were aimed at

empowering the beneficiaries to identify, select and manage the TIMPs. The first step involved identification of the existing capacity gaps. This was followed by sharing information and tools, thereby creating skills and expertise, as well as building institutional capacity. The third approach ensured that all the identified needs, gaps, and overall challenges were tailored to meet the individual needs of each participant. This was followed by the fourth step whereby the trainers explored available resources, compiled them, before synthesizing them into training modules. Finally, closer and stronger partnerships were formed, and existing ones strengthened, thereby enhancing leveraging of resources.

Based on the above-cited five guiding principles, the research revealed that the service providers strengthened the capacity of the respondents through a combination of approaches, including dissemination of practical information through workshops; seminars; innovation platforms; field schools; exchange visits and study tours; personnel exchange programs; institutional attachments; technical assistance to project teams; facilitation of transfer of relevant TIMPs; coordination of training programs; development and sharing of relevant information and knowledge products and programs; and support for feasibility studies. These were found to be effective capacity-enhancing approaches, especially where problem-solving networks had been created and operationalized. In selected cases, infrastructural support was provided to the regional projects.

As already indicated, the infrastructure support for the targeted groups included: provision of assorted office equipment; ox implements, especially for sorghum weeding; hard- and software; installations of specialized equipment (e.g. greenhouses); and renovations (especially of dilapidated laboratories and equipment). For instance, diffused light stores (DLS) were constructed in Burundi, thereby enhancing demonstration among farmers so as to popularize the potato storage technology. Similarly, renovation of seed store for potato mini-tubers was supported, including the repairs of the aeroponics unit in Kenya. This action led to an increased capacity of the store to handle extra 250 plantlets per growth chamber.

The study showed that the persistent scarcity of clean planting materials of potato has been addressed, since the repaired chambers handle at least 1,000 plantlets. On the

other hand, one of the regional projects significantly contributed to water-use efficiency in the targeted drylands of Tanzania. For instance, ten water-harvesting ponds were constructed at farm level, with resultant benefits such as availability of water at the farm level to support dryland farming as well as the recharge of sub-surface and underground aquifers.

#### 5.3.6.3. Level of Stakeholder Satisfaction with Capacity Building Processes

Regarding the methods and approaches used in the trainings, nearly 90% of the stakeholders rated the approaches as either very good or good. This rating was heavily dependent on the type of stakeholders, with the regional project beneficiaries recording more satisfaction with the approaches than the non-regional project beneficiaries. There was a highly significant variation across the countries ($P \leq 0.05$) in 2010. This was also confirmed by the fact that the need for the trainings was not highly dependent on sex ($P \leq 0.05$). Every respondent demanded to be trained and wanted to enhance the vital skills in their daily agricultural practices.

However, this trend shifted slightly, in that there was no significant difference ($P \leq 0.05$) between the stakeholders and across the countries in 2014. This variation was due to the fact that some of the beneficiaries needed no further trainings since they had had similar trainings provided to them, and the same themes addressed. Those that needed further trainings in 2014 mainly comprised of male respondents ($P \leq 0.05$), while the female counterparts were quite indifferent ($P \leq 0.05$), perhaps given that they formed the first cohort of the beneficiaries of the capacity building programme.

Given that these training programs were demand-driven, over 83% of the benefiting respondents rated these trainings as either very useful (17.5%) or useful (65.6%) for their day-to-day operations on the farms, besides also being rated as either very timely (32.2%) or just on time (61.8%). Highly significant differences were observed between the respondents with respect to the usefulness of the trainings and mentoring programs ($P \leq 0.05$). These differences were also dependent on the sex of the respondents as well as their country of operation ($P \leq 0.05$).

### 5.3.7. Integrated Natural Resources Management

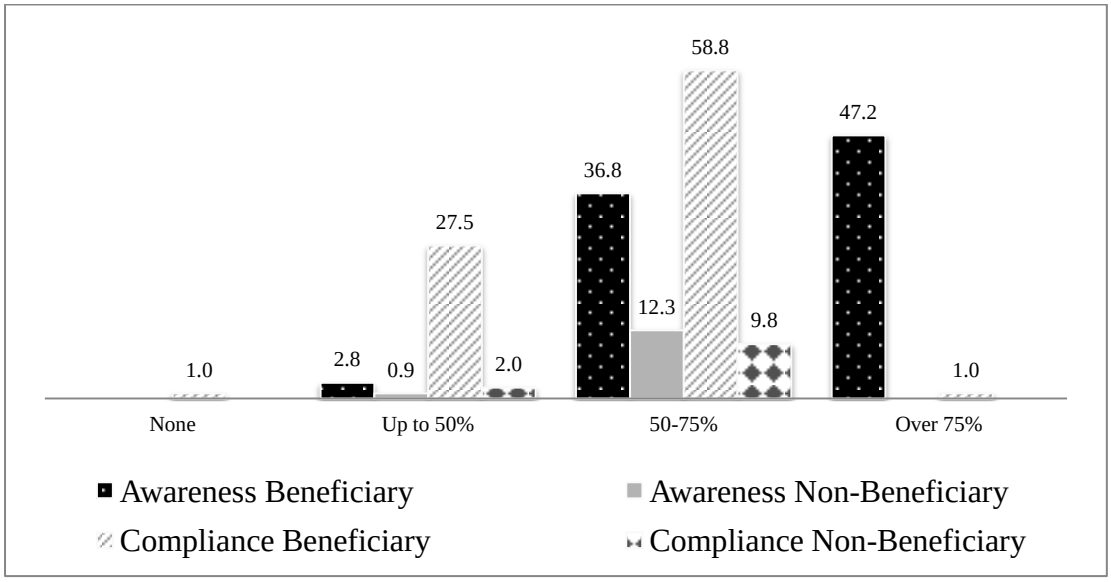
As part of ensuring integrated natural resources management, the research revealed that 9.5% of the respondents were not only aware of the various NRM by-laws under implementation, but were also part of the movement. A significant difference ($P \leq 0.05$) between the respondents engaged in the initiative was observed. For instance, there were significant differences among the beneficiaries ($P \leq 0.05$) and non-beneficiaries ($P \leq 0.05$) within the various countries. These differences were also sex dependent ($P \leq 0.05$for male; $P \leq 0.05$for female).

Besides the NRM by-laws, there were also other regulations and laws that governed land management in the various communities. Among the main by-laws in operations (and percentage of respondents engaged in ensuring operationalization) included: integrated soil fertility management (3.2%); natural resources management (2.7%); integrated water management (2.0%); and climate smart agriculture (1.0%).

Majority of these bylaws were enacted in 2009 – 2010. Before enactment at the community level, several awareness campaigns were conducted to solicit community buy-in and ownership. Eventually following several consultations with administrative organs at the local, district and national level, the bylaws were enacted. The enforcers of the enactment process involved elected leaders at the village councils, sub-county as well as at the district level (comprising 91.6% of enactors). The awareness campaigns were instrumental in ensuring sustainable enforcement of these regulations. This is in conformance with what Nkonya et al. (2001) observed, i.e., it is usually difficult to effectively enforce and educe compliance with bylaws that are not clearly understood or ratified by farmers.

Results show that 96% of the respondents engaged in the environmental management were aware of these bylaws. According to them, the level of compliance with these bylaws was satisfactory, with 29% of the targeted groups recording up to 50% compliance, while nearly 69% of the targeted respondents noted the level of compliance to be between 50 – 75% (Figure18).

**Figure 18:** Percent of Respondents Aware of, and Satisfied with level of Compliance with NRM bylaws




Source: Survey Data, 2014

An overall statistical significant difference (P≤0.05) was observed with respect to the enactment of the bylaws among the beneficiaries and non-beneficiaries. Closer analysis indicated a non-significant difference among the non-beneficiaries (P≤0.05). This was attributed to the fact that their overall engagement was low, and thus they took the laggard's position of waiting to see the benefits from these interventions, before eventually getting involved or committed.

On the other hand, with regards to levels of compliance with these bylaws among the community members, an overall significant difference (P≤0.05) was observed, notwithstanding the non-significance observed among the beneficiaries (P≤0.05). This observed non-significant difference among the beneficiaries may be attributed to the fact that since they are all actively engaged in the project, there should be an overall and unanimous compliance with rules, regulations and standards stipulated in the bylaws. This is in contrast to the non-beneficiaries that might still have queries and doubts regarding certain clauses, thus warranting their significant difference (P≤0.05) regarding levels of compliance.

### 5.3.8. Challenges Faced

The development of selected TIMPs by the regional organizations was mainly triggered by a series of challenges, including low productivity; high post-harvest handling losses; limited value addition through processing and utilization; limited markets; poor policy environment, including unfavorable policy framework and credit; degraded environment; and limited knowledge and information exchange. However, in as much as most of these challenges have been addressed, some respondents were still susceptible to them, especially the respondents still not fully engaged in on-farm activities. Among the key challenges still threatening the respondents are as further elucidated.

#### 5.3.8.1. Low productivity

Among the main causes of low productivity included prevalence of pests and diseases. The commonest pests and diseases reported to affect the smallholder farmers included sweet potato virus disease, weevils, nematodes, black sigatoka, BXW, CBSD. Most of the heightened incidences of disease and pest prevalence were attributed to the fact that there were inadequate disease- and pest-resistant varieties that were available to the stakeholders, especially to those who were not part of the wider regional projects. There was a close linkage between inadequate access to suitable improved varieties and low productivity, and this was mainly triggered by lack of financial resources by the smallholders to access quality seed or hire relevant inputs.

As a result of this, most of the farmers ended up accessing poorly adaptable varieties. Poor agronomic and management practices among the smallholder farmers were also observed to lead to low productivity. These were also very closely knit with poor management practices such as low plant density, poor weed management, and inappropriate application of fertilizers and insecticides. Cases of insufficient agricultural lands, mainly due to poor and inconsistent policies as well as increasing populations were identified to choke available lands. The study also linked low productivity to inadequate water resources, mainly due to insufficient water harvesting technologies, long distances to water points, poor or no adaptable irrigation technologies as well as inappropriate water uses.

#### 5.3.8.2. Low value addition

Among the commonest triggers of low value addition included: limited range of market products as a result of lack of relevant information; limited access to knowledge on available markets and market dynamics; poor access to markets, especially as a result of long distances, inaccessible roads, and exploitative middle men along the value chain; limited post-harvest technologies; and poor, and in some cases insufficient policies.

#### 5.3.8.3. Limited post-harvest processing

The most common challenges regarding post-harvest processing included: poor storage facilities and conditions; damages and losses caused by rodents, birds, insects, poor transportation and even theft by human; poor post-harvest processing information, mainly due to insufficient market research and prioritization; poor threshing technologies; lack of infrastructure for post-harvest sector; lack of poor institutional support; as well as poor post-harvest processing information.

#### 5.3.8.4. Limited access to markets

The most commonly cited challenges faced in accessing markets included: limited information on local, regional and international markets, including lack of databases on commodity markets; price fluctuations mainly through cartels and middlemen that determine prices; long distances to markets, leading to high transport costs, especially for the bulky and highly perishable commodities; and imbalances between demand and supply of essential commodities, mainly emanating from unstable supplies, insufficient quantities to supply the markets, as well as limited high quality and marketable products. On the other hand, due to low-income base among the smallholder farmers, access to markets was therefore hindered.

#### 5.3.8.5. Poor policy environment

The respondents characterized poor policy environments using the following attributes: weak strategic planning on commodity prioritization and support; lack of usable policy information, such as export and import regulations, types of levies, bans, restrictions, and exemptions; limited legislations regarding standards of selected commodities; lengthy policy approval processes, especially for the already analyzed and debated laws, policy reforms, regulations, and procedures; lack of germplasm and

genetic conservation policies; lack of investment in rural infrastructure; lack of a regional policy framework for sharing clean materials and improved varieties across countries; as well as lack of clear property rights. In some cases, it was also observed that mechanisms to guarantee high quality seed dissemination among the smallholder farmers were ineffective.

#### 5.3.8.6. Degraded environment

Among the most commonly cited factors leading to degraded environment included: poor policy information regarding acceptable standards and procedures in environmental management; improper use and applications of pesticides by smallholders; declining soil fertility due to over-planting, low use of inputs, and poor agronomic practices; lack of user-friendly soil management practices; lack of information on soil management; as well as inadequate water resources mainly as a result of lack of water harvesting technologies, long distances to water sources, poor or no irrigation technologies, and poor water use.

#### 5.3.8.7. Access to knowledge and information

Factors that led to limited knowledge and information exchange include, but are not limited to: poor information sharing and analysis; lack, and at times inadequate data availability to enhance rapid informed decision-making; poor information retrieval; and lack of capacity of majority of stakeholders, especially the smallholder farmers to access and utilize knowledge and information.

#### 5.3.8.8. Limited supportive infrastructure

Within the EAC block, limited supportive infrastructure was identified to be among the most critical constraints to the development of agro-industries, both from the supply and demand sides. Challenges emanating from both the perspective of supply of raw materials, as well as marketing and trade of finished products were observed. It was also observed that most major agro-industries were located along the major transportation corridors, which also coincided with the main transmission lines for grid electrical power (Kilimo, 2011). However, there is very limited access and other feeder roads connecting the smallholder farms to these agro-industries, contributing to the observed little attraction of private investors within these areas.

## 5.4. Conclusion

It can be concluded that the regional projects were effective in delivering assorted benefits to the respondents. The benefits accrued to the beneficiaries were also observed to outweigh the costs invested in the regional projects. In summary, the benefits ranged from financial increases, enhanced policy harmonization, value addition, capacity building, to awareness and adoption of TIMPs. In general, the beneficiaries of the regional projects recorded increased net revenues of up to 26.5% (up from US$ 5.24 million in 2010 to 6.63 million in 2014). On the other hand, results also indicate that farm-active beneficiaries of regional projects generated an average of US$ 259 above their non-beneficiary partners engaged off-farm. Regarding expenditures, farmers engaged in the regionally coordinated projects recorded an increase in the farm expenditure by up to 33.7%, as compared to the non-beneficiaries whose expenditure increased by 45.3%.

As a means of coping with shocks emanating from reduced household incomes, and eventual food shortages, majority of the beneficiaries of the regional projects procured other assets such as livestock, while others (12.2%) engaged in various businesses such as selling of second-hand clothes, operating small kiosks, employed in transport services, or received salaries (8.4%).

Results also showed that the membership in any organization was significantly influenced by whether the respondent was a beneficiary of the regional projects or not. This was supported by the logit model showed that the beneficiaries of the regional projects were 7.5 times more likely to be members of the organizations than non-beneficiaries (controlling for all other factors in the model). Similarly, 82% of the beneficiary respondents expressed satisfaction with the benefits they had gained by being members of regional project associations.

The main challenges faced in implementing the regional projects included: low crop and livestock productivity; high post-harvest handling losses; limited value addition through processing and utilization; limited markets; poor policy environment, including unfavorable policy framework and credit; degraded environment; and limited knowledge and information exchange among the respondents and within the community at large.

The following chapter further explores the impacts of regional projects as noted by the respondents. It further looks at the factors that influence the rate of uptake of TIMPs and best practices generated from these regional projects by smallholder farmers.

# CHAPTER SIX
# IMPACTS OF REGIONAL PROJECTS AND FACTORS INFLUENCING THEIR UPTAKE BY SMALLHOLDER FARMERS IN EAST AFRICA

## 6.1. Summary

This chapter elaborates the impacts of regional projects and the factors that influence uptake of TIMPs and best practices generated from regional projects by smallholder farmers. Specifically, it looks at the key findings of the research, and describes the factors affecting food availability; spillover effects from the regional projects; dynamics of stakeholders' access to markets, including access to market information and impacts created through use of the assorted information products. This is followed by an assessment of the stakeholders' participation in the savings-credit groups, and a review of the farm characteristics, especially variations in land holdings, tenurial systems and land sizes. Disease management in crops and livestock is further elucidated, showing also how the farmers have dealt with them. This is followed by assessment of farm-level impacts, especially crop and livestock production factors.

## 6.2. Introduction

Research systems are known to generate two types of benefits: direct and spillover (or multiplier) effect. According to Bantilan and Davis (1991), spillover effect refers to a situation when a new technology has applicability beyond the location or commodity for which it was generated or developed. The effectiveness of the spillover effects of the regionally implemented projects and programs vis-à-vis the national projects were determined. The results were estimated from the following equation:

$$\boldsymbol{S_{ij}} = \frac{\boldsymbol{Y_{ij}}}{\boldsymbol{Y_{jj}}} \quad (22)$$

Where,

$S_{ij}$= the potential of the spillovers of the TIMPs

$Y_{ij}$= the yield of the variety *j* in environment *i*

$Y_{jj}$= the yield of variety *j* within the environment *j* for which this variety was initially developed, tested and made available to the farmers,

Comparison of beneficiaries and non-beneficiaries within the study areas showed a

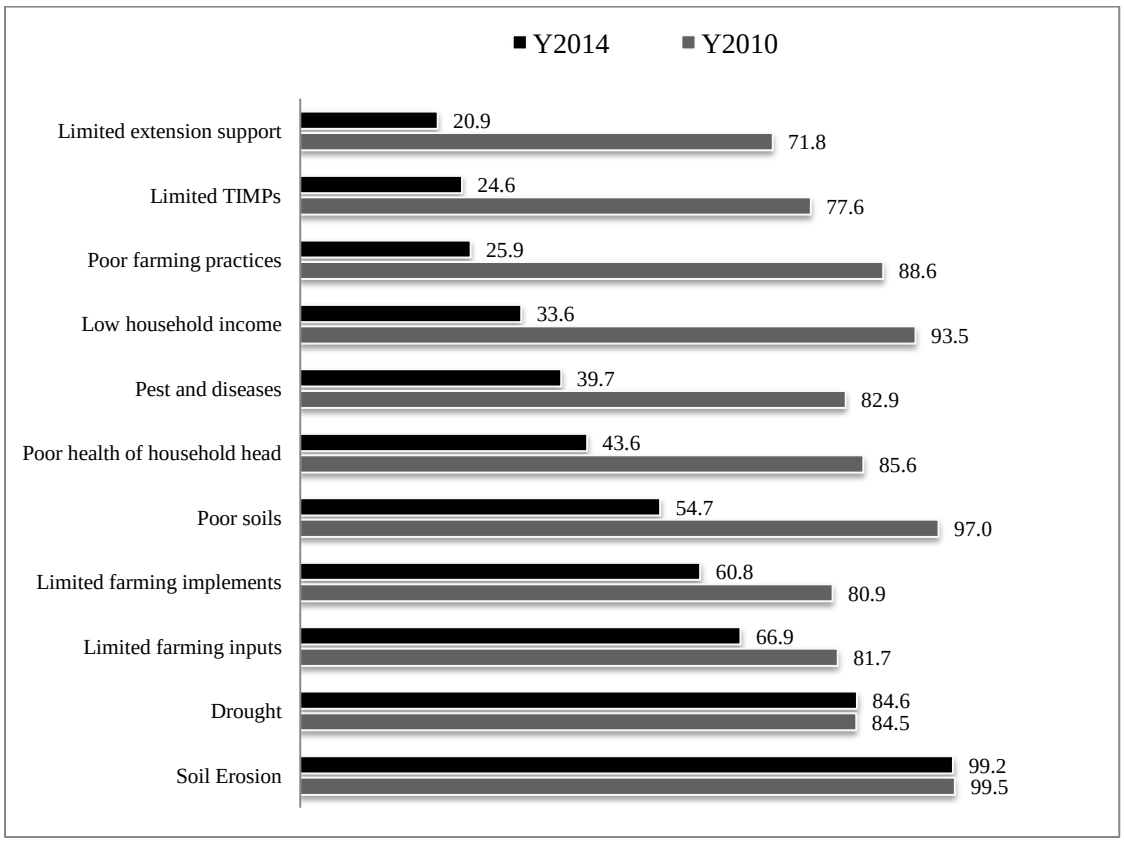
significant spillover of regional projects to non-beneficiaries. Between 2010 and 2014, the incomes of non-beneficiaries residing close to the targeted groups increased by 20% for male and 12.7% for female, mainly because of spillovers from the assorted regional projects implemented in their locations. In addition, they also benefited from advisory services, access to markets and trade fairs, observations from neighboring farms, as well as open discussion forums facilitated by local administrators (e.g., chiefs and agricultural and veterinary officers).

## 6.3. Results and Discussion

### 6.3.1. Factors Affecting Food Availability

Several factors were identified to directly affect the respondents' food availability. These factors were compared between the study's time periods to assess the level of their increased or reduced effects on food availability. The most critical factors with the highest contribution to food scarcity, and which have persisted since 2010 include soil erosion, drought, and limited access to farming inputs (Figure 19).

**Figure 19**: Factors affecting food availability




Source: Survey Data, 2014

On the other hand, low household income, poor farming practices, limited accessibility to TIMPs, as well as limited support from extension staff used to be among the topmost factors causing food unavailability in 2010. The trend has changed, and these factors have now become the least contributors to food insecurity. The major reason for this is attributed to the fact that the initiation of regional projects has introduced mechanisms of handling these factors. There are several avenues of accessing extension services, while several NARS have developed a myriad of TIMPs that can be adopted in existing agricultural development domains. The poor faming systems have been addressed through targeted capacity strengthening initiatives, such as short- and long-term trainings, provision of commodity-specific equipment and infrastructure, as well as creation of enabling environments for agricultural research, through policy harmonization, analysis and implementation.

### 6.3.2. Spillover Effects from Regional Projects

Through adoption of livestock-related TIMPs, and following an enabling policy environment that allows cross-border exchange of genetic materials, the National Dairy Programme of Uganda received 300 straws of high quality Ayrshire breed semen from the Dairy Regional Centre of Excellence based in Kenya. This breed is preferred because of its potential to survive within the agro-ecologies that are common to Kenya, Uganda and Tanzania. As part of ensuring spillover to the targeted beneficiaries, the Uganda's National Animal Genetic Resources Centre (NAGRIC) sent some straws to elite farmers as part of the first efforts to increase the number of farmers on the breed improvement initiatives. This initiative holds the potential of enabling the beneficiaries produce both bulls and heifers with the Ayrshire genes.

As part of enhancing livestock productivity, beneficiaries in Uganda's Masaka and Kumi Districts engaged in the regional project that focused on intercropping forage Napier grass with the forage legume *Centrosema pubescens*. Results showed that this practice led to 50% increase ($P \leq 0.05$) in fodder availability compared to pure stand of Napier grass. This increased productivity ensured availability of fodder for the livestock by about 30%, especially during the dry season. The TIMPs was also scaled out to Rwanda with increasing returns.

Through engagement in the regional projects, some 83 women have signed a contract with selected seed companies, especially the Kenya Seed Company to provide seeds of African Indigenous Vegetables (AIVs). Through this venture, these women beneficiaries generated over US$ 17,000 in two seasons (compared to an average of US$ 50 by non-beneficiaries). For instance, one female beneficiary received US$ 3,383 from her 0.4 ha piece of land within two seasons after planting jute mallow and Crotalaria (compared to US 85 before participating in this regional project). As part of enhancing spillover effects, Tanzanian farmers also embarked on the same model of contract farming based on the lessons they learned from Kenya.

In Rwanda, a total of 318 beneficiaries of the regional project focused on enhancing livestock management using improved productivity-enhancing TIMPs for smallholder dairy farmers received Artificial Insemination (AI) services. As a result, following the insemination of over 1,201 cows, a total of 1,123 improved calves were born. This led to an additional 720 small-scale farmers adopting the AI services.

On the other hand, TIMPs such as quality protein maize (QPM), Striga-resistant sorghum varieties, climbing and bush bean varieties, cassava and banana varieties were considered. The yields from these varieties were compared based on the country of introduction for testing, adaption and adoption and the country of origin (i.e., where the TIMPs were developed or acquired from). For instance, the yields from QPM were compared between Tanzania and Kenya, and yields from Striga-resistant sorghum varieties was compared between Uganda and Burundi. Similarly, the yields from both climbing and bush beans were compared between Tanzania and Rwanda.

The results show that cassava, millet, Striga-resistant sorghum, climbing and bush beans, as well as banana varieties (especially the low-cost tissue culture) had significantly benefited the farmers in the locations where they were introduced. It was evident that the productivity had increased by over 100% above the previous varieties that were used before introduction of these new TIMPs (Table 26). These results confirm the observations of other researchers. For example, Byerlee (1995) pointed out that the extent of spillover (i.e. the size of $S_{ij}$) depends on various factors: agro-ecological similarities between the originating and the receiving region; local food

tastes and preferences; factor prices, and institutional factors, such as land tenure and intellectual property rights.

**Table 26:** Estimated Spillover Effects

| Variety | From | Mean Yield | Mean Land Size | Estimated Productivity Yjj (T/Ha) | To | Mean Yield | Mean Land Size | Estimated Productivity Yij (T/Ha) | Sij |
|---|---|---|---|---|---|---|---|---|---|
| QPM | Tanz | 1,322 | 1.09 | 1.21 | Ken | 728 | 1.13 | 0.64 | 0.53 |
| Sorghum | Uga | 460 | 1.44 | 0.32 | Bur | 318 | 0.55 | 0.58 | 1.81 |
| Beans | Rwa | 586 | 0.62 | 0.95 | Tanz | 892 | 0.92 | 0.97 | 1.03 |
| Millet | Ken | 471 | 0.66 | 0.71 | Rwa | 540 | 0.38 | 1.42 | 1.99 |
| Cassava | Uga | 401 | 0.85 | 0.47 | Bur | 454 | 0.48 | 0.95 | 2.00 |
| Banana | Uga | 842 | 1.08 | 0.78 | Rwa | 757 | 0.69 | 1.10 | 1.41 |
| S. Potato | Ken | 642 | 0.62 | 1.04 | Tanz | 252 | 0.58 | 0.43 | 0.42 |

Source: Survey Data, 2014

On the other hand, both QPM (0.53) and orange-fleshed sweet potato (OFSP, 0.42) varieties had not been quickly uptaken by the smallholders in the targeted countries. However, the uptake was at least 40% above all other commodities or TIMPs, still indicating the superiority of regionally coordinated projects in delivering across-location and across-environmental spillover effects. The main reason for the slow uptake of OFSP was mainly attributed to agronomic, climatic, and ecological differences, in addition to susceptibility of the commodities to viral infections. The governments within the East African Community, and in collaboration with the COMESA, have enforced stringent measures to check the transfer of these germplasm. As a result of these regulations, limited flow of these germplasm have been experienced, both within and outside the country. Similarly, the exchange of QPM between Kenya and other neighboring countries has been minimal, since the Seed Regulatory Authorities must certify the seeds before being allowed to cross the borders.

Besides the already mentioned benefits associated with effective spillovers, there are challenges that only such collaborations between countries can handle. As pointed out by Alston et al. (1995), normal research experiences up to ten years lapse between the initiation of a research project and the dissemination of the research results. However,

this is where regional projects come in. By borrowing research results, such as plant varieties, germplasm, as well as livestock semen from other countries, significant amount of research time has been saved, leading to increased returns to research investments.

### 6.3.3. Access to Market Information

Agricultural information forms a main fulcrum upon which interventions leading to improving small-scale agricultural production rotate. It links increased production (from adoption of high-yielding crop varieties and management practices) to remunerative markets. Once the smallholder farmers are able to link to the markets and increase their household incomes, it increases the probability of these farmers attaining food security, improved rural likelihoods, as well as increased national economies (in form of Gross Domestic Product (GDP), and Agricultural Gross Domestic Product (AgGDP). Timely and advance accurate market information systems are vital for, not only the smallholder farmers, but also the private sector investors. Unfortunately, limited and/or inaccurate information is likely to influence farming systems and practices.

Studies have indicated that farmers can access vital information from internal and external sources (including family members, neighboring farmers, traders, processors, and transporters), verbal or written sources (journals, workshop proceedings, newspapers, and brochures and flyers), as well as through direct observation (Errington, 1986; Solano et al. (2001b; 2003). The latter scenario is very possible, especially where farmers live closer to the agricultural experimental stations, where they observe on-farm trials as well as confined field trials.

The study elucidated five main types of information that the farmers needed in order to access the markets. These included: (i) information on commodity prices in different markets; (ii) full list of commodities demanded by consumers in the various markets; (iii) periodic alerts on when the commodities are scarce, thereby enabling the farmers to meet the consumer demands; (iv) information on the prevailing commodity supply in different markets; and (v) information regarding the availability of services, such as transport, infrastructure, and knowledge products. It was also revealed that access to market information significantly increased ($P \leq 0.05$) since the

commencement of the regional projects (see Table 27), thus further illustrating the advantages created by engagement in the regionally coordinated projects.

**Table 27:** Sources of Information for Respondents

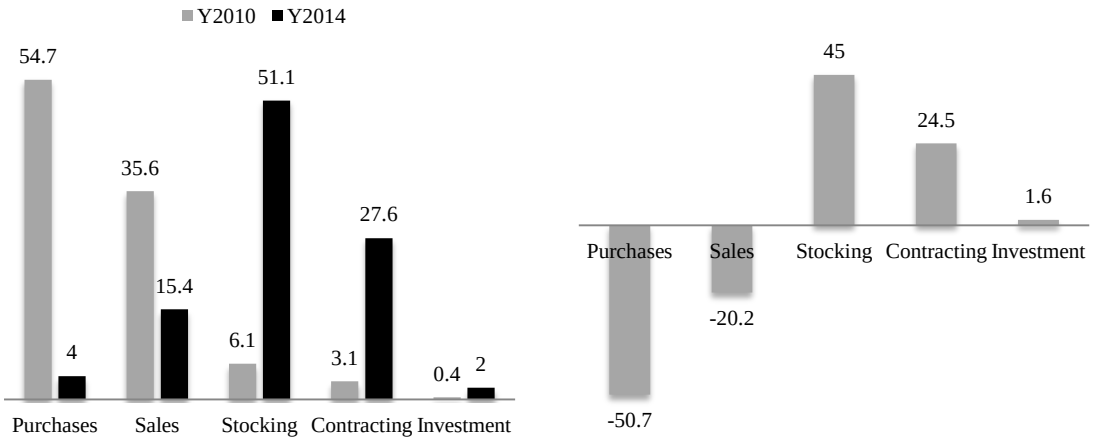
| Source of Information | Sex | 2010 | | | 2014 | | |
|---|---|---|---|---|---|---|---|
| | | Ben | Non-Ben | Total | Ben | Non-Ben | Total |
| Other farmers and RPs | Male | 110 | 36 | 146 | 147 | 35 | 182 |
| | Female | 87 | 36 | 123 | 94 | 37 | 131 |
| Other farmers | Male | 79 | 43 | 122 | 18 | 16 | 34 |
| | Female | 69 | 44 | 113 | 12 | 19 | 31 |
| Other farmers and Extension staff | Male | 52 | 22 | 74 | 7 | 21 | 28 |
| | Female | 17 | 21 | 38 | 6 | 20 | 26 |
| Other farmers and NGOs | Male | 15 | 32 | 47 | 14 | 33 | 47 |
| | Female | 17 | 34 | 51 | 15 | 31 | 46 |
| RP partners | Male | 3 | 0 | 3 | 48 | 18 | 66 |
| | Female | 1 | 0 | 1 | 57 | 22 | 79 |
| RPs and Seed Co | Male | 0 | 0 | 0 | 25 | 7 | 32 |
| | Female | 0 | 2 | 2 | 15 | 8 | 23 |
| Others | Male | 8 | 4 | 12 | 10 | 7 | 17 |
| | Female | 14 | 7 | 21 | 9 | 5 | 14 |
| TOTAL | | 472 | 281 | 753 | 477 | 279 | 756 |

Ben = Beneficiaries; Non-Ben = Non-beneficiaries

Source: Survey Data, 2014

It is observed that different stakeholders and respondents demanded for different types of information. These assorted types of information (mentioned above) were then used in dictating the type of actions to be undertaken. Regarding the use of price and market information in making decisions on purchases, a significant difference ($P \leq 0.05$) was observed between the respondents, their sex, as well as their country of nativity in both 2010 and 2014. However, there was a very significant reduction (50.7 percentage points) in the application of this information source in 2014. This was brought about by the fact that the respondents who needed this information in 2010, had acquired that information, made adjustments, and were now applying and maintaining the purchasing decisions they made then. Figure 20 shows the percentage of stakeholders' utilization of prize and market information, as well as the extent (in percentage terms) in the application of acquired information in decision making.

**Figure 20:** Use of Price and Market Information




Source: Survey Data, 2014

Similarly, there was a significant drop (20.2 percentage points) in the use of information on sales of commodities in the various markets. This information was very highly valued and used in identifying and prioritizing on the commodities, including fixing their price ranges. This decision, once made in 2010 has been used in guiding price tagging in 2014.

On the other hand, there was a shift in the use of the price and market information, especially in making decisions regarding stocking of essential commodities, as well as contracting other activities, or engaging in other investment options. For instance, decisions on stocking of commodities on high demand in the markets increased by 45 percentage points, and this increase was significantly different ($P \leq 0.05$) among the respondents. The ever-increasing cross-border trade accounted for the main cause for this increase on essential commodities (such as maize and beans). Some of the farmers stocked their produce following price speculations, and especially in periods leading to droughts, famine or emergence of diseases and pests.

The above action is also dictated by the fact that the region (EAC) currently constitute a common market for more than 142 million people who must be fed daily. Unfortunately, persisting climatic variations in different countries have also led to food deficits in some areas. As often as the beneficiaries of the regional projects keep receiving news and information on price fluctuations from the media, and other

project partners in other countries, they respond by stocking, not only the surpluses produced, but they also minimize seasonal quotas for domestic use. This stocking by the beneficiaries is also undertaken to cushion them against any emergency of seasons of deficit.

In addition, given that the profitability of a commodity constitutes a big factor in encouraging its production and area expansion, the beneficiary farmers were noticed to base their production decisions on the expectation of future relative returns available from various activities that comprised their production choices. As a result, these beneficiaries have endeavored to maximize the return in a given area, even though stocking and controlled speculations.

Significant differences ($P \leq 0.05$) were observed between the respondents and their decisions regarding contracting. According to Bindhumadhavan (2005), contract farming is defined as farming of any agricultural produce on the basis of a contract between farmers and a big wholesale buyer or seller. Basically the contract is entered before the farming activity starts because the buyer can then stipulate the condition of the cultivation, use of the grade of the seed, pesticides, insecticides, caring of the crop, grading processing and packaging. Contract farming is beneficial in that it ensures a proper price, makes up the market, increases higher production and reduces distribution cost. Further it also ensures supply of quality agricultural produce to the industry at the right time, at lesser cost and channels direct private investment in agriculture.

Between 2010 and 2014, nearly 25 percentage point increase was recorded, a clear indication of a quick shift from purchases and sales, to contracting. In this case, farmers, especially the beneficiaries of the regionally coordinated projects entered into agreements with other stakeholders, including other farmers, labourers, private investors, traders, transporters, and other NGOs. These agreements were made with very clear objectives, including: leasing more land for some years for expanded production of selected commodities; marketing of priority commodities in the markets (especially locally); transportation of produce from farmlands to the markets; as well as contracts with seed companies and middlemen, among other.

A significant correlation between access to market information and type of household was observed, with regional project beneficiaries accessing more information types than their counterparts not engaged in these regional projects. There were also some variations within the countries. For example, within the study areas, majority of the farmers accessed information from the media, as well as through recorded and numerical data. In some instances, specific comments from people and the decision-maker's own past experience acted as trusted information sources. These results are in conformance with the observations of Sutherland et al (1996), Blum (1989), as well as Ford and Babb (1989), who observed and appreciated the role played by technical advisors and family members in furnishing the farmers with vital and timely information.

According to the beneficiaries, the most commonly cited source of information for each of the information types listed above included an assemblage of other farmers and regional project implementation teams (26.2% and 31.9% in 2010 and 2014 respectively) and regional project partners (0.5% and 13.9% in 2010 and 2014 respectively). Other valuable information sources included local markets, agro-dealers, agricultural traders, extension officers, as well as seed companies. There was a significant relationship ($P \leq 0.05$) between type of household and sources of information on access to markets in each of the countries under survey.

From the study findings, it was evident that the various information types significantly determined the choices that the farmers eventually made. For instance, 4% of the farmers used the price and market information to determine their purchasing decisions; 15.4% use it to dictate their sales decisions; and 51.1% applied the information to influence their stocking decisions. Similarly, 27.6% of the farmers benefited from these information when making contractual decisions on what form of farming practice to engage in, and with which private sector to trade with. Nearly 2% of the farmers used the gathered and availed information to influence the kind of investments to engage in (whether farming or non-farm investments).

### 6.3.4. Savings-Credit Groups

Savings and credit facilities have been observed to enhance rural development agenda. In this study, credit institutions included (a) the formal arrangements, such as with commercial banks, microfinance banks, the cooperative banks, as well as state government-owned credit institutions. This requires some deposits before qualifying for the loans, and it involves adherence to strict rules. In most cases, collaterals (e.g., land titles or vehicle logbooks) are needed; (b) semiformal setups, such as non-governmental organizations-microfinance institutions (NGO-MFIs) and cooperative societies. These also require potential creditors to have some deposits as well as to adhere (though flexibly) to some rules.

These arrangements may only require peer collateral, thus are better off for the farmers than the formal systems; and (c) informal institutions, including money lenders, rotating savings and credit associations, as well as Sacco (e.g., women-groups). These are non-deposit-based, and the rules are quite informal, and so are the collaterals. This explains why smallholder farmers prefer these systems. The major challenge facing these smallholders is the number of such facilities from where they can access these services, for they are generally very few, and yet are required to serve bigger groups.

Results indicate that the respondents were engaged in, and promoted smallholder farmers' development programmes, as well as village development programmes (VDP). These groups were generating group funds by regularly collecting savings from members. These funds were then used to provide credit to members at low interest rates. Group members were provided with various training related to production and skill development by the programmes. In many instances, tasks were assigned to village level specialists, comprising agricultural and extension officers, graduates from local and national institutions, as well as engagement with non-governmental and other organizations.

Cross-tabulations indicate overall significant relationships between access to credit facilities by the respondents, and this difference was also observed when the countries under study were compared. The study reveals that 34.4% of the respondents accessed credit facilities, mainly to help them boost agricultural production on their farms

(29.1%), as well as support in the educational, medical and household-related expenses (5.3%). This low percentage of successful respondents clearly shows that there are challenges faced by the farmers in accessing the loans.

Among the key issues cited include: (i) the lack of bank accounts, collateral, and information regarding the procedure for accessing credits from banks; (ii) previous loan defaults, thereby barring the same persons from accessing the services; (iii) prevalent high interest rates, including the short-term nature of loans with fixed repayment periods that do not suit the annual cropping cycles; and (iv) fear by the banks to provide loans to farmers, and especially smallholders, since there seems to be very limited insurance against crop failures and defaults from the creditors. These confirm similar issues raised by researchers such as Okojie et al. (2010), Adejobi and Atobatele (2008), Agnet (2004), Philip et al. (2009), and Adegbite (2009).

Within the countries, significant relationship between access to credit facilities and the type of respondent was observed ($P \leq 0.05$). Further assessment showed that there was no significant relationship between non-beneficiaries within the countries ($P \leq 0.05$). This indicates strong coordination within the countries where regional projects were implemented (Table 28). This coordination, mainly facilitated by the principal investigators (PIs) of the projects linked the beneficiaries together (through capacity building, exchange visits, as well as proposal development). These joint activities strengthened the beneficiaries, thereby enabling them to, not only coordinate amongst themselves, but also link up with other project members within other implementing countries.

**Table 28:** Correlation of Respondents' Access to Credit Facility in the Countries

| Respondents | Access to Credit | Sex | Country Kenya | Rwanda | Tanzania | Uganda | Burundi | Total |
|---|---|---|---|---|---|---|---|---|
| Beneficiary | Yes | Male | 60 | 35 | 22 | 22 | 45 | 184 |
| | | Female | 16 | 43 | 16 | 25 | 23 | 123 |
| | | Total | 76 | 78 | 38 | 47 | 68 | 307 |
| | No | Male | 0 | 0 | 1 | 6 | 1 | 8 |
| | | Female | 0 | 1 | 0 | 1 | 0 | 2 |
| | | Total | 0 | 1 | 1 | 7 | 1 | 10 |
| | Sub-Total | | 76 | 79 | 39 | 54 | 69 | 317 |
| Non-Beneficiary | Yes | Male | 5 | 10 | 4 | 14 | 5 | 38 |
| | | Female | 3 | 0 | 7 | 9 | 9 | 28 |
| | | Total | 8 | 10 | 11 | 23 | 14 | 66 |
| | No | Male | 0 | 9 | 0 | 2 | 0 | 11 |
| | | Female | 0 | 1 | 1 | 3 | 0 | 5 |
| | | Total | 0 | 10 | 1 | 5 | 0 | 16 |
| | Sub-Total | | 8 | 20 | 12 | 28 | 14 | 82 |
| | Yes | Male | 60 | 35 | 23 | 28 | 46 | 192 |
| | | Female | 16 | 44 | 16 | 26 | 23 | 125 |
| | | Total | 76 | 79 | 39 | 54 | 69 | 317 |
| | No | Male | 5 | 19 | 4 | 16 | 5 | 49 |
| | | Female | 3 | 1 | 8 | 12 | 9 | 33 |
| | | Total | 8 | 20 | 12 | 28 | 14 | 82 |
| | Grand Total | | 84 | 84 | 99 | 51 | 82 | 399 |

Source: Survey Data (2014)

Moreover, gender differences played a role in the degree to which the respondents accessed credit facilities. Within the countries, a significant difference between gender and access to the facilities ($P \leq 0.05$) was observed. Nonetheless, this difference was not significant among the females ($P \leq 0.05$), a factor attributed to decision-making responsibilities. In some countries, women made decisions on whether to access credit facilities or not, without necessarily having to consult the men.

Regarding the amount of money received as credit, significant differences were observed. The amount borrowed significantly differed with the respondent as well as the country of residence ($P \leq 0.05$). Nevertheless, differences among the non-beneficiaries were non-significant at the 5% level ($P \leq 0.05$). This variation may be attributed to the fact that the respondents accessed credit facilities for different purposes. The direct beneficiaries mostly aimed at boosting their agricultural production, sales and revenues through the adoption of production-enhancing TIMPs, while this may not be the drivers for non-beneficiaries. The amount borrowed ranged from US$ 75 to US$ 500 (Table 29).

**Table 29:** Distribution of Credit Amounts Received (US$)

| Credit Received | Respondent | Sex | Country | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Ken | Rwa | Tan | Uga | Bur | Total |
| Up to 100 | Beneficiary | Male | 9 | 1 | 0 | 4 | 6 | 20 |
| | | Female | 1 | 3 | 0 | 4 | 3 | 11 |
| | | Total | 10 | 4 | 0 | 8 | 9 | 31 |
| | Non-Beneficiary | Male | 0 | 0 | 1 | 2 | 0 | 3 |
| | | Female | 0 | 3 | 1 | 3 | 0 | 7 |
| | | Total | 0 | 3 | 2 | 5 | 0 | 10 |
| 101 – 150 | Beneficiary | Male | 22 | 8 | 5 | 10 | 29 | 74 |
| | | Female | 6 | 7 | 5 | 12 | 12 | 42 |
| | | Total | 28 | 15 | 10 | 22 | 41 | 116 |
| | Non-Beneficiary | Male | 0 | 4 | 3 | 4 | 0 | 11 |
| | | Female | 0 | 3 | 1 | 4 | 2 | 10 |
| | | Total | 0 | 7 | 4 | 8 | 2 | 21 |
| 151 – 200 | Beneficiary | Male | 24 | 13 | 3 | 6 | 8 | 54 |
| | | Female | 7 | 12 | 1 | 15 | 7 | 42 |
| | | Total | 31 | 25 | 4 | 11 | 15 | 86 |
| | Non-Beneficiary | Male | 0 | 2 | 0 | 4 | 0 | 6 |
| | | Female | 2 | 2 | 1 | 2 | 0 | 7 |
| | | Total | 2 | 4 | 1 | 6 | 0 | 13 |
| 201 – 250 | Beneficiary | Male | 3 | 6 | 6 | 2 | 1 | 18 |
| | | Female | 1 | 10 | 5 | 1 | 1 | 18 |
| | | Total | 4 | 16 | 11 | 3 | 2 | 36 |
| | Non-Beneficiary | Male | 3 | 1 | 0 | 3 | 3 | 10 |
| | | Female | 0 | 1 | 2 | 0 | 1 | 4 |
| | | Total | 3 | 2 | 2 | 3 | 4 | 14 |
| 251 - 300 | Beneficiary | Male | 1 | 3 | 5 | 0 | 0 | 9 |
| | | Female | 0 | 7 | 2 | 1 | 0 | 10 |
| | | Total | 1 | 10 | 7 | 1 | 0 | 19 |
| | Non-Beneficiary | Male | 1 | 1 | 0 | 0 | 1 | 3 |
| | | Female | 0 | 0 | 2 | 0 | 3 | 5 |
| | | Total | 1 | 1 | 2 | 0 | 4 | 8 |
| Over 300 | Beneficiary | Male | 0 | 4 | 3 | 0 | 0 | 7 |
| | | Female | 1 | 2 | 2 | 1 | 0 | 6 |
| | | Total | 1 | 6 | 5 | 1 | 0 | 13 |
| | Non-Beneficiary | Male | 1 | 0 | 0 | 1 | 1 | 3 |
| | | Female | 0 | 0 | 0 | 0 | 2 | 2 |
| | | Total | 1 | 0 | 0 | 1 | 3 | 5 |
| Total | Beneficiary | Male | 59 | 35 | 22 | 22 | 44 | 182 |
| | | Female | 16 | 41 | 15 | 24 | 23 | 119 |
| | | Total | 75 | 76 | 37 | 46 | 67 | 301 |
| | Non-Beneficiary | Male | 5 | 8 | 4 | 14 | 5 | 36 |
| | | Female | 2 | 9 | 7 | 9 | 8 | 35 |
| | | Total | 7 | 17 | 11 | 23 | 13 | 71 |
| Grand Total | | | 82 | 93 | 48 | 69 | 80 | 372 |

Source: Survey Data (2014)

The respondents obtained credit for initial investment at low interest rates (compared to prevailing market conditions). It was established that prior to the initiation of these

regional projects, the households used to access credit from moneylenders, some of whom charged up to 30% interest per quarter. Some respondents indicated that they had to pay at least 30% of whatever amount they borrowed within three months. This was rather challenging for them to break-even in their agri-enterprises, and some of them had to stop the business altogether.

Another key result noted by the respondents engaged in the credit scheme was that the regional projects provided a platform for institutional development. Unlike other cooperatives and credit schemes that never had provisions beyond the farmlands, the regional projects empowered the respondents to develop joint proposals, besides linking them up to better credit facilities and other donors. Through the empowerment programmes for COAFGA (a cooperative in Rwanda dealing in pineapple processing), the 124 members qualified for a loan of US$ 20,970 from Popular Bank of Rwanda through a government fund for rural initiatives. The loan was used in accessing better services and markets, as well as in improving productivity, thereby also linking the farmers to potential buyer for the dried pineapples, especially in Uganda (Tro Foppi (U) Ltd).

### 6.3.5. Farm Characteristics

#### 6.3.5.1. Crop-Livestock Production Environment

In this section, the study focuses on the nature of the available crop-livestock production environment, as well as the appropriate technology to be applied. Given that land is a major factor of production; its contribution to adoption of regional projects is also assessed in this section. As already been stated, the average number of livestock, especially cattle owned by the respondents increased by 32% in four years (from 2.94 in 2010 to 3.89 during the period of survey). Critical tests for correlation showed that a significant difference ($P \leq 0.05$) occurred between the participants in regional projects, and those who never participated. These differences were also observed within and outside each of the countries.

The results indicate that processing of livestock into meat products (especially cattle, goats and pigs) was found to be limited in the region and was often associated with local slaughter. The processing of beef and meat from the other small ruminants was conducted close to the areas of consumption in rural trading centres. It was observed

that slaughtering was mainly undertaken using the local abattoirs situated closer to the small towns and market centres, where the demand was higher. Notwithstanding the low production of meat, the current meat processing capacity of over 870,000 MT/year in the region is far from being achieved, while the average utilization capacity of dairy plants stands out at less than 30% (Kilimo Trust, 2011). These indicate the huge potential of demand for livestock and livestock products.

The global importation of both processed and branded secondary and tertiary products, especially of meats, beans, cassava, dairy milk, and sorghum has been on the increase. However, comparison of the importation trends between the global averages and the EAC block indicated that the region has clear comparative advantages (Kilimo, 2011). This comparative advantage provides opportunities for the region to expand its agricultural sector so as to meet the ever increasing, but un-met global demands for agro-processed products. This is further supported by the fact that the EAC block is among the top 20 producers in the world for most of the aforementioned commodities.

As in most of the studies, this research focuses on the most common indicator used in measuring farm characteristics – farm size. In this study, a common definition of 'farm size' as the area of cultivated land is preferred. In his definition, Feder et al. (1985) avoided distinguishing farm size as either the area of cultivated land, or as the area of landholding. Instead, he left it to the researcher to decide on the best descriptor. Based on this, and throughout this document, the researcher opts to define farm size as the area brought under cultivation of assorted TIMPs.

This definition encompasses even the landless (or squatters) that occupy plots of land and apply new technologies. This study confirms earlier researches by Akinola (1986), Hossain and Crouch (1992), Negatu and Parikh (1999), Pingali et al. (2001), and Neill and Lee (2001), who showed a positive and strong relationship between the average farm size of the farmers and the estimated probability of the technology adoption among farmers. For example, Neill and Lee (2001) observed that if farmers had access to more than three hectares of land, the adoption rate would increase by almost 0.5%.

As indicated by Adesina et al. (1988), landholding plays a very crucial role, not only to secure the farm household's continuous existence, but also (as suggested by Feder et al., 1985; Neill and Lee, 2001; Shively, 1997) to improve farmers' capacity to access inputs and the capital needed for applying new technologies. The study further proved that the adoption rate of the targeted TIMPs depend on the types of technology itself, the location where it fits best, along with the prevailing agro-ecological conditions as well as the types of adoption decisions.

#### 6.3.5.2. Land Holdings and Tenurial Systems

In this study, land holding is defined as a unit of agricultural production comprising all the land used completely or partly for agricultural purposes and all livestock kept and operated, without regard to legal ownership (Casley and Lury, 1987). However, communal land, or any land that has never been used for agriculture, or even land under natural forest are not taken as part of an agricultural holding.

The study showed that the respondents accessed land through distinct modes, namely: state-owned lands; private land; and communal land. At least 2.6% of the respondents occupied state-owned lands; 5.9% had private parcels; 32.3% were free holders; 48.3% inherited their ancestral lands through either bequeathal or customary hand-over; and the rest, 10.9% leased land. This latter group represented either farmers from outside the project site or those that needed more land to expand their production and practices.

Results also indicated that nearly 15% of the respondents had no land rights, thus could not easily hold land beyond the leased period (Table 30). This imposed challenges to the farmers in that they could only fast-maturing crop varieties, instead of the perennial crops. In some cases, it was observed that some of the respondents were asked to vacate the land and stop cultivation even before the expiry of the lease period. Unlike the non-beneficiaries of the regional projects, such cases were minimal among the beneficiaries. This may be attributed to the fact that members of the regional projects formed groups that enabled them to negotiate the leases and sign binding contracts with the leasers.

**Table 30:** Land Tenure Systems

| Type of Household | Land tenure system | Country | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | Kenya | Rwanda | Tanzania | Uganda | Burundi | |
| Beneficiary | State owned | 0 | 0 | 12 | 0 | 3 | 15 |
| | Private land | 22 | 4 | 0 | 10 | 9 | 45 |
| | Free hold | 41 | 122 | 22 | 26 | 22 | 233 |
| | Customary | 69 | 18 | 75 | 126 | 44 | 332 |
| | Leasehold | 13 | 27 | 7 | 15 | 2 | 64 |
| | Total | 145 | 171 | 116 | 177 | 80 | 689 |
| Non-Beneficiary | State owned | 3 | 1 | 7 | 3 | 1 | 15 |
| | Private Mailo land | 4 | 3 | 1 | 8 | 6 | 22 |
| | Free hold | 20 | 66 | 13 | 22 | 15 | 136 |
| | Customary | 39 | 22 | 58 | 83 | 18 | 220 |
| | Leasehold | 3 | 25 | 16 | 14 | 2 | 60 |
| | Total | 69 | 117 | 95 | 130 | 42 | 453 |
| Total | State owned | 3 | 1 | 19 | 3 | 4 | 30 |
| | Private Mailo land | 26 | 7 | 1 | 18 | 15 | 67 |
| | Free hold | 61 | 188 | 35 | 48 | 37 | 369 |
| | Customary | 108 | 40 | 133 | 209 | 62 | 552 |
| | Leasehold | 16 | 52 | 23 | 29 | 4 | 124 |
| | Total | 214 | 288 | 211 | 307 | 122 | 1142 |

$P \leq 0.05$

Source: Survey Data, 2014

The study further revealed a significant difference in the land size holdings of the respondents ($P \leq 0.05$). There was also observed differences between the targeted beneficiaries and the non-beneficiaries ($P \leq 0.05$). The average land size was compared to 2.64 ha (for beneficiaries) and 2.10 ha (for non-beneficiaries) ha in 2010, compared to 1.92 ha (for beneficiaries) and 1.45 ha (for non-beneficiaries) in 2014, representing a 27% and 31% decrease among the beneficiaries and non-beneficiaries, respectively. This is a very clear illustration of the dangers agriculture is likely to face in the coming decades. The available land is being converted to other land uses, including leases for other non-agriculture activities, sold or subdivided and handed over to children as inheritance.

Land holdings have played vital roles in determining agricultural practices and production. Previous researchers such as Feder et al. (1988); Besley (1995); Otsuka and Place (2001) have shown, this study confirmed the role played by various land holdings in technology adoption as well as crop and livestock production. A negatively significant correlation exists between land tenure system and land tenure rights ($P \leq 0.05$), while the relationship between land size and tenurial system was negatively insignificant ($P \leq 0.05$). This is attributed to the fact that the presence of insecurity of tenure by the respondents is a major hindrance to investment in land improvement, for it is associated with fewer incentives for investments (Feder et al., 1988).

#### 6.3.5.3. Farm Size

The mean farm size was 1.92 and 1.45 ha for beneficiaries and non-beneficiaries, respectively (Table 31).It is observable that there was an overall drop in the average farm sizes for both beneficiaries (27.3%) and non-beneficiaries (31%) between 2010 and 2014. Several factors were attributed to this reduction, including: (i) increasing rural population, given the increasing birth rates; (ii) rural-urban migration of the energetic persons in search of alternative incomes, thereby leaving the vulnerable to farm; (iii) illnesses and disability. Over 13% of the respondents had an infirm person in the household, thus reducing their time on the farmlands; and (iv) limited access to credit facilities, especially for the older folks that are left in the villages to farm, among others.

**Table 31:** Distribution of Respondents' Land Size (Ha)

| Farm Size | 2010 | | Total | 2014 | | Total |
|---|---|---|---|---|---|---|
| | Beneficiaries | Non-Ben | | Beneficiaries | Non-Ben | |
| >0.25 | 31 | 50 | 81 | 27 | 49 | 76 |
| 0.26-0.5 | 54 | 35 | 89 | 54 | 37 | 91 |
| 0.51-1.0 | 90 | 107 | 197 | 86 | 100 | 186 |
| 1.01-2.0 | 225 | 137 | 362 | 218 | 136 | 354 |
| 2.01-3.0 | 148 | 61 | 209 | 153 | 71 | 224 |
| 3.01-5.0 | 71 | 28 | 99 | 78 | 25 | 103 |
| 5.01-10.0 | 33 | 15 | 48 | 36 | 17 | 53 |
| Over 10 | 22 | 11 | 33 | 27 | 11 | 38 |
| TOTAL | 674 | 444 | 1118 | 679 | 446 | 1125 |
| Average Size | 2.64 | 2.10 | | 1.92 | 1.45 | |

Source: Survey Data, 2014

However, the number of respondents with an average of at least two and a maximum of ten hectares of farm sizes increased by 6.7% and 8.1% between 2010 and 2014, respectively. This increase is an indication that more smallholders wanted to increase the production of selected commodities and incomes. On the other hand, it was noticed that more non-beneficiaries than beneficiaries (by 1.4 percentage points) had expanded their farmlands in readiness for increased production. This group of farmers represents the category that had either interacted with the beneficiaries indirectly, or was part of the farmer-to-farmer extension approach.

Results also indicate that the respondents apportioned their farmlands in different sizes and shapes so as to accommodate the commodities of choice (Table 32). This distribution of farmland sizes is heavily dependent on the following attributes: area of farmland already under-irrigation (irr), livestock (lvst) and assorted TIMPs (TIMPs); the total land area (Ha) available for the household head (LA); level of education (edu); age of the respondent (age); the total amount of money paid to secure farm labourers (lab); and the LTU (LTU). These factors were considered because they directly influence the land use patterns, given that they are potential land use alternatives for any respondent.

A multiple linear regression was used to assess the factors that affect the size of land dedicated to rainfed agriculture. This regressand was selected because of its likelihood of influencing the choice of TIMPs as well as its influence on other land use options

These factors were used to fit the following equation:

$$\mathbf{Y_i = \beta_0 + \beta_1 LA + \beta_2 Edu + \beta_3 Age + \beta_4 Lab + \beta_5 LTU + \beta_6 Irr + \beta_7 Lvst + \beta_8 TIMPs} + \varepsilon_i \quad (23)$$

Based on the above equation, the following output was generated (Table 33). In the final model, only three variables were statistically significant.

**Table 32:** Factors Determining Farmland Size for Rainfed Agriculture

| | Standardized Coefficients Beta | t |
|---|---|---|
| (Constant) | | -.071 |
| Total land area (Ha) in 2014 | .867 | 5.961* |
| Years of education | .061 | .567 |
| Age of respondent | -.055 | -.488 |
| Amount paid in 2014 | -.040 | -.369 |
| LTU14 | .122 | 1.069 |
| Area under irrigation in 2014 | .008 | .063 |
| Area under livestock in 2014 | -.513 | -2.742* |
| Area under TIMPs in 2014 | .464 | 3.229* |

* Significant at P≤0.05

Source: Survey Data, 2014

The study shows that the more the number of livestock kept by the respondents, the smaller the land set aside for rainfed agriculture. This clearly indicates some level of land use competition. This may call for training on how the farmers can optimize their profits through engagement in multiple land use activities.

**Table 33:** Mean Cropland Areas (Ha)

| Country | Status | Maize | | Sorghum | | Millet | | Beans | | Sweet Potato | | Cassava | | Banana | | Irish Potato | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| | Beneficiary | 1.29 | 1.26 | 0.94 | 1.03 | 0.56 | 0.68 | 1.09 | 1.14 | 0.57 | 0.62 | 0.67 | 0.64 | 4.22 | 1.57 | 47.70 | 6.81 |
| Kenya | Non-Beneficiary | .83 | .83 | .55 | .52 | .66 | .60 | .64 | .76 | .20 | .65 | .43 | .61 | 2.67 | 2.94 | .61 | 12.05 |
| | Mean | 1.15 | 1.13 | 0.88 | 0.95 | 0.58 | 0.66 | 0.95 | 1.02 | 0.52 | 0.62 | 0.63 | 0.63 | 3.59 | 2.13 | 38.28 | 8.12 |
| | Beneficiary | .78 | .87 | .39 | .49 | .24 | .30 | .49 | .59 | .74 | .67 | 1.35 | 1.87 | .81 | .90 | .55 | .54 |
| Rwanda | Non-Beneficiary | .50 | .55 | .21 | .24 | .44 | .48 | .62 | .66 | 1.04 | .98 | .24 | .29 | .35 | .41 | .64 | .66 |
| | Mean | .67 | .74 | .32 | .38 | .32 | .38 | .54 | .62 | .81 | .75 | .94 | 1.24 | .61 | .69 | .57 | .57 |
| | Beneficiary | 1.12 | 1.26 | 0.67 | 0.69 | 0.40 | 0.44 | 0.85 | 1.00 | 0.58 | 0.54 | 0.34 | 0.39 | 0.62 | 1.06 | 1.21 | 1.21 |
| Tanzania | Non-Beneficiary | .78 | .89 | .74 | .63 | .51 | .51 | .73 | .81 | .55 | .67 | .30 | .33 | 2.84 | 3.12 | 18.52 | |
| | Mean | .96 | 1.09 | .70 | .66 | .42 | .45 | .79 | .91 | .57 | .58 | .32 | .37 | 1.83 | 2.14 | 12.75 | 1.21 |
| | Beneficiary | 1.70 | 1.67 | 1.39 | 1.47 | 0.39 | 0.39 | 1.09 | 1.13 | 0.78 | 0.79 | 0.95 | 0.90 | 0.88 | 0.96 | 1.91 | 3.20 |
| Uganda | Non-Beneficiary | .94 | 1.05 | .57 | 1.31 | .53 | .55 | .68 | .78 | .69 | .66 | 1.08 | .78 | 2.50 | 1.24 | .50 | .59 |
| | Mean | 1.37 | 1.40 | 1.25 | 1.44 | 0.44 | 0.44 | 0.92 | 0.98 | 0.75 | 0.76 | 1.00 | 0.85 | 1.59 | 1.08 | 1.20 | 1.93 |
| | Beneficiary | .93 | .96 | .67 | .57 | .64 | .68 | .89 | .90 | .76 | .79 | .51 | .51 | .60 | .63 | | |
| Burundi | Non-Beneficiary | .67 | .70 | .46 | .49 | .47 | .47 | .65 | .69 | .42 | .44 | .33 | .35 | | | | |
| | Mean | .84 | .87 | .61 | .55 | .58 | .60 | .81 | .83 | .66 | .69 | .47 | .48 | .60 | .63 | | |
| GRAND MEAN | | 1.00 | 1.05 | .67 | .72 | .52 | .57 | .79 | .85 | .70 | .70 | .78 | .83 | 1.56 | 1.22 | 3.08 | 1.41 |

Source: Survey Data, 2014

### 6.3.6. Disease and Pest Management

Regarding disease and pest management, the survey result indicated that crops such as maize, beans, cassava and bananas, and livestock (mainly cattle) were the mostly affected commodities and livestock by diseases and pests. In 2010, pests and diseases were regarded as a major cause of food insufficiency in all the targeted countries. This has been addressed to some manageable levels, principally through the introduction of disease-resistant and tolerant varieties, among other crop protection mechanisms available to the respondents.

Studies have shown that increases in yields and intensive production leads to increased problems of weed, diseases and insects (Willocquet et al., 2002). In this study, results indicate that the respondents applied several mechanisms of dealing with disease and pest management. The most common approaches included: cultural practices, biological controls, and plant genetics.

The modal cultural practices included: intercropping as well as crop rotation between maize and legumes, cassava and maize, and maize with banana, among other possible combinations. Plant genetics was mainly employed by breeders in seeking to develop pest-resistant and tolerant varieties. These varieties were tested on farmers' fields, and were released after the variety release committees approved them.

The commonest pests cited by the respondents to have caused serious problems to the smallholder farmers included, but not limited to: weevils, armyworms, bruchids, pod borer, boll worm, whiteflies, termites, nematodes, rats, and aphids (Table 34).

**Table 34:** Major pests in the study area

| Crop | Common pests |
|---|---|
| Maize | Maize stem borer; aphid; cut and army worms, rats, termites, leafhoppers, and maize streak virus |
| Bean | Aphids; Halo blight; Beam stem maggots; Bruchids; Bollworms; Pod sucking bugs |
| Banana | Banana aphid; Banana weevil; Nematodes |
| Cassava | Cassava Green Mite (CGM); cassava Mealy Buy (CMB); White flies; Variegated and Elegant grasshoppers; Scale insects; Termites and Vertebrate pests e.g. cane rat |
| Sorghum | Shoot fly, stem borer, armyworms, aphids, grasshoppers, armored crickets (affecting seedlings) and sorghum midge (damaging the panicle and developing grain) |
| Potato | Potato tuber moth; Cutworms; potato aphids; flea beetles |
| Livestock | Tick and tick-borne diseases; |

Source: Survey Data, 2014

On the other hand, the major diseases that have caused serious damage and challenges to the respondents included, but not limited to: Banana Xanthomonas Wilt (BXW), potato blight (*Phytophthora infestans*), Cassava Brown Streak Diseases (CBSD), Cassava Mosaic Disease (CMD), anthracnose, and halo blight (Table 35).

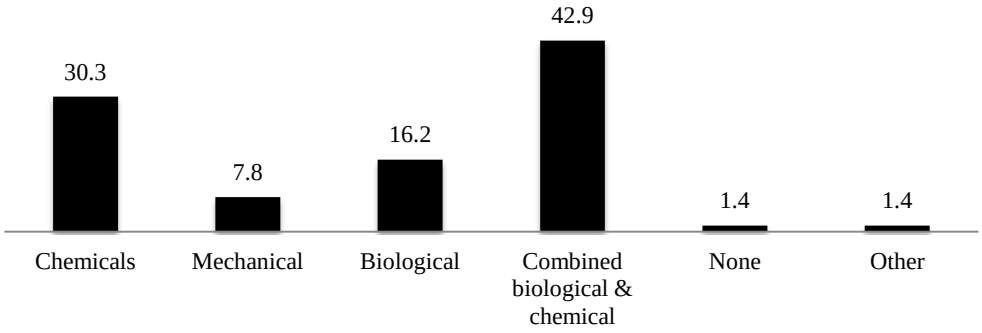
**Table 35:** Major Diseases in the Study Area

| Crop | Common diseases |
|---|---|
| Maize | Maize head smut; gall smut; ear rot; stem rot; top rot; leaf blight; gray leaf spot |
| Bean | Anthracnose; Common bacterial blight; Bean rust; Bean mosaic virus; Angular leaf spot; Stem rot |
| Banana | Anthracnose; Black sigatoka (black leaf streak); Fusarium wilt; Banana Xanthomonas Wilt; Rhizome rot; Banana mosaic (cucumber mosaic virus, CMV); cigar end rot. |
| Cassava | Cassava Mosaic Disease (CMD; Cassava Bacterial Blight (CBB); Cassava Anthracnose Disease; Leaf spot and Root rot diseases |
| Sorghum | Mildews; bacterial leaf diseases; viruses; grain molds; smut; anthracnose and ergot |
| Potato | Early and Late blight; black scurf; Rhizoctonia canker; Gray mold; Bacterial ring rot |
| Livestock | Foot and Mouth Disease; East Coast Fever; Salmonellosis; Brucellosis; Trypanosomiasis; Bluetongue; Rinderpest |

Source: Survey Data, 2014

As a means of managing these pests within the farms, over 42.9% of the affected farmers used mainly a combination of biological and chemical pesticides. Others (30.3%) used chemicals, while 16.2% applied purely biological pesticides (Figure 21). The results show that the regional projects are more effective in creating or providing a better platform for dealing with regionally experienced pests and disease invasions (such as maize lethal necrotic disease), and in supporting adoption of good agronomic practices, compared to national projects.

**Figure 21:** Types of Measures taken Manage Pests on the farms (percentage of respondents)



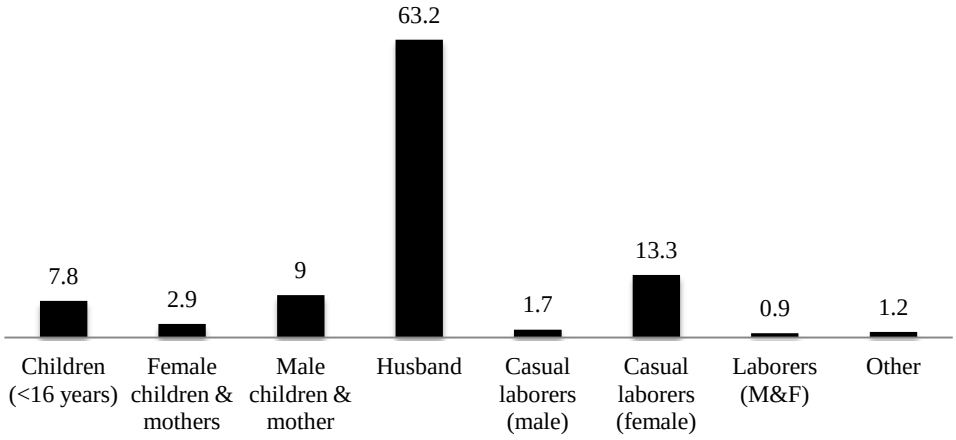

Source: Survey Data, 2014

#### 6.3.6.1. Pesticide Application

Regarding the application of pesticides on the farm or enterprise, the study revealed that the heads of the households, especially husbands (63.2%) were engaged. In some instance, mothers, with the help of their children (19.7%) and casual labourers (15.9%) were used, though at minimally (Figure 22). Over 94% of the respondents had received training on the application of various pesticides. A very high significant difference ($P \leq 0.05$) was observed between the respondents who received training and their country of residence as well as their sex.

For instance, over 78% of the beneficiaries from Tanzania (compared to 21.3% from Burundi and 39.7% from Kenya) received the trainings, and are applying the skills on their farmlands. Similarly, nearly 42% of the female beneficiaries from Uganda (compared to 13% from Burundi, and 12% from Kenya and Tanzania) received specialized training on the appropriate application of pesticides. This accounts for the observed significant differences between respondents.

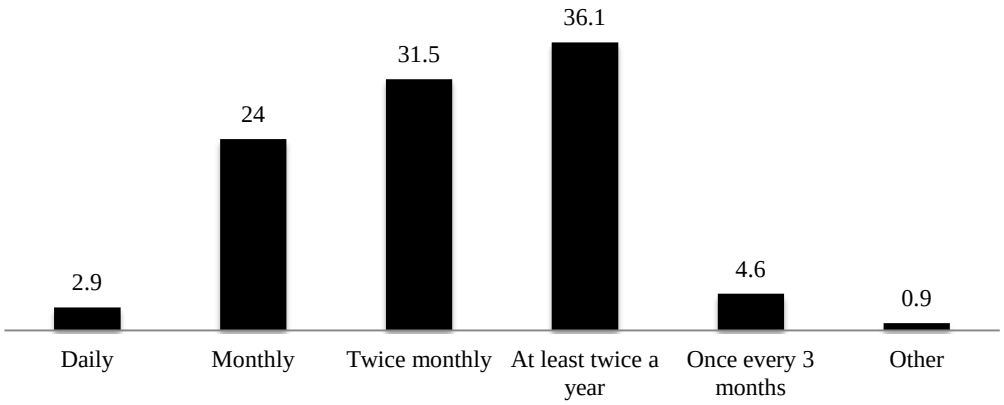
**Figure 22:** Category of People Applying Chemicals on the Farms (% of respondents)




Source: Survey Data, 2014

The results also show that the frequency of the application of the pesticide varied with commodity, with the modal frequency being at least twice a year (Figure23). This is mainly attributed to the fact that most of the crops on which these pesticides were applied were mainly seasonal crops, such as maize, beans, cassava, and sweet potatoes. There was a slightly reduced frequency of pesticide use on other commodities like millet and sorghum. This is because the existing varieties and those under field testing (in readiness for uptake by the farmers) were not only resistant to diseases and pests, but also to droughts.

**Figure 23:** Frequency (%) of application of the chemicals




Source: Survey Data, 2014

Other pesticides were applied fortnightly, and this was mainly done whenever there was suspected outbreaks of pests and diseases. For example, the emergence of maize lethal necrotic disease (MLND) forced the farmers to keep monitoring their fields at rapid frequencies so as to avoid the devastations. The invasions of crops by birds also forced the farmers to use available methods daily to protect their crops. In some cases, scarecrows were used, while in other cases, traps were set every morning and evening to guard the crops against rodents. The commonly reported livestock diseases and pests included East-Coast Fever (ECF); Foot and Mouth Diseases (FMD); Tick and Tick-borne diseases (TTBD) as well as infertility and stunting.

The study revealed that different types of (chemical) pesticides were used in the various farmlands to manage pests that were affected the crops under review. The selection of pesticides was dependent on the type of pests and diseases that needed control. The quantities applied varied, though depended on severity of the attack. Pesticides Control Product Board (PCPB) of the various countries registered almost all the pesticides that the farmers used. In some cases, especially following the advise of the agro-veterinary agents, the use of other non-chemical pest management was emphasized, specifically to minimize the adverse impacts related to chemical pesticide application on the environment and human health.

Therefore, as a means of controlling the common pests and diseases, both for crops and livestock, the farmers tried out several options. For instance, among the most commonly used chemical pesticides included: Ambush, Karate, Dimethoate, acaricides, and ash. Ambush was mainly applied on maize, beans and potatoes, where it spraying was done at tassel emergence and when pest populations appeared during flowering stages.

Karate, manufactured by Syngenta was also useful in the control of aphids, thrips, caterpillars and whiteflies and was mainly applied on vegetables. It was noticed that this insecticide was used for re-export items to Tanzania, while it was not for sale and use in Kenya. Dimethoate, on the other hand, was applied on maize, beans, and groundnuts in order to protect these crops against sucking insects and mites, aphids, beetles, grasshoppers, leafhoppers, and spider mites. The application involved a minimum spray schedule of 2-3 Dimethoate or 1-2 sprays of Dimethoate and Dithane

M45 (see Appendix 5 for assorted management practices by stakeholders against pests and diseases).

Some farmers managed pests and diseases by maintaining plant density and structure. Through the advice of the agronomists and extension staff, some farmers in the districts of Burera and Bugesera (Rwanda), Kilosa and Sengerema (Tanzania), and Kabale and Masaka (Uganda) managed farm field boundaries as well as in-field habitats, thereby attracting beneficial insects that feed on the weeds.

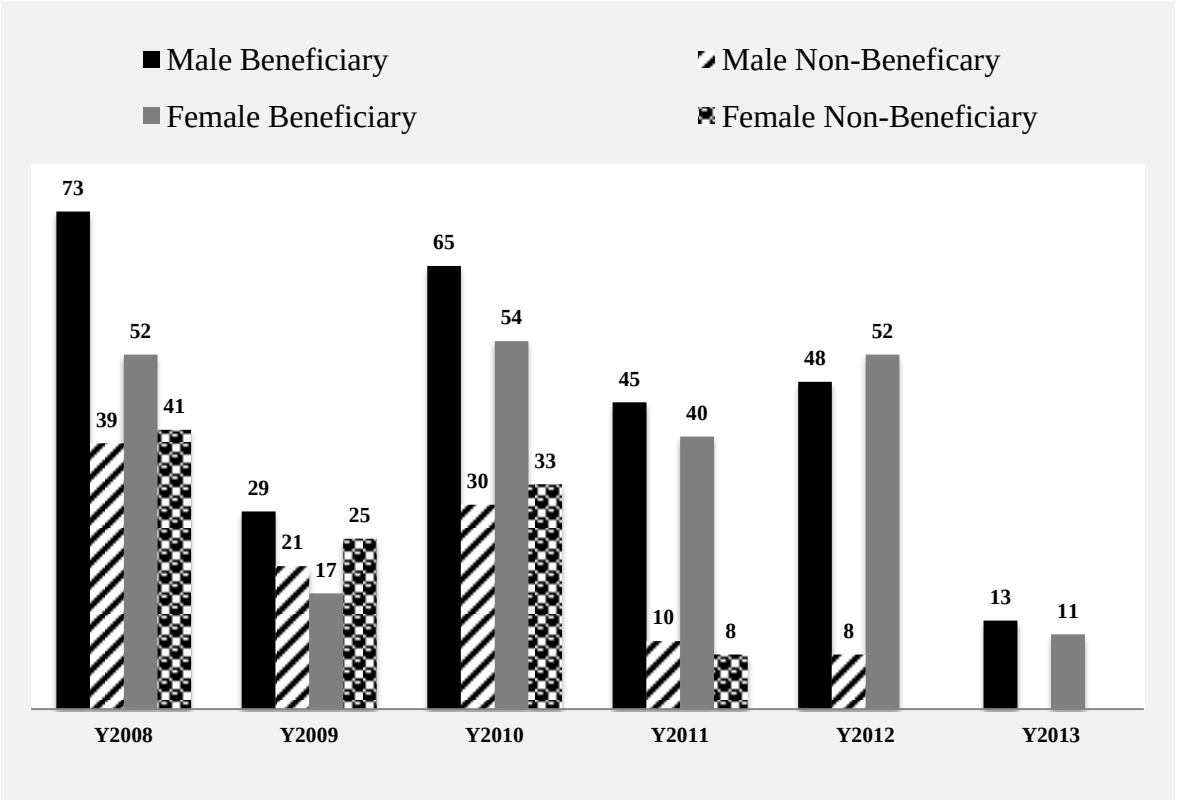
#### 6.3.6.2. Adverse Impacts of Pesticides

The research also revealed that there were several potential adverse effects associated with the application of pesticides in the targeted project areas. Among the commonest impacts include: (i) environmental pollution and contamination of surface and underground water bodies, especially the rivers surrounding the projects, the wetlands, and eventually the lakes, such as Lake Victoria Basin; (ii) in several locations, cases of pollution and contamination of soil was reported; (iii) in relation to pollution of water bodies, some respondents also reported cases of negative impacts on aquatic life (especially where aquaculture was practiced); (iv) effects on human and animal health related hazards, mainly due to indiscriminate exposure to pesticides; and (v) unintended impacts on non-target organisms like bees and insects.

#### 6.3.6.3. Capacity Strengthening on Pesticide Application

Regarding effectiveness of the application of these pesticides, farmers were expected to undergo skills enhancement programmes. However, the study revealed that only 17.9% of the smallholders applying the pesticides had actually undergone some form of training. In as much as over 67% of the trained smallholder farmers received the training between 2008 and 2010, there was a general decline in the number of people trained during the same period. This decline was attributed to the fact that most of the targeted people had been reached, and the training could not be extended beyond the specified locations. Figure 24 shows the number of beneficiaries who benefited from trainings on the management of pests and diseases.

**Figure 24:** Beneficiaries of Disease and Pest Management Training




Source: Survey Data, 2014

However, there was a significant difference between the number of regional project beneficiaries and non-beneficiaries who had undergone training and the frequency of their use of the chemicals. By the time of the study, the beneficiaries of these trainings had not only noted a very high level (78%) of satisfaction with the skills acquired, but were actually applying these skills on their farms.

Farmers reacted to changes in climatic variability and pests and diseases. Part of coping strategies `included crop, soil, and pest management. The commonly adopted crop management practices by the farmers involved identification and selection of commodities that are suited for local climatic and soil conditions. The main crop management practices included selection of pest-resistant and drought-tolerant varieties, mainly the local and native varieties, as well as tested and adapted cultivars of maize, beans, bananas, cassava, and sorghum. Studies showed that these selected varieties could not only withstand droughts and diseases, but also provide higher yields.

On the other hand, some farmers adopted the use of legume-based crop rotations to increase availability of soil nitrate. This was shown to enhance soil fertility, thereby saving some crops (e.g., maize and sorghum) from Striga attacks. Some of the smallholder farmers embarked on conservation agriculture, especially the use of cover crops and green manure. The farmers have learnt that when they cover the ground between the crops, the minimal space left between the crops choke the weeds so that competition with the crops becomes drastically reduced.

In Makueni and Bungoma (Kenya), Mwanza and Morogoro (Tanzania), and some parts of Musanze (Rwanda), the smallholders integrated intercropping and agro-forestry systems. Coupled with acceptable crop spacing, intercropping and regulated pruning, this practice has helped these farmers to improve the soil and also to reduce pest and disease infestation.

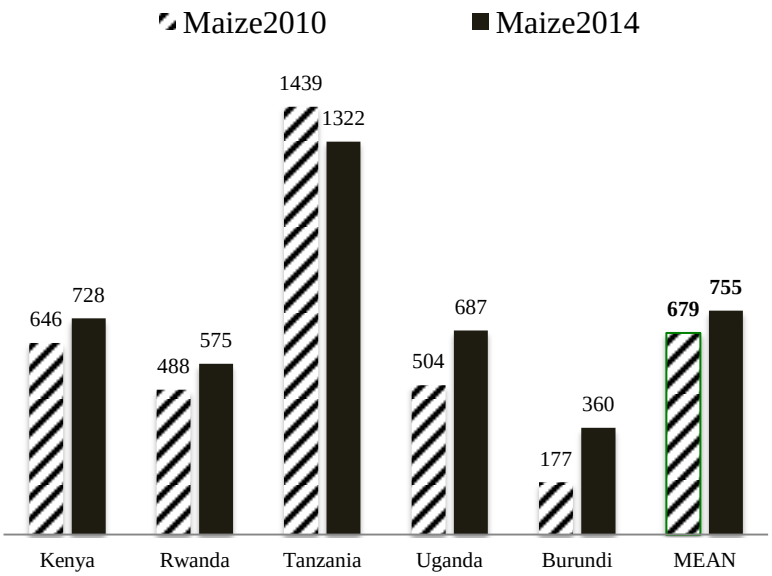
### 6.3.7. Farm Level Impacts

In this section, the researcher focused on assessing the economic impacts of the availed and adopted TIMPs at the farm level. This involved calculation of the relative cost and revenue differences between the introduced or adopted TIMPs and the existing production systems, especially within a set of gross margin budgets. The results from this process were used to calculate the marginal rates of return for each of the TIMPs.

#### 6.3.7.1. Crop Production

The average maize yield was way below the average in the region (7-9 Ton/ha). In all the areas of study, only Tanzania exceeded the one-ton per hectare margin. In most areas of Burundi, the average maize yield was only 360 kg/ha, thus confirming why Burundi still falls among the countries with very acute food and nutrition security challenges. Results indicate that even countries regarded as potentially food secure exhibit signs of susceptibility to hunger (Figure25). The production of staple crops has faced challenges ranging from climate change to pests and diseases, as well as to water scarcity and soil infertility. Land use changes have been witnessed, and rainfed agriculture nears complete abandonment.

**Figure 25:** Maize Yields (kilograms)




Source: Survey Data, 2014

In all these observed cases, there was a significant difference among the respondents and across the countries regarding the percentage change in yield impact. Apart from a slight decline in maize production between 2010 and 2014 in Tanzania, all other countries recorded some slight increments. In this study, the percentage change in yield impact from adoption of a technology under a particular climate scenario and agricultural development domain was measured as follows:

$$\%\Delta \boldsymbol{Y} = \boldsymbol{max}\left(\frac{\boldsymbol{Yield_{RP} - Yield_{NP}}}{\boldsymbol{Yield_{NP}}}\right) * \mathbf{100} \quad (24)$$

Where,

$\%\Delta Y$ = percentage change in yield impact from the adoption of availed TIMPs

$Yield_{RP}$ = the estimated yield from the regional project implementers using the availed TIMPs.

$Yield_{NP}$ = estimated business-as-usual yield from the national project implementers, and is here also regarded as the baseline value.

In this model, the yield impact becomes effectively zero when a yield with the TIMPs results in a lower yield than the one without the TIMPs adoption. This is applicable in the case of adopters of highland maize varieties in Tanzania. In this case, the

beneficiaries with improved varieties recorded a drop in the average yield by over 21.5%. On the other hand, based on the above formula, the percentage change in yield impact for maize in Kenya was 44.1%. This indicates that there was an overall increase in the average yield gain by the targeted groups that adopted the improved maize varieties above the non-targeted respondents.

However, in most cases, these increases were way below the required 6% annual production in order to meet the CAADP goals. On the other hand, productivity (i.e., production per hectare of agricultural land) of the selected commodities has failed to reach to minimum 4.4% per annum. Respondents cited the low yields of the targeted crops to be as a result of nutrient and water constraints, including persistent uncertainties of rainfall and climate variability, thereby affecting the timely applications of external inputs. However, in years of good rainfall, the surpluses produced provided a buffer for years of low rainfall, though this was also dependent on socioeconomic and demographic factors of the respondents.

Figure 26 illustrates a general trend (also reflected in all the targeted commodities) of the immediate impacts of the regional projects. Beneficiary farmers recorded an overall increase in production on their farms. For certain commodities, the country's performance was below the mean for the region.

For instance, in Kenya, the study showed that the adoption of potato seed selection TIMPs introduced through the regional project resulted in significant increase ($P \leq 0.05$) in potato yields from an average of 2.8 tons (worth US$ 2,840/ha) to over 7.5 tons (worth >US$ 7,410/ha) in a span of 2 seasons. Over 14 beneficiary groups in Burundi adopted the same approach, thereby recording over 140% increase in potato yield (12 tons/ha, up from 5 tons/ha).

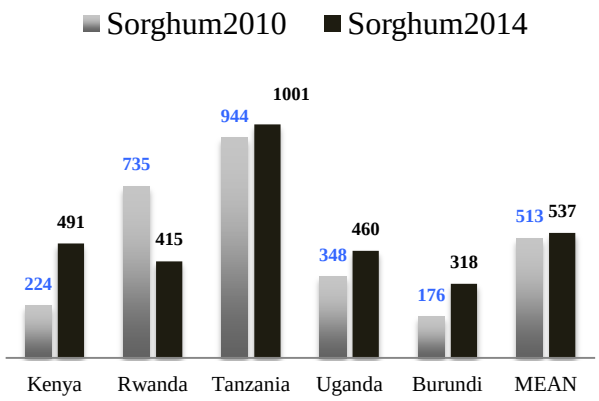
Results from Uganda and Tanzania on the utilization of improved livestock feed TIMPs showed that the beneficiaries recorded an increase in milk production from 6 to 11, and from 6 to 8 litres/cow/day, respectively. Beneficiaries generated an average monthly income of US$ 115/cow above the non-beneficiaries. On the other hand, the respondents reported that the daily consumption and sales of milk had resulted in

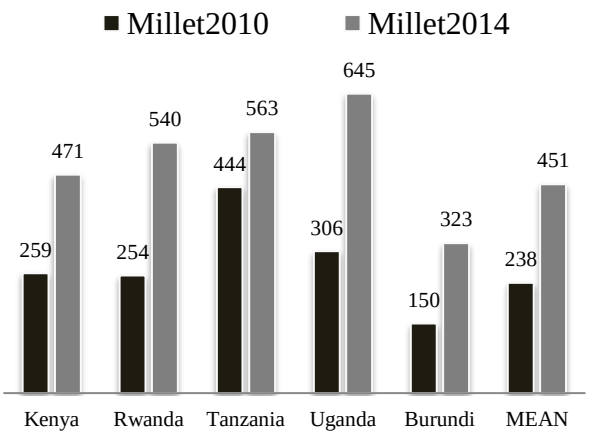
considerable impact on people's health, with some reporting cases of reduced kwashiorkor in the communities.

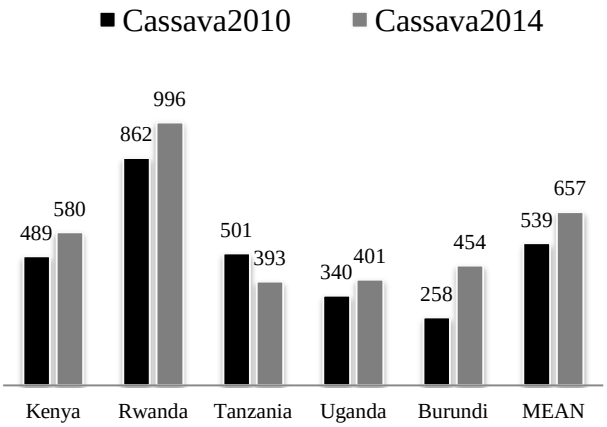
A significant difference ($P \leq 0.05$) between beneficiaries and non-beneficiaries was observed among the users of the sorghum ox-weeder. This technology was generated and adopted in Tanzania, and also shared with selected beneficiaries in Rwanda. Its adoption by the beneficiaries reduced drudgery by up to 75% per hectare, besides also saving an average of US$ 125 as labor costs.

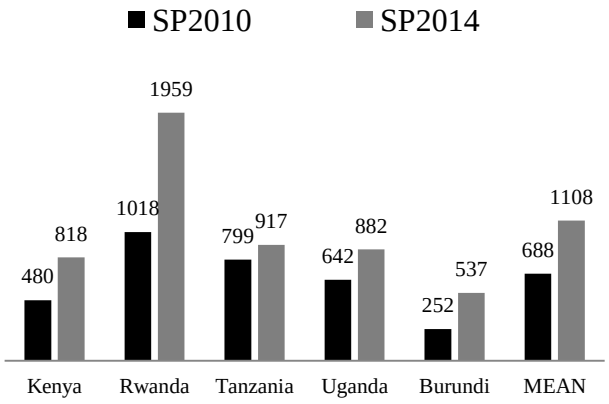
On the other hand, the mean production for sorghum (i.e., 513 kg and 537 kg in 2010 and 2014 respectively) was higher than the actual production in Kenya (224 kg and 491 kg in 2010 and 2014 respectively), Uganda (348 kg and 460 kg in 2010 and 2014 respectively), and Burundi (177 kg and 360 kg in 2010 and 2014 respectively). This general low production was attributed to factors such as fluctuating weather conditions experienced during the period of research, limited application of fertilizers, inappropriate agronomic practices, as well as incidences of regional pests and diseases. Other yield performances are as shown in Figure 26 and Table 36.

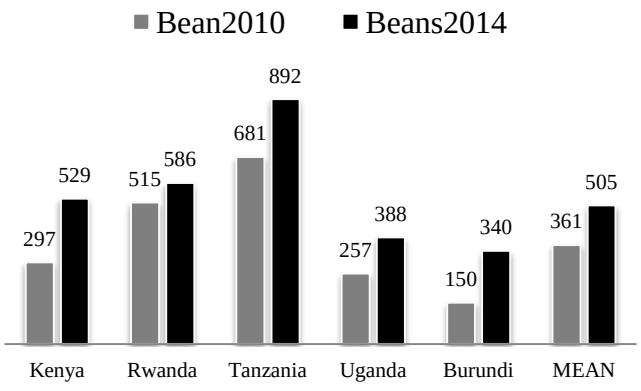
**Figure 26:** Trends in various crop yields

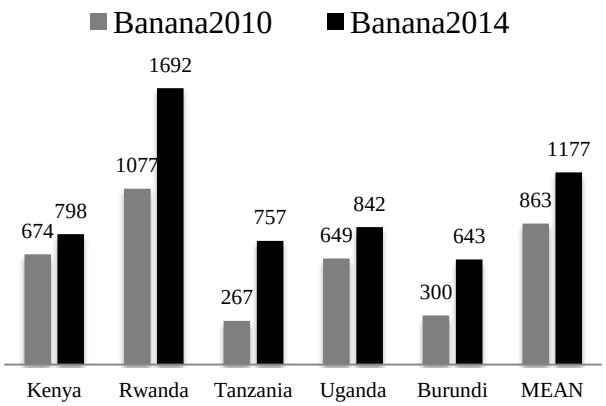



Source: Survey Data, 2014

**Table 36:** Mean Crop Yields (Kilograms/Ha)

| Country | Status | Maize | | Sorghum | | Millet | | Beans | | Sweet Potato | | Cassava | | Banana | | Irish Potato |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2014 |
| | Beneficiary | 696 | 797 | 241 | 528 | 266 | 512 | 313 | 574 | 493 | 848 | 521 | 636 | 799 | 948 | 125 |
| Kenya | Non-Beneficiary | 535 | 565 | 155 | 325 | 232 | 350 | 259 | 419 | 407 | 563 | 397 | 424 | 300 | 200 | |
| | Mean | 646 | 728 | 224 | 491 | 259 | 471 | 297 | 529 | 480 | 818 | 489 | 580 | 674 | 798 | 125 |
| | Beneficiary | 465 | 617 | 395 | 427 | 294 | 587 | 557 | 623 | 1107 | 2158 | 985 | 755 | 1131 | 1107 | 1653 |
| Rwanda | Non-Beneficiary | 520 | 513 | 1328 | 397 | 180 | 488 | 447 | 524 | 699 | 1472 | 607 | 1583 | 968 | 2681 | 942 |
| | Mean | 488 | 575 | 735 | 415 | 254 | 540 | 515 | 586 | 1018 | 1959 | 862 | 996 | 1077 | 1692 | 1458 |
| | Beneficiary | 1971 | 1731 | 1194 | 1263 | 383 | 555 | 437 | 666 | 1032 | 1120 | 451 | 389 | 267 | 840 | 904 |
| Tanzania | Non-Beneficiary | 799 | 811 | 603 | 637 | 580 | 600 | 1042 | 1157 | 422 | 586 | 575 | 397 | | 550 | |
| | Mean | 1,439 | 1,322 | 944 | 1001 | 444 | 563 | 681 | 892 | 799 | 917 | 501 | 393 | 267 | 757 | 904 |
| | Beneficiary | 502 | 795 | 363 | 490 | 312 | 644 | 283 | 469 | 740 | 1101 | 435 | 486 | 698 | 923 | 2898 |
| Uganda | Non-Beneficiary | 506 | 533 | 310 | 357 | 291 | 650 | 223 | 287 | 339 | 241 | 199 | 206 | 590 | 726 | 729 |
| | Mean | 504 | 687 | 348 | 460 | 306 | 645 | 257 | 388 | 642 | 882 | 340 | 401 | 649 | 842 | 1,597 |
| | Beneficiary | 194 | 425 | 186 | 350 | 163 | 371 | 165 | 404 | 286 | 611 | 287 | 499 | 300 | 765 | |
| Burundi | Non-Beneficiary | 144 | 233 | 151 | 240 | 126 | 215 | 121 | 204 | 178 | 351 | 140 | 310 | | 400 | |
| | Mean | 177 | 360 | 176 | 318 | 150 | 323 | 150 | 340 | 252 | 537 | 258 | 454 | 300 | 643 | |
| Grand Mean | | 679 | 755 | 513 | 537 | 238 | 451 | 361 | 505 | 688 | 1108 | 539 | 657 | 863 | 1177 | 1462 |

Source: Survey Data, 2014

#### 6.3.7.2. Cost of Crop Production

In this study, the cost of production is categorized as either fixed cost (including land input) or variable costs (including labour and capital inputs). The researcher regards the fixed costs of production of the selected commodities as land input (including rent or lease of land). It however excludes land taxes, as these data were not available. On the other hand, the labour input costs included in the analysis comprise field operations and production practices, such as sowing, weeding, and harvesting as performed by the farmer. Similarly, the use of farm labourers incurred costs in form of land clearance and preparation, sowing, weeding, irrigation, and herbicides and pesticides applications, harvesting and post-harvest handling. The capital costs included cost of purchases or acquisition of seeds, manure, fertilizers, pesticides and herbicides, as well as transport and marketing.

#### 6.3.7.3. Returns from Selected Commodities

In this section, the researcher calculated the changes in gross margins. In this case, the annual total value of the new TIMPs introduced to, and adopted by the farmers was calculated as follows:

$$\boldsymbol{TGM_{it} = A_t * \Delta\pi_{it} * \Delta\varphi_{it}} \quad (25)$$

Where,

$TGM_{it}$ = Total gross margin generated by the adopted technology, *i* within the year, *t*;

$A_t$ = Total harvested area of the respondents' farms in year, *t*;

$\Delta\pi_{it}$ = Change in profits per unit area

$\Delta\varphi_{it}$ = Difference between the percentage adoption of the technology, *i* within the reference year, *t* with the regional projects, and the percentage adoption of the technology, *i* in other projects, other than the regionally coordinated ones within the same reference year, *t*.

The change in profits per unit area $\Delta\pi_{it}$ was computed as follows:

$$\boldsymbol{\Delta\pi_{it} = \frac{\sum_{n=1}^{N}(B_{it} - C_{it})}{A_{it}}} \quad (26)$$

Where,

$B_{it}$ = Calculated annual benefits from the adopted technology, *i* within the year, *t*. These benefits include sales and revenues from crop production and other on-farm related activities.

$C_{it}$ = Calculated annual costs associated with the adopted technology, *i* within the year, *t*.

$A_{it}$ = Total area under the adopted technology, *i* in year *t*;

On the other hand, the difference between the percentage adoption of the technology, *i* within the reference year, *t* for the regional projects ($RP_{it}$) vis-à-vis in other projects other than the regionally coordinated ones ($OP_{it}$) was calculated from this simple model:

$$\Delta\boldsymbol{\varphi_{it}} = \boldsymbol{RP_{it} - OP_{it}} \quad (27)$$

This parameter was then fitted into the equation, and was used to generate the results (as presented in Table 37). From the computed table, it is evident that the respondents increased their land area under various crops.

**Table 37:** Returns from Selected Crops

| TIMPs | Crops | Area under cultivation ($A_t$) | | Mean Annual Benefits ($B_{it}$) | | Mean Annual Costs ($C_{it}$) | | Change in Profit in adoption of new TIMPs* ($\Delta\pi_{it}$) | | % Adoption with project ($RP_{it}$) | | % Adoption without project ($OP_{it}$) | | Change in percent adoption ($\Delta\varphi_{it}$) | | Total Gross Margin ($TGM_{it}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| Quality Protein Maize (QPM) | Maize | 1.00 | 1.05 | 185.31 | 223.67 | 91.54 | 101.55 | 93.77 (93.77) | 122.12 (115.97) | 47.9 | 52.1 | 15.1 | 16.2 | 32.8 | 35.9 | 30.76 | 43.84 |
| Striga-resistant sorghum variety | Sorghum | 0.67 | 0.72 | 162.80 | 121.60 | 72.75 | 85.71 | 90.05 (134.0) | 35.89 (50.13) | 67.4 | 69.6 | 8.7 | 8.7 | 58.7 | 60.9 | 52.86 | 21.86 |
| Bean innovation | Beans | 0.79 | 0.85 | 131.43 | 176.77 | 80.96 | 105.42 | 50.47 (64.05) | 71.35 (83.65) | 53.0 | 54.3 | 17.6 | 19.8 | 35.4 | 34.5 | 17.87 | 24.62 |
| Quality seed potato | Sweet Potato | 0.70 | 0.70 | 137.26 | 185.61 | 89.39 | 102.14 | 47.87 (68.68) | 83.47 (118.73) | 56.1 | 58.0 | 6.8 | 8.4 | 49.3 | 49.6 | 23.60 | 41.40 |
| Cassava varieties | Cassava | 0.78 | 0.83 | 97.95 | 133.97 | 64.71 | 100.22 | 33.24 (42.67) | 33.75 (40.91) | 69.0 | 67.2 | 15.5 | 15.5 | 53.5 | 51.7 | 17.78 | 17.45 |
| Banana varieties | Banana | 1.56 | 1.22 | 180.20 | 218.23 | 62.32 | 106.31 | 117.88 (75.42) | 111.92 (91.81) | 34.2 | 43.6 | 8.1 | 12.1 | 26.1 | 31.5 | 30.77 | 35.25 |

* The change in profit in the adoption of selected TIMPs per hectare is presented in parentheses

Source: Survey Data, 2014

For the regional project participants, there was a significant increase in the land brought under assorted TIMPs that were availed to them. In as much as there was an increase in the land sizes, the average area under banana TIMPs reduced by nearly 22%. This was mainly as a result of the outbreak of banana-related diseases, mainly banana bacterial wilt (BXW). Its outbreak and rapid spread during the research period made some farmers to resort to other TIMPs, even as some organizations like ASARECA were looking at possible ways of providing the farmers with clean banana planting materials. The better way out of this challenge was to seek to multiple the available banana planting materials, especially the low-cost tissue culture banana. The available materials were distributed to the farmers, with preference made to the participants in the regional banana projects. Results indicate that the adoption of the low-cost tissue culture banana led to an increase in the total gross margin by 14.6% above the non-beneficiaries (up from US$ 30.77 per hectare in 2010 to US$ 35.25 per hectare in 2014).

As a build up to the above discussion, it is worth noting that the percentage adoption of the TIMPs was determined through a process that included a comparison between beneficiaries and non-beneficiaries of the regional projects. Through the double difference approach (discussed in section 3.7.1), the researcher compared the percentage of adopters of the availed TIMPs in 2010, and a repeat of the same in 2014. The first set of differences between the respondents in 2010 was subtracted from the second batch of the differences in 2014, thereby giving the difference-in-differences between the respondents. The wider the double difference, the better the intervention was in bringing about greater benefits to the participants. Based on this approach, the results show that there was an overall significant difference between the two groups in 2010 and 2014.

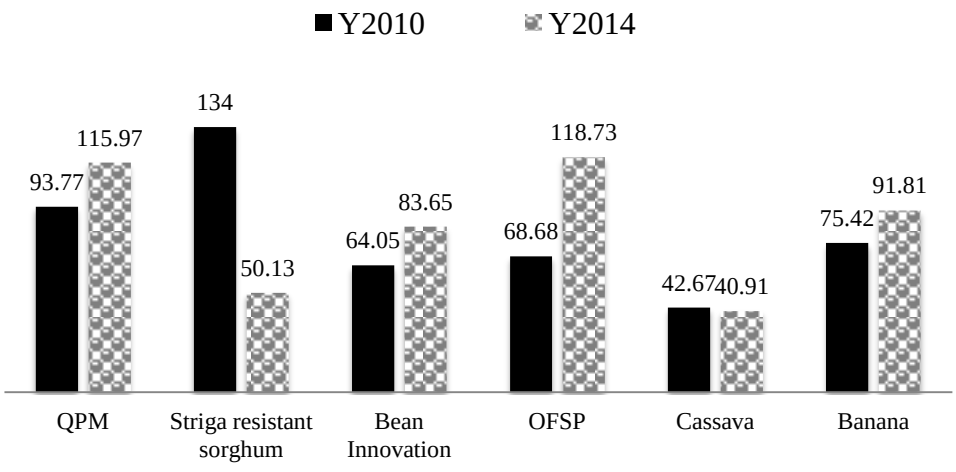
It is observable from the results that the participants in the regionally coordinated projects had higher adoption levels in all commodities, apart from cassava. On the other hand, the level of adoption of similar commodities was significantly lower among the non-targeted groups, even though they occupied the same project implementation location. For instance, the percentage adoption of QPM increased by 4.2 percentage points from 47.9% in 2010 to 52.1% in 2014, while the non-

beneficiaries recorded an increase of 1.2 percentage points (moving from 15.1% in 2010 to 16.2% in 2014).

Concerning the change in profits accrued to the beneficiaries of the regionally implemented projects, the results showed an overall increase in the revenues generated by the adopters new TIMPs for every hectare of land they dedicated to the new technology.

For instance, adopters of new varieties of orange-fleshed sweet potatoes recorded a revenue increase of 72.9% for every hectare of land they dedicated to the adoption of the new potato variety. This represented an increase from US$ 68.9 in 2010 to US$ 118.7 in 2014. However, there was a decrease in the change of profit for the adopters of the striga resistant sorghum. This change could be attributed to the fact there was limited supply of the sorghum varieties from the seed companies and from the farmers who were authorized to provide quality seed. Notwithstanding this drop in profit, the participants in the regional projects were still better off than the non-participants, in that they received on average, US$ 21.9 profit per hectare from their land above the non-beneficiaries (see Figure 27).

**Figure 27:** Change in profit in adoption of new TIMPs




Source: Survey Data, 2014

With regards to total gross margin estimates, the study revealed that the adopters of the selected TIMPs, and especially those who participated in the regional projects

recorded significant increases in gross revenues for every hectare of land dedicated to the technology. For example, adopters of QPM recorded an increase of 42.5% in financial returns (from an average of US$ 30.76 in 2010 to US$ 43.84 per person per hectare in 2014) above the gross revenues from non-beneficiaries.

#### 6.3.7.4. Animal Production

**Tropical Livestock Unit (TLU)**

The study revealed that nearly 31% of the respondents were involved in livestock production, especially cattle, goats, sheep and pigs. Out of this, over 45% used cross breeds, while 50% adopted the mixed breeds and the rest reared local breeds. It was observed that the productivity of both indigenous and exotic stocks was limited by shortage of feeds, poor adoption of improved TIMPs and inadequate access to quality veterinary services.

In order to harmonize statistical computation regarding the total number of livestock owned, a standardized method of combining all the livestock as a single unit – the Tropical Livestock Unit (TLU) was adopted. The use of the TLU ratio helps researchers to arrive at a homogenous unit for all livestock owned. In order to ensure uniformity in computation, and due to the fact that cattle were not categorized into units (e.g., bulls, cows, heifers or steers), the researcher adopted the conversion factor for TLU factors proposed by Jahnke (1982). In this case, the following factors were used: cattle = 1 LU; goats and sheep = 0.14 LU; pigs = 0.29 LU; and poultry = 0.01 LU. The results of the computations are as shown in Figure 28 and Table 38.

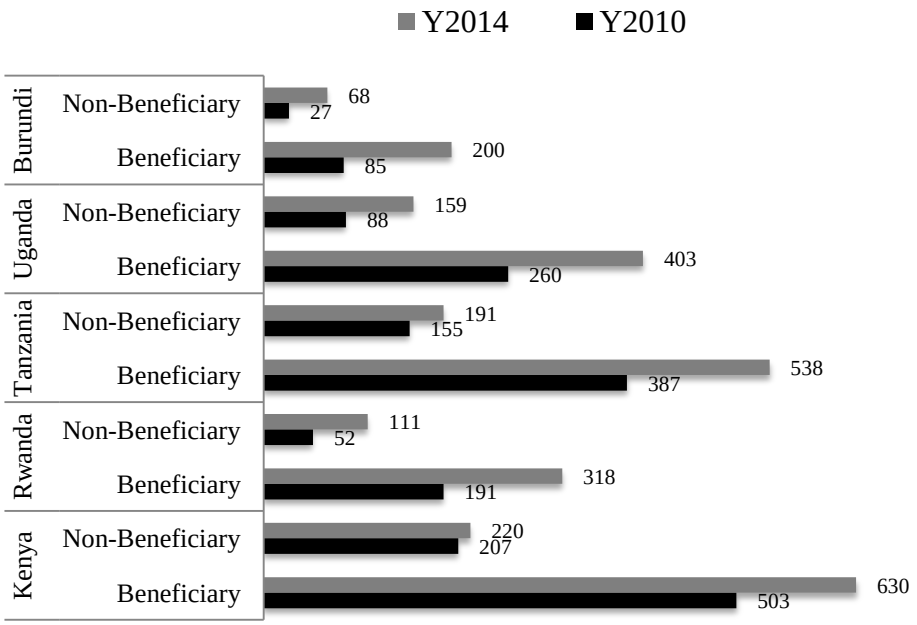
Based on the above standardization of livestock units, the study indicated a significant difference in TLU between the respondents in 2010 ($P \leq 0.05$). A further significant difference was evident among the beneficiaries ($P \leq 0.05$), while non-beneficiaries exhibited no difference among themselves ($P \leq 0.05$). This variation may be attributed to the fact that different countries had varied LTU depending on availability of livestock TIMPs, with Kenya and Tanzania leading the region in the livestock density. In both countries, there were assorted livestock TIMPs, including integrated crop-livestock systems. These systems and TIMPs included feeding packaging and feed conservation innovations; establishment of a regional feed database and feed tables; characterization of selected indigenous cattle and small ruminants breeds; prevention

and control of Tick and Tick-Borne diseases; strengthening the regional capacity for forage seed supply; developing mechanisms for crises management in pastoral systems; and refining innovations to exploit market opportunities for value added meat and milk products.

On the other hand, in 2014, due to some observed and unobserved confounding factors, there was a significant difference between the respondents ($P \leq 0.05$), though at lower levels compared to 2010 ($P \leq 0.05$). The main confounders such as village characteristics, household size, education and skills led to differences in farmer-to-farmer exchange of ideas and materials, as well as free sharing among the community members during the local community meetings. These interactions enable non-beneficiaries to access the TIMPs availed to the targeted groups.

Based on the above findings, and following the adoption of availed TIMPs, the results further indicate a 45.2% increase in TLU between 2010 and 2014 (from 1,955 in 2010 to 2,838 in 2014). Out of this, the beneficiaries of regional projects indicated an increase of 46.5% (from 1,426 in 2010 to 2,089 in 2014), compared to the non-beneficiary's 41.6% increase (from 529 in 2010 to 749 in 2014).

**Figure 28:** Tropical Livestock Units per country




Source: Survey Data, 2014

**Table 38:** Tropical Livestock Units (TLU)

| Country | Respondent | Cattle | | Goats | | Sheep | | Pigs | | Poultry | | TLU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| | Beneficiary | 388 | 477 | 595 | 800 | 84 | 110 | 18 | 31 | 1451 | 1659 | 503 | 630 |
| Kenya | Non-Ben | 142 | 145 | 362 | 398 | 26 | 29 | 14 | 25 | 657 | 780 | 207 | 220 |
| | Total | 530 | 622 | 957 | 1198 | 110 | 139 | 32 | 56 | 2108 | 2439 | 710 | 850 |
| | Beneficiary | 152 | 253 | 109 | 184 | 55 | 98 | 28 | 66 | 828 | 590 | 191 | 318 |
| Rwanda | Non-Ben | 35 | 75 | 50 | 99 | 27 | 46 | 10 | 30 | 372 | 681 | 52 | 111 |
| | Total | 187 | 328 | 159 | 283 | 82 | 144 | 38 | 96 | 1200 | 1271 | 244 | 428 |
| | Beneficiary | 321 | 431 | 292 | 528 | 60 | 110 | 14 | 12 | 1,221 | 1,425 | 387 | 538 |
| Tanzania | Non-Ben | 126 | 159 | 126 | 133 | 16 | 16 | 15 | 23 | 503 | 482 | 155 | 191 |
| | Total | 447 | 590 | 418 | 661 | 76 | 126 | 29 | 35 | 1724 | 1907 | 542 | 729 |
| | Beneficiary | 167 | 278 | 230 | 369 | 31 | 51 | 141 | 168 | 1,573 | 1,797 | 260 | 403 |
| Uganda | Non-Ben | 63 | 121 | 71 | 146 | 19 | 16 | 31 | 46 | 302 | 229 | 88 | 159 |
| | Total | 230 | 399 | 301 | 515 | 50 | 67 | 172 | 214 | 1875 | 2026 | 348 | 563 |
| | Beneficiary | 70 | 154 | 90 | 256 | | 2 | 5 | 24 | 109 | 269 | 85 | 200 |
| Burundi | Non-Ben | 21 | 48 | 29 | 77 | | | 6 | 29 | 28 | 63 | 27 | 68 |
| | Total | 91 | 202 | 119 | 333 | 0 | 2 | 11 | 53 | 137 | 332 | 112 | 268 |
| | | 1,098 | 1,098 | 1,593 | 1,316 | 2,137 | 230 | 371 | 206 | 301 | 5,182 | 5,740 | 1,426 |
| GRAND TOTAL | | 178,742 | 387 | 548 | 638 | 853 | 88 | 107 | 76 | 153 | 1,862 | 2,235 | 529 |
| | | 451,507 | 1,485 | 2,141 | 1,954 | 2,990 | 318 | 478 | 282 | 454 | 7,044 | 7,975 | 1,955 |

Source: Survey Data, 2014

The main animal products generated during the implementation of the regional projects included milk as well as sale of live animals. Results indicate that an increase of 22.9% on milk production (from over 451,000 to 554,000 litres in 2010 and 2014 respectively). Out of the quantity of milk produced, over 133,000, litres were dedicated to domestic utilization, representing an increase of 2%, from over 135,000 to over 138,000 litres in 2010 and 2014 respectively (Table 39).

In as much as the quantity of milk sold increased by 8.5% (from over 325,000 to 352,000 litres in 2010 and 2014, respectively), there was a 5.6% reduction of revenue (from nearly US$ 85,000 to US$ 80,000). This reduction may be attributed to the fact that the animals availed for sale were of low body mass and poor health. The droughts experienced in certain areas were believed to have contributed to limited amount of feeds and forage. Outbreaks of certain diseases (especially tick and tick-borne diseases) also contributed to poorer quality livestock.

In support of these findings, studies by Keya and Rubaihayo (2013) on on-farm production and productivity in the East African Community, 50 years after independence indicated that dairy and horticulture have sprung up as cash earners. They observed that the introduction of high-yielding livestock breeds have improved supply of milk, meat and other livestock products.

**Table 39:** Revenue from Sale of Milk (US$)

| Country | Respondent | Sex | Milk harvested | | Milk used domestically | | Milk sold in market | | Milk revenue generated | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| Kenya | Beneficiary | Male | 50,791 | 57,214 | 26,666 | 26,030 | 25,405 | 28,745 | 4,603 | 6,029 |
| | | Female | 24,630 | 22,123 | 19,331 | 6,106 | 13,419 | 16,749 | 8,527 | 2,561 |
| | Non-Beneficiary | Male | 31,975 | 22,713 | 15,245 | 22,385 | 18,451 | 2,842 | 1,111 | 4,784 |
| | | Female | 11,094 | 14,932 | 3,693 | 3,013 | 8,381 | 11,901 | 1,003 | 1,237 |
| | Total | | 82,766 | 79,927 | 41,911 | 48,415 | 43,856 | 31,587 | 5,714 | 10,813 |
| | | | 35,724 | 37,055 | 23,024 | 9,119 | 21,800 | 28,650 | 9,530 | 3,798 |
| Rwanda | Beneficiary | Male | 12,360 | 78,033 | 4,552 | 5,756 | 6,560 | 16,196 | 1,207 | 2,805 |
| | | Female | 31,999 | 46,215 | 11,472 | 17,375 | 20,456 | 27,510 | 2,068 | 2,900 |
| | Non-Beneficiary | Male | 5,990 | 7,200 | 1,875 | 2,025 | 3,765 | 4,785 | 422 | 521 |
| | | Female | 4,656 | 9,138 | 2,453 | 3,258 | 2,953 | 5,130 | 380 | 862 |
| | Total | | 18,350 | 85,232 | 6,427 | 7,781 | 10,325 | 20,981 | 1,630 | 3,326 |
| | | | 36,655 | 55,353 | 13,925 | 20,633 | 23,409 | 32,640 | 2,448 | 3,763 |
| Tanzania | Beneficiary | Male | 63,361 | 72,609 | 8,605 | 9,647 | 53,854 | 60,521 | 5,658 | 6,600 |
| | | Female | 19,739 | 17,275 | 3,213 | 3,793 | 14,501 | 9,167 | 6,277 | 5,992 |
| | Non-Beneficiary | Male | 13,075 | 15,804 | 2,730 | 3,830 | 10,345 | 11,974 | 3,577 | 3,764 |
| | | Female | 14,410 | 15,710 | 1,635 | 1,545 | 12,775 | 14,186 | 1,030 | 1,454 |
| | Total | | 76,436 | 88,413 | 11,335 | 13,477 | 64,199 | 72,495 | 9,235 | 10,364 |
| | | | 34,149 | 32,985 | 4,848 | 5,338 | 27,276 | 23,353 | 7,308 | 7,445 |
| Uganda | Beneficiary | Male | 25,680 | 16,104 | 3,918 | 2,413 | 22,645 | 13,679 | 15,745 | 4,522 |
| | | Female | 54,970 | 53,537 | 8,961 | 8,746 | 46,307 | 44,803 | 8,364 | 13,189 |
| | Non-Beneficiary | Male | 48,492 | 68,014 | 2,391 | 1,702 | 46,100 | 66,310 | 22,707 | 21,017 |
| | | Female | 194 | 212 | 42 | 38 | 174 | | | |
| | Total | | 74,172 | 84,118 | 6,308 | 4,115 | 68,745 | 79,989 | 38,452 | 25,539 |
| | | | 55,164 | 53,749 | 9,003 | 8,783 | 46,481 | 44,803 | 8,364 | 13,189 |
| Burundi | Beneficiary | Male | 4,030 | 4,375 | 2,550 | 2,420 | 1,495 | 1,598 | 150 | 160 |
| | | Female | 15,510 | 13,415 | 6,160 | 8,165 | 8,976 | 6,971 | 1,162 | 694 |
| | Non-Beneficiary | Male | 17,010 | 18,575 | 8,770 | 8,936 | 8,240 | 9,318 | 824 | 959 |
| | | Female | 1,540 | 1,690 | 1,095 | 1,095 | 445 | 595 | 45 | 60 |
| | Total | Male | 21,040 | 22,950 | 11,320 | 11,356 | 9,735 | 10,916 | 974 | 1,118 |
| | | Female | 17,050 | 15,105 | 7,255 | 9,260 | 9,421 | 7,566 | 1,207 | 754 |
| GRAND TOTAL | | Male | 272,764 | 360,640 | 77,302 | 85,144 | 196,859 | 215,967 | 56,005 | 51,159 |
| | | Female | 178,742 | 194,247 | 58,056 | 53,133 | 128,387 | 137,011 | 28,856 | 28,949 |
| | | M+F | 451,507 | 554,888 | 135,357 | 138,277 | 325,246 | 352,978 | 84,861 | 80,108 |

## 6.4. Conclusion

Soil erosion, drought, and limited access to farming input were the critical factors that directly affected the respondents with regards to food scarcity. Prior to engagements in regional projects, over 70% of the respondents were affected by low household income, poor farming practices, limited accessibility to TIMPs, as well as limited support from extension staff. The introduction of, and engagement in regional projects reversed these factors, especially the introduction of new coping mechanisms.

Regarding spillover impacts of regional projects, commodities such as cassava, millet, striga-resistant sorghum, climbing and bush beans, and banana varieties (especially the low-cost tissue culture) had significantly benefited the farmers in the locations where they were introduced, with productivity exceeding 100% above the previous varieties that were used before introduction of these new TIMPs. The main factors controlling spillovers were observed to include village characteristics, household size, education and farmers' skills. Farmer-to-farmer exchange of ideas and materials, and free sharing among the community members was mostly effective during the local community meetings.

The regional projects enhanced stakeholders' access to vital information needed to access markets, such as information on commodity prices in different markets, highly demanded commodities, and alerts on price elasticity. The regional projects enhanced application of environmentally friendly pesticides and insecticides. Targeted beneficiaries received assorted trainings, thereby leading to diverse positive change in crop and livestock productivity. Implementation of regional projects also led to an increase of 22.9% on milk production. Similarly, over 45% increase in TLU was observed between 2010 and 2014, with the beneficiaries of regional projects noting an increase of 46.5%, compared to the non-beneficiary's 41.6% increase.

# CHAPTER SEVEN
# MODELING SMALLHOLDER FARMERS' SATISFACTION WITH REGIONAL PROJECTS

## 7.1. Summary

The previous chapter elaborated on the impacts of regional projects, as well as the factors that influenced the rate of uptake of TIMPs and best practices generated from regional projects by smallholder farmers. This chapter explores the smallholder farmers' satisfaction with the regional projects through the application of models. In this chapter, the key findings of the research are established though the fitted models. It details the regression models used to estimate the respondents' willingness to pay for availed services; adopts the multinomial regression models to determine the strength of the respondents' attributes (such as gender, age, nativity, farm size, among others) on the choice to adopt and continue to use the availed TIMPs; and applies the double difference method to estimate the effect of regional projects on selected indicators such as adoption of TIMPs, crop productivity, livestock productivity, and agricultural income.

## 7.2. Introduction

Based on the findings illustrated in the previous chapters, the impacts of the regional projects may be further explained through the application of models. These models, including the multinomial regression equations and the double difference methods are vital in the estimation of the smallholder farmers' level of satisfaction with the regional projects as well as the availed TIMPs.

For instance, willingness to pay (WTP) is a strong research approach that involves the targeted clients for potential services in establishing the preferences of the services proposed, and the value the respondents are ready to pay. In most common cases, Contingent Valuation Method (CVM) and hedonistic methods are applied for valuing goods and services that are not traded in the markets, including natural resources and resource services (Lipton et al., 1995) such as appropriate and relevant TIMPs for household use, as well as amenities such as clean air in preserved environment. In this thesis, the WTP model was used to select a set of independent variables that significantly influenced the respondents' decision- making.

On the other hand, the double difference (DiD) method was used to estimate the effect of regional projects on selected indicators based on the assumption that the difference between "before" and "after" in the comparison group was a good counterfactual for the treatment group. The following section explains these models and approaches in greater depths.

## 7.3. Results and Discussion

### 7.3.1. Regression Models

In general, regression models take many forms, including linear regression, partial least squares regression, binary logistic regression, multinomial logistic regression, as well as ordinal, probit and non-linear regressions. In this section, the choice of the models, especially the logit, probit, and multinomial regression models by the researcher was dictated by their potential to be applied in a wide range of issues, including application in adoption studies. Researchers such as Kebede et al. (1990), Bagi (1983), Jarvis (1981), and Sarap and Vashist (1994) stated that the logit model was more used in such studies than the other models.

On the other hand Perry et al. (1986) stated that the choice between the logit and probit models is largely one of convenience and program availability. Contributing to this fact, Amemiya (1981, pg 1488) also stated that:

> "Because of the close similarity of the two distributions (probit and logit models), it is difficult to distinguish between them statistically, unless one has an extremely large number of observations."

As part of using the regression models in the estimation of selected parameters, the first approach involved the determination of the respondents' willingness to pay for the availed agricultural services. This was followed by the second approach that involved the use of the double difference (also known as difference-in-differences) method to further estimate the effect of regional projects on selected indicators, including adoption of TIMPs, crop productivity, livestock productivity, and agricultural income. The details of these models are as presented in the proceeding sections.

#### 7.3.1.1. Multinomial Regression Model

A multinomial logistic regression was performed to determine the strength of the respondents' attributes (such as gender, age, nativity, farm size, among others) on the choice to adopt and continue to use the availed TIMPs. The parameter estimation was performed through an iterative maximum likelihood algorithm. The independent variables took the form of factors (categorical) and covariates (continuous). In this process, the researcher assumed that the odds ratio of any two categories were independent of all other response categories. In this case, the researcher assumes that the introduction of any of the TIMPs to the farmers in any location, especially within the selected agricultural development domains, will equally affect or influence any other TIMPs hitherto adopted by the same farmers.

#### 7.3.1.2. Double Difference Method

Multiple regression is a family of techniques used to explore the relationship between one continuous dependent variable and a number of (usually continuous) predictors. Its use allows researchers to investigate more complex real-life research questions (Pallant, 2013).

In this research, the double difference (DiD) method was used to estimate the effect of regional projects on selected indicators, including adoption of TIMPs, crop productivity, livestock productivity, and agricultural income. The main assumption for the validity of this method was that the difference between "before" and "after" in the comparison group was a good counterfactual for the treatment group. In addition, it was used to account for potential sources of selection bias and to compare treatment and comparison groups in terms of outcome changes over time relative to the outcome observed for a pre-intervention baseline.

It is this method, a two-period setting was presented, whereby $t = 0$ was regarded as the status of the respondents before the project, and $t = 1$ regarded as their status after the project implementation. In this case, the researcher let $Y_t^{RP}$ and $Y_t^{NP}$ represent the respective impacts from the regional project beneficiaries and the non-regional project respondents in time *t*. The DiD method was therefore used to estimate the average program impact as follows:

$$\boldsymbol{DiD = E\{Y_1^{RP} - Y_0^{RP} | T_1 = 1\} - E\{\{Y_1^{NP} - Y_0^{NP} | T_1 = 0\}}} \quad (28)$$

In equation 28, $T_1 = 1$ represents the regional project at *t* = 1 (in this case, 2014), whereas $T_1 = 0$ refers to the project (in 2014) apart from the regionally implemented ones.

The DiD estimator creates room for *unobserved heterogeneity* that mostly lead to selection bias. This means that the model is used to determine the unobserved differences in the average benefits from the counterfactual between the regionally and non-regionally implemented projects. Given that the researcher used this method to account for factors that could not be readily observed, such as innate abilities, personality, and perceptions across both the participants in the regional and non-regional projects. In this case, the method assumed that the unobserved heterogeneity was time invariant, hence the bias cancelled out through differencing. Based on this, the outcome changes for non-participants revealed the counterfactual outcome changes as shown in equation 33.

#### 7.3.1.3. Theory and Application of DiD Method

Methodologically, the DiD estimator is based on comparison of two groups of participants – the beneficiaries and non-beneficiaries, both before and after the intervention. Following baseline survey of both groups (e.g., in 2010), a follow-up survey or detailed evaluation can be conducted of both groups after the intervention (in this case, 2014). Based on the data gathered, and the information generated, the difference is calculated between the observed mean outcomes for the two groups, before and after project implementation. With the baseline data, the researcher can proceed and estimate the impacts by assuming that the unobserved heterogeneity is time invariant and uncorrelated with the treatment over the time periods.

The outcome changes (e.g., on-farm incomes; land productivity; or TLU) for the non-beneficiaries of the regional projects (i.e., $E\{\{Y_1^{NP} - Y_0^{NP} | T_1 = 0\}\}$) is therefore regarded as the appropriate counterfactual, and is therefore equal to $E\{Y_1^{NP} - Y_0^{NP} | T_1 = 1\}$.Based on the above discussion, the DiD estimate can be calculated within a regression framework. In particular, the estimating equation would

be specified as follows:

$$\boldsymbol{Y_{it} = \alpha + \delta T_{i1} t + \pi T_{i1} + \gamma t + \epsilon_{it}} \quad (29)$$

Where:

$t$ = the time dummy, here regarded as the round of survey (t = 0 for baseline (i.e., 2010); t = 1 for follow up in 2014)

$Y_{it}$ = Household's benefits (in terms of income, yield or productivity) accrued from engagement in the projects;

$\alpha$ = The intercept of the equation

$\delta$ = Impact of intervention (double difference). It represents the interaction between the post-project engagements ($T_{i1}$) and time (t = 1,…,T). It is the coefficient that gives the average DiD effect. Thus, $\delta = DiD$.

$T_{i1}$ = Treatment variable, here representing engagement in intervention (T = 1 if household engages in intervention, e.g. adoption of new TIMPs, and T = 0 if otherwise);

$\pi T_{i1}$ = Time varying covariates

$\epsilon_{it}$ = The error term.

In this equation, it is observable that the coefficient $\delta$on the interaction between the post-project beneficiaries $T_{i1}$) and time ($t$ = 1...$T$) gives the average DiD effect of the regional project. In effect, using the notation from the equation 29, $\delta = DiD$. It is worth noting that besides using this interaction term, the variables, $T_{i1}$ and $t$ are included separately to identify any separate mean effects of time as well as the effect of being a beneficiary and not being a targeted group. Given that data for this research are drawn from five different countries, and following that comparable data are available on the four different groups, it implies that panel data may not be necessary in order to implement the DiD approach. In that case, the *t* subscript that is normally associated with time, can be reinterpreted to cater for the five countries or the project's provinces, districts, and villages, where *k* = 1. . .*K*).

In order for the DiD estimator described above to be interpreted correctly, the researcher ensured the following features: (i) the fitted model was correctly specified, with all the additive structures correctly imposed; and (ii) the error term was

uncorrelated with other variables in the fitted model, such that:

$$\text{Characteristics for the error term} \begin{cases} Cov(\epsilon_{it}, T_{i1}) = 0 \\ Cov(\epsilon_{it}, t) = 0 \\ Cov(\epsilon_{it}, T_{i1}t) = 0 \end{cases}$$

Similarly, the researcher ensured that more focus was paid on the last of these assumptions, also known as the *parallel-trend* assumption. This assumption infers that the unobserved characteristics affecting the implementation of, and participation in the regional projects do not vary over time with treatment status.

#### 7.3.1.4. Panel Fixed-Effects Model

As a simplification of the above two-period models, the researcher adopted a transformation approach whereby these models were generalized with multiple time periods, commonly called the *panel fixed-effects model*. This transformation is possible, given that these models control for both the unobserved time-invariant heterogeneity as well as for heterogeneity in observed characteristics over a multiple-period setting.

The study involved regressing $\boldsymbol{T_{it}}$ on not only $\boldsymbol{T_{it}}$ but also on a range of time-varying covariates $X_{it}$ as well as the unobserved time-invariant individual heterogeneity $\psi_t$ that may be correlated with both the beneficiary and other unobserved characteristics $\epsilon_{it}$. Based on this possible transformation, equation 34 is revised as follows:

$$\boldsymbol{Y_{it} = \phi T_{it} + \delta X_{it} + \psi_i + \epsilon_{it}} \quad (30)$$

As a final step, the researcher performed a differencing from both the right- and left-hand side of equation 35 using time. The resulting differenced equation is:

$$\boldsymbol{(Y_{it} - Y_{it-1}) = \phi(T_{it} - T_{it-1}) + \delta(X_{it} - X_{it-1}) + (\psi_i - \psi_i) + (\epsilon_{it} - \epsilon_{it-1})} \quad (31)$$

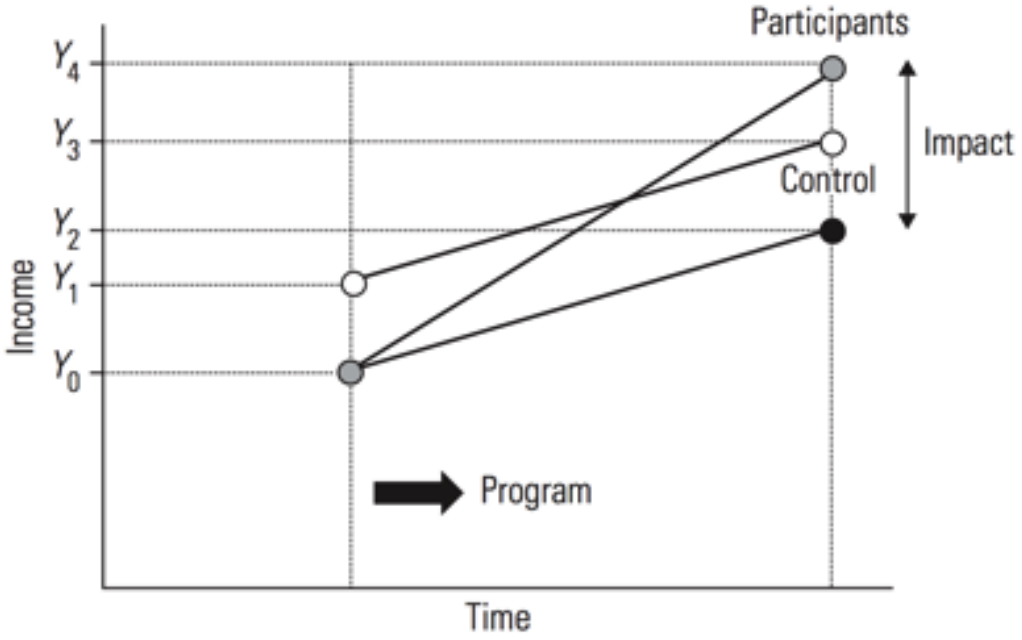
$$\boldsymbol{\Longrightarrow \Delta Y_{it} = \phi \Delta T_{it} + \delta \Delta X_{it} + \Delta \epsilon_{it}} \quad (32)$$

As is evident from the revised equation, the source of endogeneity, arising from the unobserved individual characteristics $\boldsymbol{\psi_t}$ was dropped from differencing, thereby making it possible to apply the ordinary least squares (OLS) to equation 37 to estimate the unbiased effect of the regional projects on the respondents ($\boldsymbol{\phi}$). Therefore, with two time periods, Bertrand (2004) indicates that ϕ is equivalent to the DiD estimate in equation 37, while also controlling for the same covariates $\boldsymbol{X_{it}}$. They also state that the standard errors may need to be corrected for serial correlation.

In summary, DiD can be manually estimated by calculating the average difference in outcomes separately for beneficiaries and non-beneficiaries over the 2010 to 2014 period, and then taking an additional difference between the average changes in outcomes for these two groups. The lowermost line in this illustration (Figure 29) can also reasonably depict the true counterfactual outcomes that are never observed. This can be presented graphically as follows, thereby making DiD to be estimated as:

$$\mathbf{DiD} = (\mathbf{Y_4} - \mathbf{Y_0}) - (\mathbf{Y_3} + \mathbf{Y_1}) \tag{33}$$

**Figure 29:** Graphical representation of DiD estimation




Source: Khandker et al., 2010

The main objective of this thesis was to evaluate the effect of smallholder farmers' participation in regional projects (the treatment) on several covariates (the outcome). The key covariates included: amount of farm income generated (US$); the tropical livestock units (TLU) of the respondents; the valued added through participation in these projects (VA); as well as the production of various commodities (especially maize, sorghum, millet, beans, sweet potatoes, cassava, and banana). The double difference was further estimated using available data as follows (Table 40):

**Table 40:** Framework for Calculating Double Difference (DiD)

| | Pre (2010) | Post (2014) | Post-Pre Difference (2014 – 2010) = ($\hat{\phi}_1$) |
|---|---|---|---|
| Treatment (Beneficiary) | $Y_0^{RP}$ | $Y_1^{RP}$ | $Y_1^{RP} - Y_0^{RP}$ |
| Control (Non-Beneficiary) | $Y_0^{NP}$ | $Y_1^{NP}$ | $Y_1^{NP} - Y_0^{NP}$ |
| T-C Difference ($\hat{\phi}_2$) | $Y_0^{RP} - Y_0^{NP}$ | $Y_1^{RP} - Y_1^{NP}$ | $(Y_1^{RP} - Y_1^{NP}) - (Y_0^{RP} - Y_0^{NP})$ ($\hat{\phi}_{DiD}$) |

Source: Author's conceptualization

As already explained in this section, the superscripts refer to either regional or national project (RP or NP) respectively, while the subscripts refer to either pre- or post-assessments (0 or 1 respectively). It is also noticeable that the first row ends with the estimate$\hat{\phi}_1$, the second column ends with estimate$\hat{\phi}_2$, and the lowest right hand corner provides the estimate $\hat{\phi}_{DiD}$, that represents the impact of the regional projects.

Based on these equations, the study results indicated that there was an overall positive impact experienced by beneficiaries of the regional projects ($\hat{\phi}_{DiD}$). For instance, participants in the regional projects generated an average of US$ 51.30 from farming above the non-participants in these projects and within the same project area. This was attributed to the beneficiaries' access to, as well as utilization and adoption of the various production-enhancing TIMPs, participation in capacity strengthening initiatives, as well as engagement in agronomic practices advanced through the regional projects.

Similarly, after engaging in the regional projects, thereby accessing new TIMPs, the beneficiary livestock keepers had an extra 0.52 LTU. This means that for every 1 LTU owned by the non-beneficiaries, the beneficiaries of these regional projects had 1.52 LTU. This increase was attributed to, among other factors, effective disease management, access to feeds and fodder, as well as utilization of new breed-promoting TIMPs (e.g., artificial insemination and improved breeding stock).

On the other hand, a general positive double difference was recorded on production trends of selected commodities. For example, while maize producers received an extra yield of 61.3 kg, a more than double increase in yield of sorghum (153.37 kg) and millet (121.9 kg) was recorded. The use of improved TIMPs, especially drought tolerant and disease-resistant varieties contributed to this change. However, a negative double difference in yields was recorded for cassava (-89.11 kg) and banana (-256.8 kg). This could be attributed to the high levels of shifts of beneficiaries to other more profitable commodities (e.g. QPM and beans), compared to the non-beneficiaries who still continued with the varieties introduced to them earlier by the scientists.

A significant increase ($P \leq 0.05$) in the value added on selected commodities was observed (Table 41). The participants in the regional projects received an average of US$ 324.35 above their counterparts who had no value addition programs for their commodities. These findings clearly show that there were tangible benefits associated with implementation of regional projects.

**Table 41:** Actual Double Differences

| | Farm income | | LTU | | Maize produced (Tons) | | Sorghum produced (Tons) | | Millet produced (Tons) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| Ben | 475,246 | 580,573 | 1,424 | 2,040 | 442.42 | 493.03 | 107.16 | 129.38 | 23.63 | 43.76 |
| N-Ben | 244,569 | 294,362 | 530 | 798 | 204.00 | 197.36 | 72.87 | 43.48 | 8.92 | 13.02 |
| 1st Diff | 230,678 | 286,211 | 894 | 1,243 | 238.42 | 295.67 | 34.30 | 85.90 | 14.71 | 30.74 |
| 2nd Diff | 55,534 | | 349 | | 57.26 | | 51.61 | | 16.03 | |
| Sample Size | 1,083 | | 669 | | 934 | | 337 | | 132 | |
| Mean (DiD) | 51.30 | | 0.52 | | 61.33 kg | | 153.37 kg | | 121.90 kg | |

| | Beans Produced (Tons) | | Sweet potato Produced (Tons) | | Cassava Produced (Tons) | | Banana produced (Tons) | | Value Added (US$) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| Ben | 161.49 | 244.02 | 175.81 | 259.02 | 68.39 | 65.91 | 56.92 | 53.37 | 3,219,069 | 4,027,837 |
| N-Ben | 93.05 | 119.02 | 32.00 | 53.43 | 21.06 | 32.65 | 25.91 | 45.47 | 2,022,261 | 2,603,336 |
| 1st Diff | 68.45 | 125.00 | 143.81 | 205.59 | 47.33 | 33.25 | 31.01 | 7.90 | 1,196,808 | 1,424,501 |
| 2nd Diff | 56.55 | | 61.78 | | -14.08 | | -23.11 | | 227,693 | |
| Sample Size | 713 | | 292 | | 158 | | 90 | | 702 | |
| Mean (DiD) | 79.37 kg | | 211.58 kg | | -89.11 kg | | -256.80 kg | | 324.35 | |

Ben = Beneficiaries; N-Ben = Non-beneficiaries;

1st Diff = first difference; 2nd Diff = second difference

Source: Survey Data, 2014

### 7.3.2. Willingness to Pay (WTP) for Agricultural Services

In this study, and borrowing from Yang et al. (2007), WTP is hereby regarded as the economic value of a good to an individual. It is also assessed as the maximum sum of money an individual is willing to part with in exchange for an increase in the quantity or quality of a good or service (Agudelo, 2001). In agriculture, WTP is applied in the evaluation of demand and cost curves for extension service delivery through scientists and research scientists. On the other hand, WTP studies are used in the extensive

assessment of markets, goods, services, and products (including TIMPs), as well as for environmental evaluation.

Previous studies found significant relationships between WTP for water or other natural resources and the levels of education of the household head, the total household size, farming experience in terms of years of active farming, land size dedicated to farming, proximity to the resource, access to markets, extension services, credit and training, peoples' attitudes and perceptions on payment (Casey et al., 2005; Adepoju and Omonona, 2009; Mezgebo et al., 2013; Ogunniyi et al., 2011; Wendimu and Bekele, 2011; Addis, 2010; Moffat et al., 2012; Calkins et al., 2002; Rodriguez and Southgate, 2003; Kassahun, 2009; Latinopoulos, 2001; Ulimwengu and Sanyal, 2011; Farolfi et al., 2007; Alhassan, 2012; Illukpitiya and Gopalakrishnan, 2004; Calatrava and Sayadi, 2005).

An overall significant difference ($P \leq 0.05$) was observed between the willingness of the respondents to pay for all the agricultural services (Table 42). This difference was observed among the non-beneficiaries of the regional projects, an indication of either uncoordinated implementation of the projects or widespread heterogeneity in agricultural practices adopted by various farmers. The main cause of the observed heterogeneous practices was the varied choices made by the farmers to plant whatever commodity they chose or observed from their neighbors' farms.

**Table 42:** Across country WTP for agricultural services

| | WTP | Type of HH | Sex | Age | Nativity | HHS | Years of Farming | Hires Labour | Farm Income |
|---|---|---|---|---|---|---|---|---|---|
| WTP | 1 | | | | | | | | |
| Type of HH | -.640* | 1 | | | | | | | |
| Sex | -.055 | .039 | 1 | | | | | | |
| Age | .043 | -.070* | -.062* | 1 | | | | | |
| Nativity | .224* | -.321* | -.039 | .029 | 1 | | | | |
| HH Size | .094* | -.101* | -.049 | .234* | .182* | 1 | | | |
| Years of farming | .034 | -.037 | -.062* | .737* | .020 | .224* | 1 | | |
| Hires labour | .254* | -.395* | -.034 | .037 | .153* | .118** | .029 | 1 | |
| Total Farm (2014) | .171* | -.066* | .003 | .058 | .096* | .061* | .023 | .085* | 1 |

* Correlation is significant at P≤0.05

Source: Survey Data, 2014

On the other hand, there was no significant difference (P≤0.05) among the participants of the regional projects (see Table 53 in Appendix 2 for details). This may be attributed to the fact that the implemented projects and programs are coordinated from central points. In these cases, these projects are coordinated by principal investigators, who are also charged with providing oversight in a series of projects within at least two countries. This central coordination minimizes differences, both within and outside the targeted countries.

The hiring of labour had a positive correlation with the willingness to pay. This arose out of the fact that the respondents, especially the participants in the regional projects were sensitive to market demands and price dynamics. When conducive enabling environments existed, such as through approval of laws or policy reforms, or even when a food deficit was expected in certain locations, more farmers respondent by seeking to meet the demands. They hired more labour and increased application of inputs, thereby meeting the emerging demands.

#### 7.3.2.1. The Theoretical Model for WTP

The economic value of a non-market good to an individual, such as benefits of TIMPs and regional projects can be measured by the magnitude of their WTP for those goods, products and services. As a means of reiteration, WTP is also hereby defined as the amount that must be taken away from an individual's income (to meet the costs of providing the non-market good) while keeping their utility constant. This can be presented in the equation below:

$$\boldsymbol{U(\pi - WTP, \rho, q_1; \Psi) = U(\pi, \rho, q_0; \Psi)} \quad (34)$$

Where

$U$ = Denotes the indirect utility function, and is a measure of the level of stakeholder satisfaction with the good, services or products. It can be expressed as number of *utils* generated.

$\pi$ = Refers to the income of the individual. This measures all the on-farm and off-farm incomes accruable to the respondent under survey.

$\rho$ = This is a vector of prices faced by the individual. It includes all the direct and indirect costs, including costs of inputs, transport, and value addition, among others.

$q_0$ and $q_1$= these are the alternative levels of the non-market goods, services, or products under the baseline and improved conditions as a result of the TIMPs or the regional projects, respectively. This shows that when $q_1 > q_0$, there is an improvement from the baseline (2010) and now (2014).

Ψ = This refers to a vector of individual characteristics that are likely to influence the respondents' choices, thereby leading to a compromised trade-offs made of the characteristic under review.

Based on this equation, it is evident that WTP for any product directly depends on (i) the initial and final level of the goods, products, and services in question ($q_1$ and $q_0$); (ii) the respondent's total income; (iii) prices that the respondent has to pay; and (iv) the respondent's socioeconomic characteristic (e.g., age, level of education, years of farming, and whether respondent saves money from income sources or not).

#### 7.3.2.2. Empirical Model for WTP

During the data analysis, the researcher estimated the respondents' WTP for the available agricultural goods, services and products, including TIMPs and participation in regional projects, by estimating the double-log Ordinary Least Square (OLS), hereby represented as:

$$\boldsymbol{ln\, WTP_i = \beta_0 + \beta_i lnX_i + U_i} \quad (35)$$

Where

$ln\, WTP_i$= The natural log of the dependent variable, here taken as WTP for the services, good, and products

$X_i$ = Is hereby regarded as a vector of explanatory variables

$\beta_0$ and $\beta_i$= these refer to the parameters to be estimated, and whose magnitude are to show the direction and impact of change

$U_i$= This refers to the random error term.

The double log regression is preferred because all the variables are expressed in the natural log, thus enhancing interpretation. The above equation is then transformed to estimate the expected WTP based on the some predictor variables (selected factors and covariates).

$$\boldsymbol{\ln WTP = \beta_0 + \beta_1 \ln EDU + \beta_2 \ln YrF + \beta_3 \ln INC + \beta_4 \ln SAV + \beta_5 \ln HHT + \varepsilon_i} \quad (36)$$

Where

WTP = Farmers' willingness to pay for agricultural services, including TIMPs

EDU = Level of education of household head measured in years of schooling

YrF = Number of years of active farming by the respondents

INC = This parameter assesses the respondents' average total income

SAV = this is an estimate of the respondents' saving style, especially the frequency.

The frequency of saving was presented as follows:

OSAV = refers to respondents who occasionally save

RSAV = these are respondents whose savings was Regular, but not always

ASAV = these are respondents who saved money always

HHT = this disaggregates the respondents into two categories, beneficiaries and non-beneficiaries

$\varepsilon_i$ = Error term

Based on the above procedures and processes, and in order for the researcher to verify these observations, a logistic regression was performed to assess the willingness of the respondents to pay for products and services for the promotion of the regional projects. The model contained seven independent variables thought to directly influence respondents' choices. These included: type of household (i.e., whether the respondent was a direct beneficiary or not); the highest level of education attained; the respondent's length of experience in farming (i.e., number of years of active farming); the total on-farm income generated; whether the respondent had a money-saving scheme; and the frequency of saving the money earned from engagement in other economic activities. The sex and age of the respondents were excluded, given that the initial attempts to fit them in the model yielded very highly insignificant relationships.

The fitted model is presented in the following equation:

$$\ln \boldsymbol{WTP} = \mathbf{2.52} + \mathbf{0.48} \ln \boldsymbol{EDU} + \mathbf{0.02} \ln \boldsymbol{YrF} - \mathbf{1.42} \ln \boldsymbol{SAV} - \mathbf{3.92}\boldsymbol{HHT} + \mathbf{1.83} \ln \boldsymbol{OSAV} + \mathbf{1.43} \ln \boldsymbol{RSAV} + \mathbf{1.34} \ln \boldsymbol{ASAV} \quad (37)$$

The whole model with all predictor variables was statistically significant ($P \leq 0.05$). This shows that the model can distinguish between beneficiaries and non-beneficiaries of regional projects, as well as who was willing to pay for the services or not. It is reasonable to conclude that the model as a whole is capable of explaining between 36.9% (Cox and Snell R-Square) and 55.9% (Nagelkerke R-squared) of the variance in willingness to pay (Pallant, 2013). It also correctly classified 83.9% of the cases. Following regression iterations, only four of the independent variables generated unique statistically significant contribution to the model. These included: the type of household (i.e., beneficiary or non-beneficiary); level of education attained; total on-farm income generated; and the frequency of saving the money earned from income-generating activities. In addition, the most significant frequency the respondents saved money were done either occasionally or somewhat regularly, but not at all times.

The results also indicate that the strongest predictor of the willingness to pay for agricultural products and services was the frequency of ensuring that the revenues generated were saved or invested (Table 43). It recorded an odds ratio of 6.25, thereby indicating that the respondents who occasionally saved their money were over six times more likely to pay for agricultural services and products than those who did save (controlling for all other factors in the model). Similarly, the more educated respondents were over 1.6 times more likely to pay for the products than those with less or none at all.

**Table 43:** Logistic Regression Predicting Likelihood of WTP for services

| | B | S.E. | Wald | df | p | Odds Ratio | 95% C.I. for Odds Ratio | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| Respondent | -3.96 | 0.30 | 178.10 | 1.00 | 0.00 | 0.02 | 0.01 | 0.03 |
| Education | 0.48 | 0.22 | 4.71 | 1.00 | 0.03 | 1.61 | 1.05 | 2.47 |
| Years of farming | 0.02 | 0.02 | 1.24 | 1.00 | 0.27 | 1.02 | 0.99 | 1.06 |
| Income from farming | 0.00 | 0.00 | 25.59 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 |
| Savings? | -1.42 | 0.73 | 3.84 | 1.00 | 0.05 | 0.24 | 0.06 | 1.00 |
| Frequency of savings | | | 7.34 | 3.00 | 0.06 | | | |
| Occasional saving | 1.83 | 0.77 | 5.66 | 1.00 | 0.02 | 6.25 | 1.38 | 28.31 |
| Regular saving | 1.43 | 0.74 | 3.76 | 1.00 | 0.05 | 4.19 | 0.98 | 17.84 |
| Saving always | 1.34 | 0.82 | 2.70 | 1.00 | 0.10 | 3.83 | 0.77 | 18.98 |
| Constant | 2.52 | 0.42 | 35.87 | 1.00 | 0.00 | 12.38 | | |

Source: Survey Data, 2014

#### 7.3.2.3. Adoption of TIMPs

Logistic regression is a popular statistical technique in which the probability of a dichotomous outcome (in this case the adoption or non-adoption of availed TIMPs) is related to a set of explanatory variables that are hypothesized to influence outcomes. Binary logistic regression models can be fitted through the use of Logistic Regression procedure, or at times the Multinomial Logistic Regression procedure. The choices of the procedure depend on the intended results. For instance, the logistic regression procedure is used to generate required predictions, including residuals, influence statistics, as well as the goodness-of-fit tests.

The implicit models of the probability of adoption or non-adoption of the targeted TIMPs by the sample households are determined through the following logit model:

$$\boldsymbol{ln}\left\{\frac{\boldsymbol{P_i}}{\boldsymbol{1-P_i}}\right\}= \beta_0 + \beta_1 SEX_i + \beta_2 AGE_i + \beta_3 EDU_i + \beta_4 HHS_i + \beta_5 NTV_i + \beta_6 OFI_i + \beta_7 FSZ_i + \beta_8 ACC_i + \beta_9 LBF_i + \beta_{10} EXT_i + \beta_{11} FO_i + \beta_{12} LTN_i + \varepsilon_i \quad (38)$$

Where

$P_i$ = adoption status of $TIMP_i$ measured as a dummy

SEX = gender of the respondent

AGE = age in years

EDU = education status

HHS = household size

NTV = nativity of the farmer

OFI = off-farm income

FSZ = farm size

ACC = access to TIMPs

LBF = labour force size

EXT = contact with extension staffs

FO = membership in farmer organizations

LTN = land tenure system

$u_i$= a random error

$i$ = the household.

Regarding the adoption of availed TIMPs, the rate of adoption by the various respondents was determined using the multinomial logistical regression. This regression was performed to assess the level of how QPM as a technology has been adopted among both the beneficiaries and non-beneficiaries of the regional projects implemented in the targeted countries, and especially between 2010 and 2014. The model contained at least 14 independent variables assumed to directly influence the respondents' adoption patterns. Among the key predictors were: type of respondent (direct or indirect); sex; age; nativity; education; household size; length of farming; use of labourers; amount paid to labourers; total household income; membership in regional organization; prior use of the technology; engagement with extension agents; as well as land tenure system.

It is notable that the whole model with all predictor variables was statistically significant ($P \leq 0.05$). This shows that the model can distinguish between beneficiaries and non-beneficiaries of regional projects, as well as who their levels of adoption were. It is practical to conclude that the model as a whole is capable of explaining between 64% (Cox and Snell R-Square) and 89.5% (Nagelkerke R-squared) of the variance in utilization of QPM. It also correctly classified 96.4% of the cases. As is commonly done in regressions of this nature, the regression iterations came up with four independent variables with unique statistical significant contribution to the model. These predictors included: the type of respondents (beneficiary or non-beneficiary); hiring of labourers; amount paid to labourers; and previous use of the technology.

The results also indicate that the strongest predictor of the adoption rate was previous use of the technology (Table 44). It recorded an odds ratio of over 1,440, thereby indicating that the respondents who had had previous experience with some similar TIMPs were over 1,440 times more likely to adopt the QPM technology availed to them than those who had not had any prior experience with such TIMs (controlling for all other factors in the model).

**Table 44:** Logistic Regression Predicting Likelihood of Adopting QPM Technology

| | B | S.E. | Wald | df | p | Odds Ratio | 95% C.I. for Odds Ratio | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| Respondent | 2.36 | 0.97 | 5.98* | 1.00 | 0.02 | 10.62 | 1.60 | 70.62 |
| Sex | 0.19 | 0.85 | 0.05 | 1.00 | 0.82 | 1.21 | 0.23 | 6.39 |
| Age | -0.09 | 0.07 | 1.62 | 1.00 | 0.20 | 0.92 | 0.80 | 1.05 |
| Nativity | 1.14 | 1.36 | 0.71 | 1.00 | 0.40 | 3.13 | 0.22 | 44.77 |
| Education | -1.39 | 0.97 | 2.07 | 1.00 | 0.15 | 0.25 | 0.04 | 1.66 |
| Household size | 0.09 | 0.12 | 0.56 | 1.00 | 0.46 | 1.09 | 0.86 | 1.39 |
| Years of farming | 0.11 | 0.17 | 0.46 | 1.00 | 0.50 | 1.12 | 0.81 | 1.56 |
| Hires labour | -4.13 | 1.51 | 7.48* | 1.00 | 0.01 | 0.02 | 0.00 | 0.31 |
| Amount paid to labourers | 0.02 | 0.01 | 6.36* | 1.00 | 0.01 | 1.02 | 1.00 | 1.03 |
| Total income | 0.00 | 0.00 | 0.01 | 1.00 | 0.93 | 1.00 | 1.00 | 1.00 |
| Membership in organization | -0.76 | 1.04 | 0.53 | 1.00 | 0.47 | 0.47 | 0.06 | 3.63 |
| Previous use of TIMPs | 7.27 | 1.24 | 34.19* | 1.00 | 0.00 | 1,441.29 | 125.87 | 16,504.16 |
| Extension agent | 17.33 | 16,058.39 | 0.00 | 1.00 | 1.00 | | | |
| Land tenure system | | | 4.30 | 4.00 | 0.37 | | | |
| State owned | 1.15 | 8.76 | 0.02 | 1.00 | 0.90 | 3.16 | 0.00 | |
| Private | -0.30 | 2.90 | 0.01 | 1.00 | 0.92 | 0.74 | 0.00 | 220.30 |
| Freehold | 1.27 | 2.85 | 0.20 | 1.00 | 0.66 | 3.54 | 0.01 | 941.07 |
| Customary | 2.29 | 2.99 | 0.59 | 1.00 | 0.44 | 9.91 | 0.03 | 3,467.74 |
| Constant | -21.54 | 16,058.39 | 0.00 | 1.00 | 1.00 | 0.00 | | |

- Significant at P≤0.05

Source: Survey Data, 2014

Generally, the estimated coefficients do not directly indicate the effect of change in the corresponding explanatory variables on the probability of the outcome occurring. Instead, the coefficients reflect the effect of individual explanatory variables on its log of odds ($ln\left\{\frac{P_i}{1-P_i}\right\}$). The positive coefficients indicate that the log of odds increases as the corresponding independent variable increases. In this case, higher values result in a higher probability of adoption, and vice versa. These coefficients in the equation are estimated using the maximum likelihood estimation method.

From this model, the factors influencing rate of adoption of the TIMPs included: age of the respondent, level of education, household size, farm size, nativity, labor force, non-farm sources of income, and membership in farmer organizations. The research showed that the respondents adopting at least one of the TIMPs were between the ages of 25 and 50 years for both male (53%) and female (47%), and varied significantly ($P \leq 0.05$) between those participants engaged in the regional projects and those who were engaged in any other form of projects (Table 45).

**Table 45:** Distribution of Adopters of TIMPs (aged 25 to 50 years)

| | Number (and %) of respondents | | |
|---|---|---|---|
| | Male | Female | Total |
| Beneficiary | 274 (33.17) | 233 (28.21) | 507 (61.38) |
| Non-Beneficiary | 166 (20.10) | 153 (18.52) | 319 (38.62) |
| Total | 440 (53.27) | 386 (46.73) | 826 (100.00) |

Number in parenthesis represents percentage of respondents

Source: Survey Data, 2014

From the findings, younger people are more willing to try out the availed TIMPs, learn how to apply them, and embrace positive change as compared to the older groups. This finding is beneficial in agricultural research for development because it indicates potentials for sustainable agricultural practices unlike if the technology was applied, promoted, and adopted by the old farmers whose active participation in agriculture diminishes with age faster than the youths. Table 46 summarizes the correlations of factors that were identified to affect the adoption of assorted TIMPs.

**Table 46:** Correlations of Factors Affecting Adoption of TIMPs

| | Sex | Age | Edu | HHS | NTV | FSZ | ACC | THH | LBF | TInc | TNF | FO | LTN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | 1.000 | | | | | | | | | | | | |
| Age | -.062* | 1.000 | | | | | | | | | | | |
| Education | -.029 | -.222* | 1.000 | | | | | | | | | | |
| HH size | -.049 | .234* | .014 | 1.000 | | | | | | | | | |
| Nativity | -.039 | .029 | .067* | .182* | 1.000 | | | | | | | | |
| Farm Size | -.080* | .104* | .008 | .129* | .034 | 1.000 | | | | | | | |
| Access to TIMPs | -.073 | -.053 | .069 | .030 | .045 | -.026 | 1.000 | | | | | | |
| HH type | .039 | -.070* | -.203* | -.101* | -.321* | -.081* | .004 | 1.000 | | | | | |
| Labour force | -.034 | .037 | .181* | .118* | .153* | .082* | .083 | -.395* | 1.000 | | | | |
| Total income | .000 | .111* | .061 | -.024 | .051 | -.027 | | .055 | -.015 | 1.000 | | | |
| Non-farm income | -.011 | .087* | .070* | .016 | .046 | .053 | -.029 | -.017 | .033 | .986* | 1.000 | | |
| Farmer Org. | -.014 | -.076* | -.136* | -.085* | -.135* | -.064* | -.003 | .478* | -.258* | -.022 | -.066* | 1.000 | |
| Land tenure | .046 | -.056 | -.014 | -.025 | -.019 | -.014 | -.014 | .044 | -.046 | .064 | .011 | -.022 | 1.000 |

* Significant at $P \leq 0.05$

Source: Survey Data, 2014

There was significant relationship between farm household structure and the decisions on what TIMPs to adopt (Table 47). Nearly 13% more beneficiaries were ready to adopt QPM TIMPs – an indication of potential room for horizontal expansion (or scaling out) of vital TIMPs. However, it was observed that there were no significant differences between beneficiaries and non-beneficiaries, not only on the choices of which TIMPs to adopt, but also in the continued use of the same. Such cases included continued use of QPM in Kenya. It is evident that this technology has been expanded horizontally such that it becomes difficult to restrict its use to only the project implementers. The same scenario was observed on quality seed potato in Kenya; integrated soil fertility management in Kenya; as well as OFSP in Kenya, Rwanda, and Tanzania. The results confirm similar findings by Neill and Lee (2001) and Savadogo et al. (1998), who found a strong and positive relationship between family size and technology adoption.

**Table 47:** Percentage of Adopters of TIMPs

| TIMPs | | Kenya | | Rwanda | | Tanzania | | Uganda | | Burundi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ben | NBen | Ben | NBen | Ben | NBen | Ben | NBen | Ben | NBen |
| QPM | % | 43.8 | 31.3 | 46.8 | 17.0 | 50.6 | 12.4 | 54.7 | 16.3 | 90.9 | 9.1 |
| | P | .102 | | .000 | | .000 | | .000 | | .000 | |
| QSP | % | 71.1 | 22.2 | 86.0 | 5.3 | 63.2 | 5.3 | 71.2 | 10.2 | 73.3 | 2.7 |
| | P | .105 | | .000 | | .007 | | .000 | | .000 | |
| OFSP | % | 55.7 | 11.4 | 62.5 | 6.3 | 73.9 | 8.7 | 42.9 | 0.0 | 46.7 | 0.0 |
| | P | .350 | | .142 | | .435 | | .047 | | - | |
| Bean | % | 59.6 | 17.3 | 63.4 | 22.0 | 21.3 | 14.8 | 52.6 | 27.8 | 66.2 | 10.8 |
| Innovation | P | .000 | | .000 | | .000 | | .000 | | .000 | |
| CLI | % | 90.0 | 5.0 | 81.3 | 12.5 | 83.3 | 0.0 | 81.8 | 9.1 | 74.0 | 0.0 |
| | P | .002 | | .032 | | .001 | | .009 | | .000 | |
| Banana | % | 43.8 | 6.3 | 60.9 | 8.7 | 16.7 | 9.5 | 27.1 | 31.0 | 93.8 | 0.0 |
| | P | .003 | | .000 | | .000 | | .026 | | .000 | |
| IWM | % | 84.7 | 9.2 | 78.6 | 9.8 | 47.4 | 15.8 | 67.9 | 10.7 | 68.9 | 2.2 |
| | P | .000 | | .000 | | .011 | | .054 | | .000 | |
| ISFM | % | 88.2 | 9.8 | 78.0 | 11.9 | 63.6 | 9.1 | 72.7 | 9.1 | 76.5 | 0.0 |
| | P | .739 | | .000 | | .072 | | .187 | | .000 | |

QPM = Quality Protein Maize; QSP = Quality Seed Potato; OFSP = Orange fleshed sweet potato; CLI = crop-livestock integration; IWM = integrated water management; ISFM = integrated soil fertility management; Ben = Beneficiaries; NBen = Non-Beneficiaries

Source: Survey Data, 2014

## 7.4. Conclusion

A significant difference between the willingness of the respondents to pay for agricultural services was observed especially among the non-beneficiaries of the regional projects. This difference arose due to either uncoordinated implementation of the projects or widespread heterogeneity in agricultural practices adopted by various farmers. It was also concluded that the WTP model explained between 36.9% and 55.9% of the variance in willingness to pay, besides correctly classifying 83.9% of the cases.

Following regression iterations, only four independent variables generated unique statistically significant contribution to the model, and these included the type of household (i.e., beneficiary or non-beneficiary); level of education attained; total on-farm income generated; and the frequency of saving the money earned from income-generating activities.

Based on the DiD model, the beneficiary livestock keepers had an extra 0.52 LTU after engaging in the regional projects, an indication that for every 1 LTU owned by the non-beneficiaries, the beneficiaries of these regional projects had 1.52 LTU. Similarly, maize producers received an extra yield of 61.3 kg, a more than double increase in yield of sorghum (153.37 kg) and millet (121.9 kg) compared to non-beneficiary counterparts.

A negative double difference in yields was recorded for cassava (-89.11 kg) and banana (-256.8 kg), mainly due to high levels of shifts of beneficiaries to other more profitable commodities (e.g. QPM and beans). In addition, beneficiaries of regional projects received an average of US$ 324 above their counterparts who had no value addition programs for their commodities.

# CHAPTER EIGHT
# CONCLUSIONS AND RECOMMENDATIONS

## 8.1. Conclusions

**1.** On average, the beneficiaries of the regional projects were slightly older than the non-beneficiaries (by 1.7 years), and had more years of education (1.8 years), thus directly influencing selection and adoption of TIMPs. These beneficiaries had practiced farming for slightly longer duration (11.75 years) compared to non-beneficiaries (11.32 years). This difference had significant influence on the respondents' choices of participation in regional projects, participation in agriculture-based groups, or adoption of the availed TIMPs. The logit model showed that beneficiaries of regional projects were 7.5 times more likely to be members of agriculture-based groups than non-beneficiaries. This group expressed over 82% satisfaction with membership-related benefits.

**2.** The regional projects effectively delivered assorted benefits to the respondents, such as: increased farm-related outputs; early plant maturity and harvest; reduced farm labour and time spent on the farms; increased food security among the targeted households; better nutrition and access to high quality food; better soil and water conservation; increased soil fertility; preservation and conservation of the environment; heightened collaboration among the partners; increased income; capacity building; and increased awareness and adoption of TIMPs.

**3.** The beneficiaries of regional projects recorded at least 26.5% increase in revenues (up from US$ 5.24 million in 2010 to 6.63 million in 2014).These farm-active beneficiaries generated an average of US$ 259 above the non-beneficiaries engaged in off-farm activities. Farm expenditure by beneficiaries increased by 33.7% compared to 45.3% by non-beneficiaries.

**4.** Regarding spillover impacts of regional projects, cassava, millet, striga-resistant sorghum, climbing and bush beans, and low-cost tissue culture banana varieties had significantly benefited the farmers, with productivity exceeding 100% more than the previous varieties planted before adoption of new TIMPs. The main factors controlling spillovers included village characteristics, household size,

education and farmers' skills. Farmer-to-farmer exchange of ideas and materials, and free sharing among the community members was mostly effective during the local community meetings.

5. Regional projects enhanced stakeholders' access to vital information needed to access markets. They regularly received alerts on price changes in various markets and the commodities on high demand. The beneficiaries also benefited from assorted trainings, including application of environmental friendly pesticides and insecticides and good agricultural practices on the TIMPs. The study showed that prior to engagements in regional projects, 70% of the respondents were affected by low household income, poor farming practices, limited accessibility to TIMPs, and limited support from extension staff. The introduction of, and engagement in regional projects contributed to significant reversal of these.

6. Beneficiaries of regional projects recorded22.9% increase in milk production and nearly 5-percentage points increase in TLU above the non-beneficiaries. This was attributed to the 32% increase in acquisition of improved cattle breeds.

7. There was a significant difference between the willingness of the beneficiaries and non-beneficiaries to pay for agricultural services. This difference was due to uncoordinated implementation of the projects and widespread heterogeneity in agricultural practices adopted by various farmers. The WTP model showed that these factors contributed to 36.9 – 55.9% of the variance in willingness to pay. These respondents faced challenges of raising the necessary capital to actually pay for these services since most of them had no sufficient savings or collateral for agricultural loans.

8. Based on the DiD model, the beneficiary livestock keepers had an extra 0.52 LTU after engaging in the regional projects, an indication that for every 1 LTU owned by the non-beneficiaries, the beneficiaries of these regional projects had 1.52 LTU. Similarly, maize producers received an extra yield of 61.3 kg, a more than double increase in yield of sorghum (153.37 kg) and millet (121.9 kg) compared to non-beneficiary counterparts. Similarly, negative double difference in yields was recorded for cassava (-89.11 kg) and banana (-256.8 kg), mainly due to high

levels of shifts of beneficiaries to other more profitable commodities (e.g. QPM and beans). In addition, beneficiaries of regional projects received an average of US$ 324 above their counterparts who had no value addition programs for their commodities.

**9.** The main challenges faced in implementing the regional projects included: low crop and livestock productivity; high post-harvest handling losses; limited value addition through processing and utilization; limited markets; poor policy environment, including unfavourable policy framework and credit; degraded environment; and limited knowledge and information exchange.

### 8.2. Recommendations

**1.** The research indicated that the farmers who engaged in regional projects still incurred increased farm expenditure by over 33%, compared to over 45% by non-beneficiaries. Given that these figures are still high, thus likely to reduce net profits, new cost-reducing approaches should be explored, such as introducing subsidies and tax exemptions on all farm inputs.

**2.** Sustainable profitability of smallholder farming is possible. The farmers need to be linked to agri-food value chains, while institutional innovations for vertical and horizontal coordination among these farmers need bolstering. Among the targeted innovations include booster capital for group lending, establishment and/or strengthening of rural marketing cooperatives and farmer groups, and facilitation of producer associations to access low-cost equipment.

**3.** In order to enhance spillover effects, even among the non-beneficiaries, it is further recommended that strategic and demand-driven capacity strengthening initiatives be introduced to the non-beneficiaries. Vital information needed to access markets, such as information on commodity prices in different markets, highly demanded commodities, and alerts on price elasticity should also be promoted widely to these groups.

**4.** As part of ensuring sustainable productivity in major farming systems, the five governments, through the East African Community charter should aim at further

transforming production systems, mainly by promoting the adoption of available TIMPs. This can be done through fast tracking of policies aimed at removing restrictions of movement of tested and approved TIMPs; creating enabling policy environment that ensure cross-border trade and exchange of affordable crop and livestock breeds; as well as fostering agricultural mechanization among the smallholder farmers.

5. Given that results showed some variability in farm productivity across the five countries and within similar commodities, these variability need to be further jointly investigated and the causes documented and addressed. Farmer-centred research methods, such as participatory technology development, which involve farmers in all stages of the research process, would be most appropriate for this.

6. Following the observed risks and challenges faced by the smallholder farmers in the five countries, especially price and weather shocks, it is hereby recommended that these farmers, especially non-beneficiaries of regional projects, be introduced to risk-management tools and strategies that increase their resilience to these shocks. Among the targeted tools and mechanisms include: introduction and adoption of new TIMPs; promotion of information and communication technologies for real-time market information; and switching to high-value crops.

### 8.3. Possible future research

The contributions of regional projects in household food security through adoption of regional TIMPs were discussed in the different chapters in this research. Notwithstanding the effort made by implementers of these regional projects, a lot still remains to be explored. The following proposals for future research are worth exploring:

1. The study indicated that spillover effects were already felt among the targeted beneficiaries. Given also that more people were reached through the promotion of the best practices by the beneficiaries, further research is needed to explore the trends in spillovers of not only the selected TIMPs in this study, but also other TIMPs excluded by the researcher.

2. In order to ensure increased incentives to smallholder farmers, especially the youths, there is need for increased capital flows towards on-farm activities. On the other hand, increased capital flows to these targeted groups require appropriate channels and instruments. Based on this, there is need to explore the variability and benefits of these appropriate innovative services, and how they can be scaled up and scaled out.

3. Despite continuous efforts and significant investments by agricultural development projects to introduce new agricultural TIMPs to smallholder farmers, existing studies on farmers' adoption or dis-adoption of these TIMPs are largely limited in their scope and are inherently resource and time-demanding to scale-out in large areas. There is need to design a suite of cost-effective data collection protocols using ICT-assisted methods and to analyze the spatial diffusion pattern of select agricultural TIMPs.

4. Given the increasing demand by various stakeholders on the TIMPs adoption evidences, including geo-referenced data illustrating the rate and geographical extent of specific agricultural technologies adopted by smallholder farmers, there is need for further research to meet the demand and generate such evidences through ICT-assisted data collection tools and geospatial analytics.

5. Given that majority of the stakeholders adopted new TIMPs in the regional projects, it was not very clear how long the TIMPs were used before being abandoned for other newer ones. There is need for more research to monitor the lifecycle of TIMPs in temporally- and spatially-explicit ways, taking advantage of accessible ICT-assisted data collection tools and techniques. The generated evidence-base are anticipated to help researchers and donors better understand how the improved agricultural TIMPs research and development can be best targeted and prioritized for their maximum impacts on sustainable food security.

## REFERENCES


ADB. (2010). Asian Development Bank. Annual Report

Abdulai, A., Johnson, M. and Diao, X. (2006). Leveraging regional growth dynamics in African agriculture. *African Journal of Agricultural and Resource Economics* 1 (1): 49–66.

Addis, T. (2010). Economic valuation of irrigation water: The case of Erere Woldia irrigation project in Harari Regional State, Ethiopia. MSc. Thesis, Addis Ababa University, Ethiopia.

Adegbite, D.A. (2009). Repayment performance of beneficiaries of Ogun State Agricultural and Multipurpose Credit Agency (OSAMCA) in Ogun State, (2004-2007). *American-Eurasian Journal of Sustainable Agriculture* 3 (1): 117–125.

Adejobi, O. and Atobatele, J.T. (2008). An analysis of loan delinquency among small-scale farmers in southwestern Nigeria: Application of logit and loan performance indices. *East African Agricultural and Forestry Journal* 74 (3).

Adeleke, S., Kamara, A.B. and Brixiova, Z. (2010). Smallholder agriculture in East Africa: Trends, constraints and opportunities, Working Papers Series N° 105. African Development Bank, Tunis, Tunisia.

Adepoju, A.A. and Omonona, B.T. (2009). Determinants of willingness to pay for improved water supply in Osogbo Metropolis, Osun State, Nigeria. Department of Agricultural Economics, Ladoke Akintola University of Technology.

Adesina, A.A. (1996). Factors affecting the adoption of fertilizers by rice farmers in Côte d'Ivoire. *Nutr. Cycling Agroecosyst*. 46, 29–39.

Adesina, A. A., Abbott, P. C. and Sanders, J. H. (1988). Ex-ante risk programming appraisal of new agricultural technology: experiment station fertilizer recommendations in Southern Niger. *Agricultural Systems, 27*(1), 23-34.

Adesina A. A. and Sirajo S. (1995). Farmers' perceptions and adoption of new agricultural technology: analysis of modern mangrove rice varieties in Guinea-Bissau. *Q. J. Int. Agric* 34 (4), 358-371.

Adjeberg-Asem, S. (1988). Social factors influencing the translation of innovation into entrepreneurship. IDRC, May.

Agnet. (2004). Making farm credit work for the small-scale farmers. <<http://www.agnet.org/library/nc/145b/>> Accessed on July 20, 2010.

Agudelo, J.I. (2001). The economic valuation of water: Principles and methods. Value of water research report series No.5. IHE Delft, Netherlands.

Ahmed, M. M., Sanders, J.H. and Nell, W.T. (2000). New sorghum and millet cultivar introduction in sub-Saharan Africa: impacts and research agenda. *Agricultural Systems* 64: 55–65.

Akinola, A. A. (1986). Determinants of diffusion of cocoa-spraying chemicals among Nigerian cocoa farmers. *Agricultural Systems, 22*(3), 191-202.

Alhassan, M. (2012). Estimating farmers' willingness to pay for improved irrigation: An Economic study of the Bontanga irrigation scheme in Northern Ghana. MSc. Thesis, Colorado State University.

Alston, J. M. (2002). Spillovers. *The Australian Journal of Agricultural and Resource Economics* 46 (3): 315–346.

Alston, J.M., Andersen, M.A., James, J.S. and Pardey, P.G. (2010). *Persistence pays: U.S. agricultural productivity growth and the benefits from public R&D spending.* New York: Springer.

Alston, J.M., Norton, G.W. and Pardey, P.G. (1995). *Science under Scarcity: Principles and practices for agricultural research evaluation and priority setting.* Ithaca: Cornell University.

Alston, J.M., Marra, M.C., Pardey, P.G., Wyatt, T.J. (2000). "Research returns *redux*: A meta-analysis of the returns to agricultural R&D". *Australian Journal of Agricultural Resource Economics* 44 (2), 185–215.

Amemiya, T. (1981). Qualitative response models: a survey. *Journal of Economic Literature* 19: 1483–1536.

Amwata, D.A., Dickson, M.N. and Nasho, R.K.M. (2015). Factors influencing pastoral and agropastoral household vulnerability to food insecurity in the drylands of Kenya: A case study of Kajiado and Makueni Counties. *Journal of International Development*. DOI: 10.1002/jid.3123

ASARECA/IFPRI, 2005. *Strategic priorities for agricultural development and agricultural research for development in ECA*. Entebbe: Association for Strengthening Agricultural Research in Eastern and Central Africa. pp

AUC (African Union Commission). 2003. *Maputo Declaration on food security*. Addis Ababa.

_____. 2006. “Declaration of the Abuja Food Security Summit”. Abuja, Nigeria, 4-5 December.

_____. 2014. “Malabo Declaration on accelerated agricultural growth and transformation for shared prosperity and improved livelihood. Doc. Assembly/AU/2(XXIII).

Bagi, F.S. (1983). A logit model of farmers’ adoption decisions about credit. Southern *Journal of Agricultural Economics*. 15, 13–19.

Balmford, A., Green, R. and Phalan, B. (2012). “What Conservationists Need to Know about Farming.” *Proceedings of the Royal Society* B 279: 1–12. http://rspb.royalsocietypublishing.org/content/early/2012/04/24/rspb.2012.0515.full.pdf+html.

Bantilan, M.C.S. and Davis, J.S. (1991). Across-commodity spillover effects of research and opportunity costs in a multiproduct production environment. ACIAR/ISNAR Project Paper Series no. 30. Canberra, Australia: Australian Centre for International Agricultural Research and The Hague: International Service for National Agricultural Research.

Barrett, C.B. (2002). Food security and food assistance programs. *In* B.L. Gardner & G.C. Rausser, eds. *Handbook of Agricultural Economics*. Vol. 2B (2103–2190). Amsterdam, Elsevier.

Beintema, N.M., and Stads, G.J. (2006). *Agricultural R&D in Sub-Saharan Africa: An era of stagnation.* ASTI (Agricultural Science and Technology Indicators). Background Report. *Washington, DC: International Food Policy Research Institute (IFPRI)*.

_____. 2011. *African Agricultural R&D in the New Millennium: Progress for some, challenges for many*. Washington, DC: International Food Policy Research Institute (IFPRI).

Benin, S., Nim Pratt, A., Wood, S. and Guo, Z. (2011). *Trends and spatial patterns in agricultural productivity in Africa, 1961-2010*. ReSAKSS Annual Trends and Outlook Report 2011. International Food Policy Research Institute (IFPRI).

Berdegue, J. and Escobar, G. (2003). Meta-analysis of reviews and evaluation of ecoregional programs. Report for the Science Council. CGIAR (Consultative Group on International Agricultural Research), Washington, DC, USA.

Berner, D.K., Kling, J.G. and Singh, B.B. (1995). Striga research and control. A perspective from Africa. *Plant Disease* 79: 652-660.

Besley, T. (1995). Property rights and investment incentives: Theory and evidence from Ghana. *Journal of Political Economy* 103(5): 903-937.

Bertrand, M., Duáo, E. and Mullainathan, S. (2004). How much should we trust difference-in-differences estimates? *Quarterly Journal of Economics* 119(1): 249-275.

Bindhumadhavan, P.R. (2005). Executive summary of round table discussion on "Crop diversification and water resource management: More crops per drop". Tamil Nadu State Planning Commission, Chennai, India.

Binswanger-Mkhize, H. and A.F. (2009).*The Changing Context and Prospects for Agricultural and Rural Development in Africa*. Rome and Tunis: International Fund for Agricultural Development and African Development Bank.

Blackledge, J. (1979). A joint UNDP/UNIDO report on industrial research and service institutes. UNIDO.

Blum, A. (1989). Use of different information sources for decision making by traditional farmers in a progressive knowledge system. *Journal of Extension Systems* 5, 60–73.

Blumberg, B., Cooper, D. and Schindler, P. (2008). Business Research Methods.2nd European Edition. McGraw-Hill Education.

Bryman, A. and Bell, E. (2007). *Business Research Methods*. 2nd Edition. Oxford University Press.

Bryson, J. (1995).*Strategic Planning for Public and Nonprofit Organizations* (rev. edn), San Francisco, CA: Jossey- Bass.

Byerlee, D. (1995). On the comparative advantage of international agricultural research: exploiting economies of size to generate global spillovers. Presented at the workshop on 'Integration of Research Efforts of ICRISAT with NARSs and with other International Research Institutions, 14-16 Dec 1994, ICRISAT, Hyderabad, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Byerlee, D. and Eicher, C.K. (1997). *Africa's Emerging Maize Revolution*. Boulder, CO: Lynne Rienner.

CAB International. (2011). The Food and financial crises in sub-Saharan Africa: Origins, impact and policy implications (eds D.R. Lee and M. Ndulo). Pp

Calatrava, J.L. and Sayadi, S. (2005). Economic valuation of water and willingness to pay analysis with respect to tropical fruit production in south eastern Spain. *Spanish J. Agric. Res*. 3(1):25-33.

Calkins, P., Larue, B. and Vézina, M. (2002). Willingness to pay for drinking water in the Sahara: The case of Douentza in Mali. *Cahiers d' Econ. Sociol. Rurales* 64:37-56.

Casey, J.F., Kahn, J.R. and Rivas, A. (2005). Willingness to pay for improved water services in Manaus, Amazonas, Brazil. *Ecological Economics*.

Casley, D.J. and Lury, D.A. (1987). *Data Collection in Developing Countries*, 2nd ed. London: Oxford University Press.

Charles, H., Godfray, J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M. and Toulmin, C. (2010). Food security: The challenge of feeding 9 billion people. *Science*, *327*(5967), 812-818.

Chema, S., Roseboom, J. and Gilbert, E.(2004). *A review of key issues and recent experiences with reforming agricultural research in Africa*. ISNAR Research Report 24. The Hague: International Service for National Agricultural Research.

Chisnall, P. M. (1997). *Marketing Research* (5th edition), London: McGraw-Hill.

Conway, G. and Toenniessen, G. (2003). Science for African food security. *Science*, Feb 21 2003, 1187-1188.

Cook, T.D., Shadish, W.R. and Wong, V.C. (2008). Three conditions under which experiments and observational studies produce comparable causal estimates: New findings from within-study comparisons. *Journal of Policy Analysis and Management.* 27(4):724-750.

Cooper, D. and Schindler, P. (2003). *Business Research Methods*. 8th Edition. McGraw Hill.

Cotlear, D. (1986). 'Technological and institutional change among the Peruvian peasantry''. D. Phil. Dissertation, Oxford University.

de Janvry, A. and Kassam, A.H. (2001). Advantages and Added Value of the Regional Approach to Research for the International Agricultural Research System. Reunion FORAGRO Sobre Prioridades Regionales de Investigacion, CIMMYT, Mexico D.F., 2 al 4 de Mayo del 2001, pp

de Janvry, A. and Kassam, A.H. (2004). Regional approach to research for the CGIAR and its partners.

Devellis, R.F. (2003). *Scale Development: Theory and Application*, second edition, Thousand Oaks, California: Sage

Diao, X., Thurlow, J., Benin, S. and Fan, S. (2012). Strategies and Priorities for African Agriculture: Economywide Perspectives from Country Studies. IFPRI issue brief 73

Diaz, J. J. and Handa, S. (2005). An Assessment of Propensity Score Matching as a Non-experimental Impact Estimator: Evidence from Mexico's PROGRESA Program. *Journal of Human Resources*. 41(2): 319-345.

Dillenbourg, P. (1999). *Collaborative learning: Cognitive and computational approaches*. Advances in Learning and Instruction Series. New York, NY: Elsevier Science, Inc.

Dillenbourg, P. (1999). What do you mean by 'collaborative learning? In P. Dillenbourg (Ed.), *Collaborative-learning: Cognitive and computational approaches* (pp.1–19). Oxford: Elsevier.

Dixon J., Tanyeri-Abur, A. and Wattenbach, H. (2003). Context and framework for approaches to assessing the impact of globalization on smallholders, In Dixon J., K. Taniguchi and H. Wattenbach edited, Approaches to assessing the impact of globalization on African smallholders: Household and village economy modeling. Proceedings of working session globalization and the African smallholder study, FAO and World Bank, Rome, Italy, Food and Agricultural Organization United Nations.

EAC Facts and Figures Report, 2014.

Eicher, C. K. (2003). Flashback: Fifty years of donor aid to African agriculture. In *CTA conference on successes in African agriculture, Pretoria, South Africa, December 1–3, 2003*, Conference Paper No. 16. Washington, DC: International Food Policy Research Institute.

Eponou, T. (1998). Financing Research Through Regional Cooperation. In *Financing Agricultural Research: A Sourcebook*. The Hague, ISNAR GFAR Secretariat. 2001.

Errington, A. (1986). The delegation of decisions on the farm. *Agricultural Systems* 19, 299–317.

Ervin, C.A. and Ervin, D.E. (1982). Factors affecting the use of soil conservation practices: Hypothesis, evidence and policy implications. *Land Economics.* 58 (3): 277-292.

Evenson, R.E. (2001). Economic impacts of agricultural research and extension. In: Gardner, B., Rausser, G. (Eds.), *Handbook of Agricultural Economics*, vol. 1. Elsevier Science, Amsterdam. Ch. 11.

Evenson, R.E. (1989). Spillover Benefits of Agricultural Research: Evidence from US Experience. *American Journal of Agricultural Economics* 71 (2): 447–452.

FAO (Food and Agriculture Organization of the United Nations). (2002). The state of food insecurity in the world 2001. Rome: FAO.

_____ (2003). *Trade reforms and food security: Conceptualizing the linkages*. Rome: Commodity Policy and Projections Service, Commodities and Trade Division, FAO.

_____ (2011). *Global food losses and food waste – extent, causes and prevention*. Rome.

_____(2013). *FAO Statistical Yearbook, 2013*. Rome: Commodity Policy and Projections Service, Commodities and Trade Division, FAO.

FAOSTAT (2013), *On-line database*, FAO, Rome, *http://faostat.fao.org/*.

FARA (Forum for Agricultural Research in Africa). (2008). *A review of selected multi-country agricultural and natural resources management research programmes and projects in Africa: Lessons for the future.* Accra, Ghana. 68 pp.

Farolfi, S., Mabugu, R. and Ntshingila, S. (2007). Domestic water uses and values in Swaziland: A Contingent Valuation Analysis. *Agrekon* 46(1):157-170.

Feder, G., Just, R.E. and Zilberman, D. (1985). Adoption of agricultural innovations in developing countries: A survey. *Economic Development and Cultural Change* 33(2): 255-298.

Feder, G., Onchan, T., Chalamwong, Y. and Hongladarom, C. (1988). Land Policies and Farm Productivity in Thailand. Baltimore, Md.: Johns Hopkins University Press

Fiore, S., Rosen, M., Smith-Jentsch, K., Salas, E., Letsky, M. and Warner, N. (2010). Toward an understanding of macro-cognition in teams: Predicting process in complex collaborative contexts. *The Journal of the Human Factors and Ergonomics Society, 53,* 203-224.

Flores-Moya, P., Evenson, R.E. and Hayami, Y. (1978). Social returns to rice research in the Philippines: Domestic benefits and foreign spillover. *Economic Development and Cultural Change* 26 (3), 591–607.

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., Mueller, N. D., O'Connell, C., Ray, D. K., West, P.C., Balzer, C., Bennett, E.M., Carpenter, S.R., Hill, J., Monfreda, C., Polasky, S., Rockström, J., Sheehan, J., Siebert, S., Tilman, D. and Zaks, D. P. M. (2011). Solutions for a cultivated planet. *Nature* 478: 337–342.

Ford, S.A., Babb, E.Y. (1989). Farmers sources and use of information. *Agribusiness* 5, 465–476.

Fuglie, K.O. and Walker, T.S. 2001. Economic Incentives and Resource Allocation in U.S. Public and Private Plant Breeding. *Journal of Agricultural and Applied Economics 33(3):459–73*.

Funke, J. (2010). Complex problem solving: A case for complex cognition? *Cognitive Processes, 11,* 133- 142.

Gabre-Madhin, E. Z., and Haggblade, S. (2004). Successes in African Agriculture: Results of an Expert Survey. *World Development* 32: 745–766.

GAP Report. (2012). Global Harvest Initiative. Washington, D.C.

Garnett, T., Appleby, M. C., Balmford, A., Bateman, I. J., Benton, P. Bloomer, B. Burlingame, M. Dawkins, L. Dolan, D. Fraser, M. Herrero, I.T., Hoffmann, G., Smith, P., Thornton, P.K., Toulmin, C., Vermeulen, S. J. and Godfray,H. C. J. (2013). "Sustainable Intensification in Agriculture: Premises and Policies." *Science* 341: 33–34.

Gijsbers, G. and Contant, R. (1996). Regionalization of Agricultural Research: Selected Issues. *Briefing Paper 28.*The Hague: ISNAR.

Glaister, K. (1989). The entrepreneur. Heinnemann

Glaser, R., Linn, R. and Bohrnstedt, G. (1997). *Assessment in Transition: Monitoring the Nation's Educational Progress*. National Academy of Education.

Glazerman, S., Levy, D.M. and Meyers, D. (2003): "Non-experimental versus experimental estimates of evaluating earning impacts, in: *Annals of the American Academy of Political and Social Science* 589, 63–93

Godfray, H.C.J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M. and Toulmin, C. (2010). Food security: the challenge of feeding nine billion people. *Science*, 327: 812–818.

Gould, B.W., Saupe, W.E. and Klemme, R.M. (1989). Conservation tillage: the role of farm and operator characteristics and the perception of erosion. *Land Econ.* 65, 167–182.

Hares, J. and Royle, D. (1994). *Measuring the Value of Information Technology*. Wiley, Chichester.

Hacker, D.J., Dunlosky, J. and Graesser, A. C. (Eds.). (2009). *Handbook of meta-cognition in education*. Mahwah, NJ: Erlbaum/Taylor and Francis.

Hatibu, N., Banadda, N., Ayaa, F. and Mawanda, H. (2011). Development of Agro-industries and agribusiness as an alternative to large scale leasing of land. Paper presented at the Regional Policy Dialogue on FDI in Agriculture in Eastern Africa.

Heckman, J. and Navarro-Lozano, S.(2004). Using matching, instrumental variables and control functions to estimate economic choice models. *The Review of Economics and Statistics* 86 (1): 30-57.

Heckman, J., Ichamura, H. and Todd, P. (1997). Matching as an econometric evaluation estimator: Evidence from evaluating a job training programme. *Review of Economic Studies* 64 (4): 605–654.

Heckman, J., Ichamura, H. and Todd, P. (1998). Matching as an econometric evaluation estimator. *The Review of Economics Studies* 65 (2): 261-694.

Heckman, J., Ichamura, H., Smith, J.A. and Todd P.E. (1998). Characterizing selection bias using experimental data. *Econometrica*66, 1017–1098.

Heisey, P., Sun L.W. and Keith F. (2011).*Public agricultural research spending and future U.S. agricultural productivity growth: Scenarios for 2010-2050*, EB-17, U.S. Department of Agriculture, Economic Research Service, July 2011.ppp

Henry, G.T. and Yi, P. (2009). "Design Matters: A within-study of propensity score matching designs." Paper presented at the meeting of the Association for Public Policy Analysis and Management. Washington, DC. Nov. 7, 2009.

Hossain, S. M. A. and Crouch, B. R. (1992). Patterns and determinants of adoption of farm practices: some evidence from Bangladesh. *Agricultural Systems, 38*(1), 1-15.

Hox, J. and Boeije, H. (2005). Data Collection, Primary vs. Secondary. Encyclopaedia of Social Measurement, Vol. 1, pp. 593-599.

Huffman, W.E. and Evenson, R.E. (2006). *Science for agriculture—A long-term perspective*. Second edition, Blackwell Publishing.

IITA. (2012). IITA's Refreshed Strategy 2012-2020.

Illukpitiya, P. and Gopalakrishnan, C. (2004). Decision-making in soil conservation: Application of a behavioural model to potato farmers in Sri Lanka. *Land Use Policy*. 21(4):321-331.

International assessment of agricultural knowledge, science and technology development (IAASTD, 2009): sub-Saharan Africa (SSA) report. Edited by Beverly D. M., H.R. Herren, J. Wakhungu, and R.T. Watson.

Jahnke, H. E. (1982). *Livestock Production Systems in Livestock Development in Tropical Africa.* Kiel, Germany: Kieler Wissenschaftsverlag Vauk.

Jarvis, L.S. (1981). Predicting the diffusion of improved pastures in Uruguay. *American Journal of Agricultural Economics* 63: 495–502.

Johnson, M., Benin, S., Diao, X. and You, L. (2011). *Prioritizing Regional Agricultural R&D Investments in Africa: Incorporating R&D Spillovers and Economy-wide Effects*. Working Paper 15, ASTI/FARA Conference on Agriculture R&D: Investing in Africa's Future, Accra, Ghana, December 5-7.

Johnson, M., Masters, W.A. and Preckel, P.V. (2006). Diffusion and Spillover of New Technology: A Heterogeneous-Agent Model for Cassava in West Africa. *Agricultural Economics* 35 (2): 119–129.

Kanampiu, F.K., Kabambe, V., Massawe, C., Jasi, L., Friesen, D., Ransom, J.K. and Gressel, J. (2003). Multi-site, multi-season field tests demonstrate that seed coating herbicide-resistance maize controls SPP and increase in yields in several African countries. *Crop Protection* 22:697-706

Kassahun, H.T. (2009). Payment for environmental service to enhance resource use efficiency and labour force participation in managing and maintaining irrigation infrastructure, the case of Upper Blue Nile basin. PhD Thesis, Cornell University.

Kebede, Y., Gunjal, K. and Coffin, G. (1990). Adoption of new technologies in Ethiopian agriculture: the case of Tegulet-Bulga District, Shoa Province. *Agricultural Economics* 4: 27–43.

Keya, S. and Rubaihayo, P. (2013). Progress in on-farm production and productivity in the EAC: 50 years after independence.

Khan, Z.R., Overholt, W.A., Hassanali, A., Chiliswa, P., Wandera, J., Muyekho, F., Pickett, J.A., Smart, L.E. and Wadhams, L.J. (1999). An integrated management of cereal stemborers and striga weed in a maize-based cropping

system in Africa. In: CIMMYT and EARO. Maize Production Technology for future: Challenges and Opportunities. Procedures of the Sixth Eastern and Southern Africa Regional Maize Conference. Addis Ababa, Ethiopia: CIMMYT. pp 190-193.

Khandker, R.S., Koolwal, G.B. and Samad, H.A. (2010). *Handbook on impact evaluation: Quantitative methods and practices*. Washington, DC: World Bank.

Kilimo Trust, EAC, UNIDO and FAO. (2011). Report on regional workshop and policy dialogue. Development of agro-industries and agro-Enterprises in the EAC region.

Kristjanson, P., Mango, N., Krishna, A., Radeny, M. and Johnson, N. (2010). Understanding poverty dynamics in Kenya. *Journal of International Development, 22*(7), 978-996.

Krueger, A.B. (1993). How computers have changed the wage structure: Evidence from microdata, 1984-1989. *Quarterly Journal of Economics* 108 (February) 33-60.

Lapar, M. L. A. and Ehui, S. K. (2004). Factors affecting adoption of dual-purpose forages in the Philippine uplands. *Agricultural Systems, 81*(2), 95-114.

Latinopoulos, P.Z.M. (2001). Willingness to pay for irrigation water: A case study in Chalkidiki, Greece. Aristotle University of Thessaloniki, Greece.

Likert, R. (1932).A Technique for the measurement of attitudes. *Archives of Psychology* 140:1-55.

Lipton, D., Wellman, K., Sheifer, I. and Weiher, R. (1995). Economic valuation of natural resources: A guidebook for coastal resources policymakers. NOAA Coastal Ocean Program Decision Analysis Series No. 5. Available online: www.mdsg.umd.edu/Extension/valuation/handbook.htm

Liverpool-Tasie, L.S., Kuku, O. and Ajibola, A. (2011). *Review of literature on agricultural productivity, social capital, and food security in Nigeria.* Nigeria Strategy Support Program Working Paper 21. Washington, DC: International Food Policy Research Institute.

Lleras-Muney, A. and Lichtenberg, F. (2002). "The Effect of education on medical technology adoption: Are the more educated more likely to use new drugs?" *NBER Working Paper #9185*.

Mackill, D. J., Singh, U.S., Thomson, M.J., Septiningsih, E. and Kumar, A. (2010). "Technological Opportunities for Developing and Deploying Improved Germplasm for Key Target Traits." In *Rice in the Global Economy: Strategic Research and Policy Issues for Food Security*, edited by S. Pandey, D. Byerlee, D. Dawe, A. Dobermann, S. Mohanty, S. Rozelle, and B. Hardy, 433–448. Los Baños, the Philippines: International Rice Research Institute.

Maddala, G.S. (1983). Limited dependent and qualitative variables in econometrics. Cambridge, U.K.: Cambridge University Press.

Mallawaarachchi, T., Walcott, J., Hughes, N., Gooday, P., Georgeson, L. and Foster, A. (2009). *Promoting productivity in the agriculture and food sector value chain: issues for R&D investment*, ABARE and BRS report to the Rural R&D Council, Canberra, December.

Maredia, M. 2009. *Improving the proof: Evolution of and emerging trends in impact assessment methods and approaches in agricultural development*. Discussion Paper 929. Washington, D.C.: International Food Policy Research Institute.

Maredia, M. K., and Byerlee, D. (2000). Efficiency of Research Investments in the Presence of International Spillovers: Wheat Research in Developing Countries. *Agricultural Economics* 22 (1): 1–16.

Mayer, R.E. (1998). Cognitive, meta-cognitive, and motivational aspects of problem solving. *Instructional Science, 26,* 49-63.

Mezgebo, A., Tessema, W. and Asfaw, Z. (2013). Economic Values of Irrigation Water in Wondo Genet District, Ethiopia: An Application of Contingent Valuation method. *J. Econ. Sustain. Develop*. 4(2):23-36.

Moffat, B., Motlaleng, G.R. and Thukuza, A. (2012). Households' willingness to pay for improved water quality and reliability of supply in Chobe Ward, Maun. Botswana. *J. Econ.* 8(12):45-61.

Moser, C. M. and Barrett, C. B. (2003). The disappointing adoption dynamics of a yield-increasing, low external-input technology: the case of SRI in Madagascar. *Agricultural Systems, 76*(3), 1085-1100.

Mtei K., Ngome F.A., Wambua S. and Becker M. (2013). Assessment of Technology Options Addressing Agricultural Production Constraints in Western Kenya, *Greener Journal of Agricultural Sciences* Vol. 3 (3), (2013) 222-234

Mugisha, J., Madsen, O., Tumusiime, E. and Byekwaso, J. (2004). Performance of farmers led extension system in agricultural technology transfer and adoption, *Uganda J. Agric. Sci.*, 9: 730–735

Mugunieri, L.G., Nyangito, H.O. and Mose, L.O. (1997). Agronomic and socio-economic factors determining maize yield response to fertilizers in western Kenya. *African Crop Sci. Conf. Proc.*, 1: 134–136.

Murphy, K. E. and Simon, S. J. (2002). Intangible benefits valuation in ERP projects. *Information Systems Journal*, *12*(4), 301-320.

Nankinga, C.M., Ogenga-Latigo, M.W., Allard, B.G. and Ogwang, J. (1994). Potential of *Bauveria bassiana* for control of banana weevil in Uganda. *African Crop Sci. Conf. Proc.*, 1: 300–302.

Negatu, W.and Parikh, A. (1999). The impact of perception and other factors on the adoption of agricultural technology in the Moret and Jiru Woreda (district) of Ethiopia. *Agricultural Economics*, *21*(2), 205-216.

Neill, S.P. and Lee, D.R. (2001). Explaining the adoption and dis-adoption of sustainable agriculture: the case of cover crops in Northern Honduras. *Economic Development and Cultural Changes*, *49*(4), 793-820.

Nelson, R.R. and Phelps, E.S. (1966). Investment in humans, technological diffusion, and economic growth. *American Economic Review* 56(1/2), 69–75

Nin Pratt, A., Johnson, M., Magalhaes, E., You, L., Diao, X. and Chamberlin, J. (2011). *Yield gaps and potential agricultural growth in West and Central Africa*. Washington, DC: International Food Policy Research Institute (IFPRI).

Nkonya, E., Babigumira, R. and Walusimbi, R. (2001). Soil conservation by- laws: Perceptions and enforcement among communities in Uganda. Mimeo. Washington, D.C. Environment and Production Technology Division, International Food Policy Research Institute.

Nweke, F., Spencer, D.S.C. and Lynam, J.K. (2002). *The cassava transformation: Africa's best-kept secret*. East Lansing, MI: Michigan State University Press.

Nyariki, D.M. (1997). Resource Availability and Productivity, Farmer Efficiency and Household Food Security in Semi-Arid Kenya, Ph.D. Thesis, Department of Agricultural and Food Economics, University of Reading, Reading, UK.

Nyariki, D.M. (2011). Farm Size, Modern Technology Adoption, and Efficiency of Small Holdings in Developing Countries: Evidence From Kenya. *Journal of Developing Areas*, 45(1), 35-52.

Nyariki D.M. and Thirtle, C. (2000). "Technical innovation and farm productivity growth in dryland Africa: the effects of structural adjustment on smallholders in Kenya". *Agrekon*, Vol 39, No.4: 597- 606

O'Neil, H.F. (1999). Perspectives on computer-based performance assessment of problem solving: Editor's introduction. *Computers in Human Behavior, 15,* 255-268.

Odongo, O.M., Abayo, G., Ransom, J.K., Ojiem, J., DeVries, J. and Kling, J. (1999). *Striga hermonthica* control strategy through maize variety resistance/tolerance in Western Kenya. In: CIMMYT and EARO. Maize production for future: Challenges and opportunities. Procedures of the Sixth Eastern and Southern Africa Regional Maize Conference. Addis Ababa, Ethiopia.

Ogunniyi, L.T., Sanusi, W.A. and Ezekiel, A.A. (2011). Determinants of rural household willingness to pay for safe water in Kwara State, Nigeria. Aquaculture, Aquarium, Conservation and Legislation. *Int. J. Bioflux* 4(5):660-669.

Okojie, C., Monye-Emina, A., Eghafona, K., Osaghae, G. and Ehiakhamen, J.O. (2010). Institutional environment and access to microfinance by self-employed women in the rural areas of Edo State. NSSP Brief No. 14. Washington. D.C.: International Food Policy Research Institute.

Omamo, S. W., Diao, X., Wood, S., Chamberlin, J., You, L., Benin, S., Wood-Sichra, U. and Tatwangire, A. (2006). *Strategic priorities for agricultural development in Eastern and Central Africa*. IFPRI Report 150. Washington, DC: International Food Policy Research Institute (IFPRI).

Otsuka, K. and Place, F. (2001). Issues and theoretical framework. In K. Otsuka and F. Place (eds), *Land Tenure and Natural Resource Management: A Comparative Study of Agrarian Communities in Asia and Africa*. Baltimore: John Hopkins.

Pallant, J. (2013). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS*. 5th Edition. McGraw Hill.

Pardey, P., James, J., Alston, J.M., Wood, S., Koo, B., Binenbaum, E., Hurley, T. and Glewwe, P. (2007). *Science, technology and skills*. INSTEPP Report. St. Paul, MN: University of Minnesota, International Science and Technology Practice and Policy.

Parker, J. (ed.) (2011). The 9 billion-people question", in "Special report: Feeding the world, *The Economist*, Supplement, 26 February.

Partington, D. (2002). *Essential skills for management research*. 1st Edition. SAGE.

Pender, J.L., Place, F. and Ehui, S. (1999). *Strategies for sustainable agricultural development in the East African highlands*. EPTD Discussion Paper 41. Washington DC: IFPRI.

Perrault, P.T. (2001). Regionalization of agricultural research: Implications for planning. In *Planning agricultural research: A sourcebook*. Wallingford: CAB International. *Research: A Sourcebook.* The Hague, ISNAR.

Perry, G.M., Rister, M.E., Richardson, J.W. and W.R. Grant. (1986). "Analyzing tenure arrangements and crop rotations using farm simulation and profit analysis." *Southern Journal of Agricultural Economics*, 18: 165- 174.

Phillip, D. Nkonya, E., Pender, J. and Oni, O.A. (2009). Constraints to increasing agricultural productivity in Nigeria: A review. Nigeria *Strategy Support Program* (NSSP). Background Paper, No. NSSP 006.

Polson, R. and Spencer, D.S.C. (1991). The technology adoption process in subsistence agriculture: the case of cassava in southwestern Nigeria. *Agric. Syst*. 36, 65–77.

Pingali, P. L., Rozelle, S. D. and Gerpacio, R. V. (2001). The farmers' voice in priority setting: a cross-country experiment in eliciting technological preferences. *Economic Development and Cultural Change, 49*(3), 591-610.

Punam, C. and Angwafo, M. (2011). *Yes Africa can: success stories from a dynamic continent*. Washington, DC.: World Bank.

Roberts, D. and Josling, T. (2011). Tracking the implementation of internationally agreed standards in food and agricultural production. Background Paper for International Food and Agricultural Trade Policy Council, Washington, DC: International Food and Agricultural Trade Policy Council.

Robins, P. (2011). Commodity exchanges and smallholders in Africa. IIED. International Institute for Environment and Development. United Kingdom: London.

Rockström J. (2001). Green water security for the food makers of tomorrow: Windows of opportunity in drought-prone savannahs. *Water Science and Technology* 43(4): 71-78.

Rodriguez, F. and Southgate, D. (2003). Water resources management and willingness to pay: The case of Cotacachi, Ecuador. Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program. Res. Brief. P.15.

Rogers, E.M. (1983). Diffusion of innovations. The Free press.

Royal Society. (2009). *Reaping the Benefits: Science and the Sustainable Intensification of Global Agriculture.* London.

Ruecker, G., Park, S.J., Ssali, H. and Pender, J. (2003). Strategic targeting of development policies to complex region: A GIS-based stratification applied to Uganda. ZEF Discussion Papers on Development Policy, Discussion Paper No. 69, Bonn: Centre for Development Research, University of Bonn.

Salami, A., Kamara, A.B. and Brixiova,Z. (2010). Smallholder agriculture in East Africa: Trends, constraints and opportunities, Working Papers Series No. 105 African Development Bank, Tunis, Tunisia.

Sanginga N. and Woomer, P.L. (eds.). (2009). Integrated soil fertility management in Africa: Principles, practices and development processes. Tropical Soil Biology and Fertility Institute of the International Center of Tropical Agriculture. Nairobi. 263 pp.

Sarap, K. and Vashist, D.C. (1994). Adoption of modern varieties of rice in Orissa: a farm level analysis. *Indian Journal of Agricultural Economics* 49: 88–93.

Saunders, M., Lewis, P. and Thornhill, A. (2000).*Research Methods for Business Students*. 2nd Edition. Prentice Hall.

Scobie, G.M., Posada, R.T. (1977). The impact of high-yielding rice varieties in Latin America – with special emphasis on Colombia. Series JE-01. Centro Internacional de Agricultura Tropical (CIAT), Cali.

Sekaran, U. (2003). *Research Methods for Business: A Skill Building Approach*. 4th Edition. John Wiley and Sons.

Shively, G. E. (1997). Consumption risk, farm characteristics, and soil conservation adoption among low-income farmers in the Philippines. *Agricultural Economics, 17*(2-3), 165-177.

Simpson, E.H. (1949). Measurement of diversity. *Nature 163: 688.*

Smith, P. (2013). Delivering Food Security without Increasing Pressure on Land. *Global Food Security* 2: 18–23.

Solano, C., Leon, H., Perez, E. and Herrero, M. (2001). Characterizing objective profiles of Costa Rican dairy farmers. *Agricultural Systems* 67, 153–179.

Solano, C., Leon, H., Perez, E. and Herrero, M. (2003). The role of personal information sources on the decision-making process of Costa Rican dairy farmers. *Agricultural Systems* 70, 3–18.

Sutherland, A.J., McGregor, M.J., Dent, J.B., Willock, J., Deary, I., Gibson, G., Grieve, R. and Morgan, O. (1996). Edinburgh farmer decision making study: Elements important to the farmer. In: Beers, G., Huirne, R.B.M., Pruis, H.C. (Eds.), Farmers in Small-scale and Large-scale Farming in a New Perspective. Objectives, Decision Making and Information Requirements. Agricultural Economics Research Institute, The Netherlands, pp. 162–171.

TAC 2001. Regional Approach to Research for the CGIAR and its Partners. Rome: TAC Secretariat.

Thornton, P.K., Rufino, M.C., Karanja, S., Jones, P.G., Mutie, I. and Herrero, M. (2011).*Genesis reversed: Climate change impacts on agriculture and livelihoods in mixed crop-livestock systems of East Africa. Final report to the World Bank* (p.162). Nairobi: International Livestock Research Institute (ILRI).

Tull, D.S. and Hawkins, D. I. (1990). *Marketing Research: Measurement and Method* (5th edition), New York: John Wiley and Sons Inc.

Ulimwengu, J. and Sanyal, P. (2011). Joint estimation of farmers' stated willingness to pay for agricultural services. International Food Policy Research Institute Discussion Paper. P. 1070.

UN. (2011). World population prospects: the 2011 revision: highlights. New York, USA.

UNIDO (2011). Agribusiness for Africa's prosperity. Edited by Kandeh, K.Y., Patrick, M.K., Torben, M.R. and Anthony, M.H. Vienna: UNIDO

Wadsworth, J. (1995). Adoption of innovations by Costa Rican livestock producers under different levels of extension intensity: predicted versus observed behaviour. *Agricultural Systems, 49*(1), 69-100.

Walton, D. (1994). Regional priority-setting: Report of a roundtable. *Briefing Paper 12*. The Hague: ISNAR.

Waters, D. (2001). *Quantitative Methods for Business*. 3rd Edition. Prentice Hall.

Welch, F. (1970). Education in production. *Journal of Political Economy* 78:35-59.

Welch, F. (1973). Education, Information, and Efficiency. *NBER Working Paper #1*.

Wendimu, S. and Bekele, W. (2011). Determinants of individual willingness to pay for quality water supply: The case of Wonji Shoa sugar estate, Ethiopia.

Wettasinha, C., Waters-Bayer, A., van Veldhuizen, L., Quiroga, G. and Swaans, K. (2014). Study on impacts of farmer-led research supported by civil society organizations. Penang, Malaysia: CGIAR Research Program on Aquatic Agricultural Systems. Working Paper: AAS- 2014-40.

Wiggins, S. (2009). *Can the smallholder model deliver poverty reduction and food security for a rapidly growing population in Africa?* Paper for the Expert Meeting on how to feed the world in 2050. Rome.

Willocquet, L., Savary, S., Fernandez, L., Elazegui, F.A., Castilla, N., Zhu, D., Tang, Q., Huang, S., Lin, X., Singh, H.M. and Srivastsava, R.K.(2002). "Structure and Validation of RICEPEST, a Production Situation-Driven, Crop Growth Model Simulating Rice Yield Response to Multiple Pest Injuries for Tropical Asia." *Ecological Modeling* 153: 247–268.

Wood, S. and Chamberlin, J. (2003). Enhancing the role of spatial analysis in strategic impact assessment: Improving data resolution for regional studies. *Quarterly Journal of International Agriculture* 42 (2): 167–187.

Wood, S., Sebastian, K., Nachtergaele, F., Nielsen, D. and Dai, A. (1999). *Spatial Aspects of the Design and Targeting of Agricultural Development Strategies*. EPTD Discussion Paper 44. Washington, DC: International Food Policy Research Institute.

World Bank. (2008). World Development Report 2008: Agriculture for Development. Washington, DC: World Bank.

World Bank. (2012). *Agricultural Innovation Systems: An investment sourcebook*. Washington, D.C: World Bank.

World Bank. (2014). Implementation Completion and Results Report (TF-93070). Agriculture, Rural Development and Irrigation Unit (AFTAI-3). Sustainable Development Department. Africa Region.

Wozniak, G.D. (1984). The Adoption of Interrelated Innovations: A Human Capital Approach. *Review of Economics and Statistics* 66: 70-79.

Wozniak, GG.D. (1987). Human Capital, Information, and the Early Adoption of New Technology. *Journal of Human Resources* 22:101-112.

Yang, S., Markoczy, L. and Min, Q. (2007). Unrealistic optimism in consumer credit card adoption. *Journal of Economic Psychology*, 28, 170–185.

Yaron, D., Ariel, D. and Voet, H. (1992). Innovations on family farms. The Nazareth region in Israel. *American Agricultural Economics Association.* 74: 361–370.

You, L. and Johnson, M. (2010). Exploring Strategic Priorities for Regional Agricultural R&D Investments in East and Central Africa. *Agricultural Economics* 41 (2): 177–190.

# APPENDIX

## 9.1. Appendix 1: Sampling Frame

| Combinations Clusters | No. of Projects | Supported Commodities | Selected Commodity | No. of respondents (household heads) |
|---|---|---|---|---|
| BKR* | - | Maize, banana, livestock | - | - |
| BKT | - | Maize, livestock | - | - |
| BKU | 3 | Potato, livestock | Potato | 130 |
| BRT | - | Maize | - | - |
| BRU | 2 | Beans | Beans | 140 |
| BTU | - | | - | - |
| KRT | - | | - | - |
| KRU | 1 | Beans | - | - |
| KTU | 7 | Maize, potato, sorghum, livestock | Maize, Sorghum | 150 |
| RTU | 1 | Livestock | Livestock | 180 |
| BKRT | - | | - | |
| BKRU | 1 | Banana | Banana | 140 |
| BKTU | 3 | Cassava, potato, livestock | Cassava | 210 |
| BRTU | - | | - | - |
| KRTU | 8 | Beans, cassava, livestock potato | - | - |
| All countries | 6 | Maize, livestock | Maize, livestock | 210 |
| | 34 | | | 1,160 |

* B = Burundi; K = Kenya; R = Rwanda; T = Tanzania; and U = Uganda

## 9.2. Appendix 2: Figures and tables referenced in the thesis

**Figure 30:** Distribution of respondents' levels of education

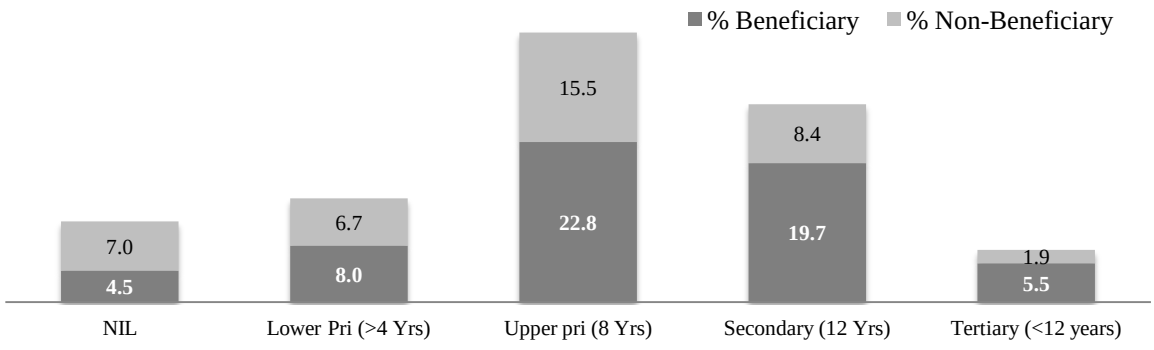


**Table 48:** Years of Farming (disaggregated by period)

| Years of Farming | Sex | Country Kenya | Rwanda | Tanzania | Uganda | Burundi | Total |
|---|---|---|---|---|---|---|---|
| Less than 5 | Male | 4 | 6 | 3 | 23 | 1 | 37 |
| | Female | 5 | 6 | 2 | 11 | 2 | 26 |
| 5 – 8 | Male | 22 | 50 | 38 | 53 | 5 | 168 |
| | Female | 20 | 62 | 39 | 67 | 5 | 193 |
| 9 – 12 | Male | 28 | 37 | 39 | 31 | 26 | 161 |
| | Female | 26 | 31 | 22 | 41 | 13 | 133 |
| 13 - 16 | Male | 27 | 30 | 19 | 19 | 14 | 109 |
| | Female | 11 | 25 | 20 | 21 | 13 | 90 |
| 17 - 20 | Male | 30 | 18 | 16 | 20 | 19 | 103 |
| | Female | 17 | 21 | 9 | 19 | 17 | 83 |
| 21 - 24 | Male | 13 | 2 | 3 | 3 | 4 | 25 |
| | Female | 5 | - | 2 | 2 | 2 | 11 |
| 25 - 28 | Male | 6 | - | - | - | - | 6 |
| | Female | 3 | 2 | - | 1 | 3 | 9 |
| Over 28 | Male | 1 | 2 | 1 | - | - | 4 |
| | Female | - | 1 | - | - | 1 | 2 |
| | Total | 218 | 293 | 213 | 311 | 125 | 1160 |

Source: Survey Data, 2014

**Table 49:** Income Distribution by Type of Household

| Income (Farming) | Sex | 2010 Beneficiary | Non-Beneficiary | Total | 2014 Beneficiary | Non-Beneficiary | Total |
|---|---|---|---|---|---|---|---|
| Less than 100 | Male | 16 | 13 | 29 | 12 | 13 | 25 |
| | Female | 20 | 19 | 39 | 15 | 11 | 26 |
| 100 - 250 | Male | 65 | 80 | 145 | 52 | 60 | 112 |
| | Female | 69 | 67 | 136 | 50 | 57 | 107 |
| 251 - 500 | Male | 110 | 42 | 152 | 88 | 42 | 130 |
| | Female | 74 | 41 | 115 | 55 | 51 | 106 |
| 501 - 750 | Male | 85 | 28 | 113 | 108 | 38 | 146 |
| | Female | 53 | 37 | 90 | 69 | 40 | 109 |
| 751 - 1000 | Male | 28 | 23 | 51 | 32 | 25 | 57 |
| | Female | 26 | 13 | 39 | 36 | 14 | 50 |
| 1001 - 1500 | Male | 13 | 4 | 17 | 22 | 12 | 34 |
| | Female | 15 | 6 | 21 | 22 | 11 | 33 |
| 1501 - 2000 | Male | 18 | 6 | 24 | 19 | 7 | 26 |
| | Female | 21 | 8 | 29 | 15 | 7 | 22 |
| 2001 - 2500 | Male | 11 | 2 | 13 | 15 | 3 | 18 |
| | Female | 12 | 1 | 13 | 17 | 3 | 20 |
| Over 2500 | Male | 2 | 6 | 8 | 9 | 6 | 15 |
| | Female | 2 | 5 | 7 | 9 | 5 | 14 |
| TOTAL | | 640 | 401 | 1041 | 645 | 405 | 1050 |
| Average (US$) | Male | 651 | 609 | | 743 | 731 | |
| | Female | 653 | 560 | | 808 | 631 | |

Source: Survey Data, 2014

**Table 50:** Respondents' Income by Country - 2010 and 2014

| | Sex | Country Kenya | | Rwanda | | Tanzania | | Uganda | | Burundi | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| Less than 100 | Male | 9 | 7 | - | - | 12 | 14 | 7 | 2 | 1 | 2 | 29 | 25 |
| | Female | 9 | 8 | - | - | 13 | 9 | 17 | 9 | - | - | 39 | 26 |
| 100 - 250 | Male | 36 | 28 | 13 | 9 | 35 | 30 | 39 | 23 | 22 | 22 | 145 | 112 |
| | Female | 22 | 16 | 16 | 12 | 22 | 22 | 50 | 31 | 26 | 26 | 136 | 107 |
| 251 - 500 | Male | 36 | 31 | 25 | 14 | 24 | 28 | 43 | 41 | 24 | 16 | 152 | 130 |
| | Female | 19 | 15 | 27 | 18 | 23 | 20 | 31 | 41 | 15 | 12 | 115 | 106 |
| 501 - 750 | Male | 17 | 28 | 42 | 53 | 13 | 7 | 21 | 33 | 20 | 25 | 113 | 146 |
| | Female | 10 | 19 | 37 | 40 | 6 | 9 | 28 | 31 | 9 | 11 | 90 | 110 |
| 751 - 1000 | Male | 6 | 5 | 26 | 23 | 9 | 10 | 10 | 17 | - | 2 | 51 | 57 |
| | Female | 4 | 6 | 20 | 23 | 3 | 3 | 11 | 15 | 1 | 2 | 39 | 49 |
| 1001 - 1500 | Male | 3 | 5 | 16 | 12 | 1 | 9 | 4 | 8 | - | - | 24 | 34 |
| | Female | 5 | 3 | 8 | 13 | 4 | 5 | 4 | 12 | - | - | 21 | 33 |
| 1501 - 2000 | Male | 4 | 4 | 5 | 15 | 2 | - | 6 | 7 | - | - | 17 | 26 |
| | Female | 1 | - | 19 | 15 | 5 | 3 | 4 | 4 | - | - | 29 | 22 |
| 2001 - 2500 | Male | 2 | 1 | 9 | 11 | 1 | 3 | 1 | 3 | - | - | 13 | 18 |
| | Female | 1 | 1 | 10 | 15 | 1 | 1 | 1 | 2 | - | - | 13 | 19 |
| Over 2500 | Male | 2 | 5 | - | 1 | 3 | 6 | 3 | 3 | - | - | 8 | 15 |
| | Female | 1 | 2 | - | 1 | 2 | 5 | 4 | 7 | - | - | 7 | 15 |
| TOTAL | | 187 | 184 | 273 | 275 | 179 | 184 | 284 | 289 | 118 | 118 | 1041 | 1050 |

Source: Survey Data, 2014

**Table 51:** Number of Respondents aware of Existing TIMPs (2010)

| Technology | Sex | Beneficiary | Non-Beneficiary | Total |
|---|---|---|---|---|
| QPM | Male | 95 | 81 | 176 |
| | Female | 63 | 69 | 132 |
| | Total | 158 | 150 | 308 |
| Quality Seed Potato | Male | 111 | 45 | 156 |
| | Female | 91 | 45 | 136 |
| | Total | 202 | 90 | 292 |
| OFSP | Male | 28 | 7 | 35 |
| | Female | 30 | 10 | 40 |
| | Total | 58 | 17 | 75 |
| Bean Innovation | Male | 125 | 116 | 241 |
| | Female | 103 | 105 | 208 |
| | Total | 228 | 221 | 449 |
| Sorghum-Legume | Male | 46 | 15 | 61 |
| | Female | 38 | 14 | 52 |
| | Total | 84 | 29 | 113 |
| Crop-Livestock Integration | Male | 46 | 15 | 61 |
| | Female | 50 | 20 | 70 |
| | Total | 96 | 35 | 131 |
| Striga-resistant Maize | Male | 19 | 6 | 25 |
| | Female | 4 | 8 | 12 |
| | Total | 23 | 14 | 37 |
| Striga-resistant Sorghum | Male | 26 | 14 | 40 |
| | Female | 9 | 13 | 22 |
| | Total | 35 | 27 | 62 |
| Banana Varieties | Male | 36 | 47 | 83 |
| | Female | 22 | 38 | 60 |
| | Total | 58 | 85 | 143 |
| Cassava Variety | Male | 20 | 13 | 33 |
| | Female | 14 | 10 | 24 |
| | Total | 34 | 23 | 57 |
| Soil Erosion Management | Male | 29 | 8 | 37 |
| | Female | 19 | 15 | 34 |
| | Total | 48 | 23 | 71 |
| Integrated Water Management | Male | 133 | 46 | 179 |
| | Female | 108 | 54 | 162 |
| | Total | 241 | 100 | 342 |
| Integrated Soil Fertility Management | Male | 89 | 30 | 119 |
| | Female | 51 | 23 | 74 |
| | Total | 140 | 53 | 193 |

**Table 52:** Number of Respondents aware of Existing TIMPs (2014):

| Technology | Sex | Kenya | Rwanda | Tanzania | Uganda | Burundi | Total |
|---|---|---|---|---|---|---|---|
| QPM | Male | 19 | 30 | 54 | 65 | 8 | 176 |
| | Female | 17 | 26 | 41 | 39 | 9 | 132 |
| | Total | 36 | 56 | 95 | 104 | 17 | 308 |
| Quality Seed Potato | Male | 37 | 30 | 10 | 23 | 56 | 156 |
| | Female | 23 | 30 | 10 | 40 | 33 | 136 |
| | Total | 60 | 60 | 20 | 63 | 89 | 292 |
| OFSP | Male | 18 | 3 | 10 | 3 | 1 | 35 |
| | Female | 21 | 4 | 13 | 2 | 0 | 40 |
| | Total | 39 | 7 | 23 | 5 | 1 | 75 |
| Bean Innovation | Male | 36 | 68 | 32 | 56 | 49 | 241 |
| | Female | 22 | 70 | 30 | 60 | 26 | 208 |
| | Total | 58 | 138 | 62 | 116 | 75 | 449 |
| Sorghum-Legume | Male | 6 | 11 | 33 | 3 | 8 | 61 |
| | Female | 3 | 8 | 19 | 5 | 17 | 52 |
| | Total | 9 | 19 | 52 | 8 | 25 | 113 |
| Crop-Livestock Integration | Male | 17 | 9 | 9 | 7 | 19 | 61 |
| | Female | 8 | 9 | 7 | 29 | 17 | 70 |
| | Total | 25 | 18 | 16 | 36 | 36 | 131 |
| Striga-resistant Maize | Male | 14 | 4 | 1 | 1 | 5 | 25 |
| | Female | 2 | 2 | 0 | 2 | 6 | 12 |
| | Total | 16 | 6 | 1 | 3 | 11 | 37 |
| Striga-resistant Sorghum | Male | 15 | 4 | 1 | 1 | 19 | 40 |
| | Female | 6 | 4 | 1 | 0 | 11 | 22 |
| | Total | 21 | 8 | 2 | 1 | 30 | 62 |
| Banana Varieties | Male | 12 | 18 | 23 | 20 | 10 | 83 |
| | Female | 8 | 19 | 20 | 7 | 6 | 60 |
| | Total | 20 | 37 | 43 | 27 | 16 | 143 |
| Cassava Variety | Male | 9 | 6 | 4 | 7 | 7 | 33 |
| | Female | 2 | 7 | 0 | 7 | 8 | 24 |
| | Total | 11 | 13 | 4 | 14 | 15 | 57 |
| Soil Erosion Mgt | Male | 6 | 11 | 2 | 4 | 14 | 37 |
| | Female | 2 | 14 | 1 | 1 | 16 | 34 |
| | Total | 8 | 25 | 3 | 5 | 30 | 71 |
| Integrated Water Management | Male | 71 | 52 | 11 | 15 | 30 | 179 |
| | Female | 44 | 68 | 9 | 18 | 23 | 162 |
| | Total | 115 | 120 | 20 | 33 | 53 | 342 |
| Integrated Soil Fertility Management | Male | 49 | 30 | 5 | 10 | 25 | 119 |
| | Female | 9 | 37 | 6 | 5 | 17 | 74 |
| | Total | 58 | 67 | 11 | 15 | 44 | 193 |

Source: Survey Data, 2014

**Table 53:** Willingness to Pay for Agricultural Services

| Type of Household | Willingness to Pay | Country Ken | Rwa | Tan | Uga | Bur | Total | Significance |
|---|---|---|---|---|---|---|---|---|
| Beneficiary | Yes | 4 | 5 | 2 | 7 | 0 | 18 | |
| | No | 145 | 169 | 115 | 173 | 82 | 684 | P≤0.05 |
| | Total | 149 | 174 | 117 | 180 | 82 | 702 | |
| Non-Beneficiary | Yes | 44 | 76 | 63 | 73 | | 271 | |
| | No | 25 | 43 | 33 | 58 | | 187 | P≤0.05 |
| | Total | 69 | 119 | 96 | 131 | 43 | 458 | |
| TOTAL | Yes | 48 | 81 | 65 | 80 | | 289 | |
| | No | 170 | 212 | 148 | 231 | | 871 | P≤0.05 |
| | Total | 218 | 293 | 213 | 311 | 125 | 1160 | |

**Table 54:** Engagement of Respondents in Agricultural Research and Extension Trainings

| | | Country Kenya | Rwanda | Tanzania | Uganda | Burundi | Total |
|---|---|---|---|---|---|---|---|
| Male | Beneficiary | 95 | 81 | 60 | 78 | 45 | 359 |
| | Non-beneficiary | 29 | 55 | 51 | 63 | 16 | 214 |
| | Total | 124 | 136 | 111 | 141 | 61 | 573 |
| Female | Beneficiary | 43 | 86 | 49 | 88 | 29 | 295 |
| | Non-beneficiary | 37 | 52 | 40 | 57 | 20 | 206 |
| | Total | 80 | 138 | 89 | 145 | 49 | 501 |
| TOTAL | Beneficiary | 138 | 167 | 109 | 166 | 74 | 654 |
| | Non-beneficiary | 6 | 107 | 91 | 120 | 36 | 420 |
| | Grand Total | 204 | 274 | 200 | 286 | 110 | 1074 |

Source: Survey data, 2014

**Table 55:** Participation in Regional Projects

| Type of household | Regional Projects? | Country Kenya | Rwanda | Tanzania | Uganda | Burundi | Total |
|---|---|---|---|---|---|---|---|
| Beneficiary | Yes | 68 | 130 | 66 | 124 | 12 | 400 |
| | No | 19 | 15 | 11 | 12 | 7 | 64 |
| | Total | 87 | 145 | 77 | 136 | 19 | 464 |
| Non-Beneficiary | Yes | 4 | 14 | 1 | 18 | | 37 |
| | No | 32 | 14 | 8 | 11 | | 65 |
| | Total | 36 | 28 | 9 | 29 | | 102 |
| Total | Yes | 72 | 144 | 67 | 142 | 12 | 437 |
| | No | 51 | 29 | 19 | 23 | 7 | 129 |
| | TOTAL | 123 | 173 | 86 | 165 | 19 | 566 |

**Table 56:** Sources of Information for Respondents (by countries)

| Income | | Country Kenya | | Rwanda | | Tanzania | | Uganda | | Burundi | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| Other farmers and Regional Projects | B | 41 | 81 | 48 | 46 | 20 | 22 | 22 | 25 | 66 | 67 | 197 | 241 |
| | NB | 10 | 9 | 22 | 18 | 6 | 7 | 17 | 20 | 17 | 18 | 72 | 72 |
| | | 51 | 90 | 70 | 64 | 26 | 29 | 39 | 45 | 83 | 85 | 269 | 313 |
| Other farmers | B | 22 | 5 | 33 | 3 | 46 | 5 | 47 | 16 | 0 | 1 | 148 | 30 |
| | NB | 10 | 1 | 17 | 6 | 21 | 10 | 37 | 17 | 2 | 1 | 87 | 35 |
| | | 32 | 6 | 50 | 9 | 67 | 15 | 84 | 33 | 2 | 2 | 235 | 65 |
| Other farmers and Extension staff | B | 43 | 5 | 17 | 4 | 2 | 0 | 3 | 1 | 4 | 3 | 69 | 13 |
| | NB | 11 | 11 | 12 | 11 | 2 | 1 | 3 | 3 | 15 | 15 | 43 | 41 |
| | | 54 | 16 | 29 | 15 | 4 | 1 | 6 | 4 | 19 | 18 | 112 | 54 |
| Other farmers and NGOs | B | 10 | 10 | 7 | 6 | 9 | 6 | 4 | 4 | 2 | 3 | 32 | 29 |
| | NB | 20 | 21 | 12 | 14 | 19 | 17 | 9 | 6 | 6 | 6 | 66 | 64 |
| | | 30 | 31 | 19 | 20 | 28 | 23 | 13 | 10 | 8 | 9 | 98 | 93 |
| Regional Project partners | B | | 13 | | 26 | | 32 | | 34 | | 0 | 0 | 105 |
| | NB | 2 | 9 | 0 | 5 | 2 | 8 | 0 | 18 | 0 | 0 | 4 | 40 |
| | | 2 | 22 | 0 | 31 | 2 | 40 | 0 | 52 | 0 | 0 | 4 | 145 |
| Regional Projects and Seed Company | B | | 6 | | 22 | | 12 | | 0 | | 0 | 0 | 40 |
| | NB | 0 | 1 | 2 | 11 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 15 |
| | | 0 | 7 | 2 | 33 | 0 | 15 | 0 | 0 | 0 | 0 | 2 | 55 |
| Others | B | 3 | 1 | 9 | 9 | 2 | 3 | 2 | 2 | 6 | 4 | 22 | 19 |
| | NB | 3 | 2 | 5 | 5 | 1 | 2 | 1 | 2 | 1 | 1 | 11 | 12 |
| | | 6 | 3 | 14 | 14 | 3 | 5 | 3 | 4 | 7 | 5 | 33 | 31 |
| TOTAL | | 175 | 175 | 184 | 186 | 130 | 128 | 145 | 148 | 119 | 119 | 753 | 756 |

## 9.3. Appendix 3: Categories of TIMPs

**Crop Technologies:**

1. **Genetic resources** include any material of plant, animal, microbial or other origin containing functional units of heredity, germplasm of plants, animals or other organisms containing useful characters of actual or potential value, and or genetic materials, genes, markers, DNA sequences, breeds of livestock, varieties of crops, collections of crops and their wild relatives.

2. **New varieties** are distinct, uniform, stable, high yielding, and resistant to pests, diseases, and drought, and have the potential of regional adaptability to different environments and growing conditions.

3. **New breeds** that are registered and released. They can be natural from another country, and have a higher genetic value (estimated breeding value, EBV) in terms of growth rate, or production.

4. **Cropping systems** refer to the sum total of all of the production practices on a particular field or farm, including types of crops grown, their planting sequence, time, rate and pattern of planting, tillage, nutrient, irrigation, and pest control management strategies and may involve crop rotation, multiple cropping, mixed cropping, strip intercropping, and planting for genetic diversity.

5. **Plant protection** includes weed and pest control, and informed use of agrochemicals (as part of Integrated Pest Management).

6. **Crop management practices**. This refers to the various agronomic practices applied by various stakeholders in the management of crops. It involves the application of assorted TIMPs, leading to increased yields and tolerance to weather vagaries through climate change.

**Livestock Technology:**

1. **Genetic resources** include any material of animal, microbial or other origin containing functional units of heredity, germplasm of animals or other organisms containing useful characters of actual or potential value, and or genetic materials, genes, markers, DNA sequences and breeds of livestock.

2. **Animal husbandry practices** include activities, tasks, schedules and establishments set up to ensure effective production and efficient productivity of domestic animals and profitable marketing of their products.

3. **Livestock breeding** focuses on maximum returns to the breeder (e.g. semen from progeny-tested sires used for artificial insemination) and vaccines.

4. **New breeds** refer to those that are registered and released. They can be natural from another country, and have a higher genetic value (estimated breeding value (EBV)) in terms of growth rate, or production of eggs, meat, or milk.

5. **Forage and range management** refers to the practical management of livestock feeds and forages, especially for the livestock within the arid and semi-arid lands.

**Other Types of Technology (e.g. Mechanical and Management)**

1. **Farming** s**ystems** refer to "the entire complex of development, management and allocation of resources as well as decisions and activities, which, within an operational farm unit or a combination of such units results in agricultural production, and the processing, and marketing of the products".

2. **Soil and water management practices** refer to mechanisms of ensuring minimal soil disturbance and loss through runoff or otherwise, as well as proper water conservation systems within the farmlands and the catchment areas.

3. **Farm mechanization** refers to the use of tractors, harvesters and equipment for cultivation, planting and feed conservation, but excludes machinery and equipment used for irrigation, livestock production, grain drying and storage, and transport.

4. **Post-harvest technology** includes handling, cooling, cleaning, sorting, transporting, drying, storing and packaging.

5. **Farm management** refers to decisions about choice of activity on the farms, e.g. crop grown, use of chemical inputs, labour, animal traction, and machinery.

6. **Methodologies** refer to, for instance, on-farm demonstrations; field days; radio messages, and leaflets used to demonstrate the TIMPs with regard to implementation, performance and superiority over alternative technologies.

7. **Protocols** include sets of agreed upon and openly published and distributed standards that enable different firms or organizations to manufacture compatible devices/products to the same specifications. All devices made under the same protocol work with one another without any adjustment or modification.

8. **Laboratory techniques** include the sum of procedures, methods and tests performed in the laboratory and used on natural sciences such as in breeding, transformation, genetics, and in examination of microbiological, cytological, chemical, and biochemical specimens, normal and pathological experiments in order to conduct an experiment.

## 9.4. Appendix 4: List of East African Standard for Cassava and Sweet Potatoes

| Standard Number | Standard Title |
|---|---|
| FDEAS 771:2012 | Fresh Sweet Potatoes – Specifications |
| FDEAS 772:2012 | Dried Sweet Potato chips – Specifications |
| FDEAS 773:2012 | Sweet Potato Flour – Specifications |
| FDEAS 774:2012 | Sweet Potato Crisps – Specifications |
| FDEAS 775:2012 | Code of Hygienic Practice for Producing and Handling Fresh Potatoes |
| FDEAS 776:2012 | Code of Hygienic Practice for Producing and Handling Fresh Cassava |
| FDEAS 777:2012 | Code of Practice for Reduction of Acryl amide in Potato Products |
| FDEAS 778:2012 | Fresh-Bitter Cassava – Specification |
| FDEAS 779:2012 | High-Quality Cassava Flour (HQCF) – Specification |
| FDEAS 780:2012 | Fresh Cassava Leaves – Specification |
| FDEAS 781:2012 | Biscuits – Specification |
| FDEAS 782:2012 | Composite Flour – Specification |
| FDEAS 43:2012 | Bread – Specification |

Source: http://www/eac-quality.net/the-sqmt-community/standardization/public-drafts.html

## 9.5. Appendix 5: Management Practices against Pests and Diseases

| Crop | Management Practices |
|---|---|
| Maize | • Selection and introduction of disease-resistant and pest-resistant varieties that are fit for the local farms<br>• Avoiding sowing varieties or hybrid with the same genetic background for a long term in the same area (i.e., reduction of recycling of seeds)<br>• Selection of varieties with good resistance and diversified genetic background (available in gene banks)<br>• Diversified agronomic practices, including intercropping; deep tillage, and intensive soil harrowing<br>• Enhanced use of natural enemies, such as ladybug against *Ostrinia nubilalis* and aphid<br>• Controlled spraying of bio-pesticides such as Bt emulsion, matrine to control *Ostrinia nubilalis*<br>• Use of insecticidal lamp or installation of sex pheromones to trap male imagos and prevent *Ostrinia nubilalis* from mating<br>• Control chemical practices, including mixing seeds with chemical agents (e.g., covering seeds with seed coatings, thus effectively preventing maize head smut, top rot, and stem rot, as well as underground pests). |
| Banana | • Careful uprooting of the affected plants and burying them<br>• Use of clean healthy materials, including paring of corms at planting<br>• Destruction of post-harvest residues<br>• Some nematode-resistant varieties have been developed in Uganda<br>• Resistant cultivars to black sigatoka have been produced and availed to farmers in the region<br>• Adoption of good crop husbandry (e.g., weeding, desuckering, pruning, manuring and mulching) |
| Cassava | • Constant and regular weeding of cassava farm. |

| Crop | Management Practices |
|---|---|
| | • Hand picking of larvae of large caterpillars and adults insects<br>• Use clean planting materials (mainly hybrid varieties)<br>• Use of plant varieties resistant to disease and pests (especially those being up-scaled in the regional projects) |
| Sorghum | • Systematic screening of germplasm accessions to identify sources of resistance to important pests and diseases<br>• Identification and utilization of disease resistance sources<br>• Adoption of crop mixtures (in mixed cropping) |
| Livestock | • Preventing incidence of trans-boundary diseases and disease transmitting vectors through minimizing the movement of animals across the borders<br>• Prompt practice of quarantine protocol<br>• Use of Geographic information system (GIS) and remote sensing as early warning systems and in the surveillance and control of infectious diseases<br>• Animal breeding strategies, leading to creation of disease resistant gene pools<br>• Enhancing host genetic resistance to disease by selective breeding of resistant animals<br>• Ensuring implementation of government policies to enhance agricultural and animal research and training, and technology development<br>• Capacity building of respondents on ensuring appropriate preparedness and response to emerging diseases and pest. |

Source: Survey Data, 2014

## 9.6. Appendix 6: Survey Tool

# HOUSEHOLD SURVEY QUESTIONNAIRE

Household ID No: [ ][ ][ ][ ]

Interviewer's Name: _____

Signature: _____ Date _____

## SECTION A: RESPONDENT INDENTIFICATION

| IDENTIFICATION | NAME | CODE |
|---|---|---|
| **A1.** Country | | |
| **A2.** Region/Province/County | | |
| **A3.** District | | |
| **A4.** Village | | |
| **A5.** Type of household | 1. Beneficiary Household<br>2. Non-Beneficiary Household | |

**A6.** Name of household head: _____

**A7.** Name of respondent: _____

**A8.**Relationship to the beneficiary:

**Beneficiary (self) [ ] Spouse [ ] Other family member [ ] None (non-beneficiary HH) [ ]**
**Other (Specify): ……..**

**A9.** GPS coordinates of residence: Northings:_____ Eastings:_____ Elevation:_____

## SECTION B: GENERAL HOUSEHOLD CHARACTERISTICS:

**B1.**Sex of respondent:

**1. Male [ ] 2. Female [ ]**

**B2.**Relationship of the respondent to household head

**Household head [ ] Spouse [ ] Son [ ] Daughter [ ] Other relative (Specify): ……**

**B3.**Sex of Household Head:

**1. Male [ ] 2. Female [ ]**

**B4.**Age of respondent: [ ] **B5.**Age of Household Head (if not B4): [ ]

**B6.**Marital status of Household Head:

**Single [ ] Married–single [ ] Married – polygamous [ ] Widowed [ ] Divorced/separated [ ]**

**B7.**What is highest level of Education of the household head and Spouse?

| | Household Head | Spouse |
|---|---|---|
| NIL | | |
| Primary – Lower | | |
| Primary – Upper | | |
| Secondary | | |
| Tertiary | | |
| Functional Adult Literacy | | |
| Others (Specify) | | |

**B8.**Number of people living in the household

| Age groups | Number of persons | |
|---|---|---|
| | **Male** | **Female** |
| Under 5 years | | |
| 5 – 15 years | | |
| 16 – 35 years | | |
| Over 35 years | | |
| **TOTAL** | | |

**B9.**Do you have any person in your household with any chronic illness or disability? …….
**1 = Yes; 0 = No**

**B10.**How long has the household head been farming? ……. years

**Welfare Indicators**
***Household income***

**B11.** Do you hire any labour to work on your farm?.....
**1 = Yes; 0 = No**

**B12.** If yes, how much did you pay for all your hired labour in the past 12 months? US$.....

**B13.** Do you have any savings?.....
**1 = Yes; 0 = No**

**B14.** If yes, how often do you save money?.....
**0 = Never; 1 = Occasionally; 2 = Regularly; 3 = Always**

**B15.** What is your primary and secondary occupation? Please rank them in order of importance.

| | **Occupation** | **Primary Occupation** | **Secondary Occupation** | **Years of engagement** |
|---|---|---|---|---|
| **1** | Agricultural self-employed | | | |
| **2** | Agricultural paid labourer | | | |
| **3** | Agricultural unpaid family member | | | |
| **4** | Herding | | | |
| **5** | Mason | | | |
| **6** | Fisher | | | |
| **7** | Wage employment | | | |
| **8** | Carpenter | | | |
| **9** | Petty trading | | | |
| **10** | Casual labourer | | | |
| **11** | | | | |

**B16.** Please, provide the details regarding your welfare

| | **Income source** | **Do you get income from this source?** **1 = Yes; 0 = No** | **How regularly do you get income from this source?** **1 = Don't get; 2 = Occasionally; 3 = Regularly; 4 = Always** | **How much income have you got from this source in the last 12 months? (US$)** | **How important is this source of income in contributing to your total HH income?** **1 = Not at all; 2 = Moderately; 3 = Indifferent; 4 = Important; 5 = Very important** |
|---|---|---|---|---|---|
| **1** | Sale of crops | | | | |
| **2** | Sale of livestock | | | | |
| **3** | Sale of other products | | | | |
| **4** | Regular employment | | | | |
| **5** | Casual employment (agricultural-related) | | | | |
| **6** | Casual employment (non-agricultural related) | | | | |

| | Income source | Do you get income from this source? 1 = Yes; 0 = No | How regularly do you get income from this source? 1 = Don't get; 2 = Occasionally; 3 = Regularly; 4 = Always | How much income have you got from this source in the last 12 months? (US$) | How important is this source of income in contributing to your total HH income? 1 = Not at all; 2 = Moderately; 3 = Indifferent; 4 = Important; 5 = Very important |
|---|---|---|---|---|---|
| **7** | Running own business | | | | |
| **8** | Remittances (from family members) | | | | |
| **9** | Remittances (from non-family members) | | | | |
| **10** | Pension | | | | |
| **11** | | | | | |
| **12** | | | | | |

**B17:** Please, provide the status of your household assets

| | | | | Ownership (%) | | | |
|---|---|---|---|---|---|---|---|
| **Agricultural enterprise equipment** | | **No.** | **Estimated Value** | **Joint Ownership** | **Male Spouse** | **Female Spouse** | **Other HH Members** |
| 1 | Hoes, cutlasses, machetes | | | | | | |
| 2 | Ox-ploughs | | | | | | |
| 3 | Draft cattle | | | | | | |
| 4 | Draft donkeys | | | | | | |
| 5 | Tractor, including tractor plough | | | | | | |
| 6 | Transport equipment for agricultural enterprise, e.g. ox-cart | | | | | | |
| 7 | Spray pump | | | | | | |
| **Non-agricultural enterprise equipment** | | | | | | | |
| 8 | Sewing machine | | | | | | |
| 9 | Ox-cart | | | | | | |
| 10 | Car | | | | | | |
| 11 | Bicycle | | | | | | |
| 12 | Motorcycle | | | | | | |
| 13 | Radio, Cassette Player | | | | | | |
| 14 | Television | | | | | | |
| 15 | Fishing boat | | | | | | |
| 16 | Mobile phone | | | | | | |
| 17 | Paraffin stove | | | | | | |
| 18 | Sofa chairs | | | | | | |
| **Other** | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| 21 | | | | | | | |
| 22 | | | | | | | |
| 23 | | | | | | | |

## SECTION C: SOCIAL CAPITAL

**C1. Do you and/or any other household member belong to any organization or group in this community?** 1. Yes [ ] 2. No [ ]

**If C1 is** YES**, ask the following questions:**

| | C2. Name of organization | C3. Regional Project supported? (Yes/No) | C4. Year of first membership | C5. Who influenced you to join the group? 1 = Joined myself freely; 2 = Existing member; 3 = Others (Specify) | C6. Expected benefits from the group | C7. Actual benefits from the group | C8. How satisfactorily have your expectations been met? 1 = Very satisfied; 2 = Satisfied; 3 = Indifferent; 4 = Unsatisfied; 5 = Very unsatisfied; 6 = Don't know; 7 = No response |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |

## SECTION D: TECHNOLOGY/INNOVATIONS

**D1: Are you aware of any of the following farming technologies/innovations?** ***(If yes, ask questions D2, D3, D4 AND D5)***

| Technology | D1. Aware of the technology (Yes/No) | D2. Ever used the technology (Yes/No) | D3. Year of first use | D4. Are you still using the technology? (Yes/No) | D5. Reasons for using the technology |
|---|---|---|---|---|---|
| Quality Protein Maize | | | | | |
| Quality Seed Potato | | | | | |
| Orange Fleshed Sweet Potatoes | | | | | |
| Crop protection | | | | | |
| Bean innovation | | | | | |
| Sorghum-legume | | | | | |
| Crop-Livestock Integration | | | | | |
| Striga-resistant maize varieties | | | | | |
| Striga resistant sorghum varieties | | | | | |
| Banana varieties | | | | | |
| Cassava varieties | | | | | |
| Soil erosion control structures | | | | | |
| Post-harvest handling | | | | | |
| Integrated Water Management | | | | | |
| Integrated Soil Fertility Management | | | | | |

**What were your expected and actual benefits from the technology?**

**On a scale of 1 to 5, how satisfied were you with the technology? How confident are you that you have sufficient knowledge/understanding to take up the technologies on your own**?

| **Technology** | **D6. Expected benefits** **1.** Increased out put; **2.** Early plant maturity and harvest; **3.** Reduced farm labour; **4.** Reduced time used on tasks; **5.** Increased food security; **6.** Better nutrition; **7.** Better soil & water conservation; **8.** Increased soil fertility; **9.** Others (Specify) | **D7. Actual benefits** **1.** Increased out put; **2.** Early plant maturity and harvest; **3.** Reduced farm labour; **4.** Reduced time used on tasks; **5.** Increased food security; **6.** Better nutrition; **7.** Better soil & water conservation; **8.** Increased soil fertility; **9.** Others (Specify) | **D8. Level of satisfaction** **1.** Very satisfied; **2.** Satisfied; **3.** Indifferent; **4.** Unsatisfied; **5.** Very unsatisfied; **6.** Don't know; **7.** No response | **D9. Level of confidence for undertaking on project alone** **1.** Very confident; **2.** Confident; **3.** Indifferent; **4.** Not confident; **5.** Not confident at all; **6.** Don't know; **7.** No response | **Did this technology met your needs?** **1 = Yes; 0 = No** |
|---|---|---|---|---|---|
| Quality Protein Maize | | | | | |
| Quality Seed Potato | | | | | |
| Orange Fleshed Sweet Potatoes | | | | | |
| Crop protection | | | | | |
| Bean innovation | | | | | |
| Sorghum-legume | | | | | |
| Crop-Livestock Integration | | | | | |
| Striga-resistant maize varieties | | | | | |
| Striga resistant sorghum varieties | | | | | |
| Banana varieties | | | | | |
| Cassava varieties | | | | | |
| Soil erosion control structures | | | | | |
| Post-harvest handling | | | | | |
| Integrated Water Management | | | | | |
| Integrated Soil Fertility Management | | | | | |

**D10: Who mostly participates in the following agricultural production stages?**

| **S/N** | | **Female Household members** | **Male Household members** | **Both Females and Males** | **Hired labour** | **Other** | **N/A** |
|---|---|---|---|---|---|---|---|
| 1 | Choice of crop for cultivating | | | | | | |
| 2 | Marketing decisions (selling, transport to market, negotiating etc.) | | | | | | |
| | | | | | | | |

Constraints to marketing – What are the priority constraints to crop and livestock marketing?

| | **Constraints to crop marketing** | **Rank (1 = Most important constraint)** | | **Constraints to livestock marketing** | **Rank (1 being the most important constraint)** |
|---|---|---|---|---|---|

| | Constraints to crop marketing | Rank (1 = Most important constraint) | | Constraints to livestock marketing | Rank (1 being the most important constraint) |
|---|---|---|---|---|---|
| **1** | Low quality of produce | | **1** | Low quality of produce | |
| **2** | Low market prices at the time of selling | | **2** | Low market prices at the time of selling | |
| **3** | Unavailability of markets | | **3** | Unavailability of markets | |
| **4** | Lack of market information | | **4** | Lack of market information | |
| **5** | Difficulties in processing farm produce | | **5** | Difficulties in processing farm produce | |
| **6** | Difficulties in storage | | **6** | Difficulties in storage | |
| **7** | Limited access to transport to markets | | **7** | Limited access to transport to markets | |
| **8** | Farmers are not organized to market collectively | | **8** | Farmers are not organized to market collectively | |
| **9** | Difficulties in setting prices | | **9** | Difficulties in setting prices | |
| **10** | Other (specify) | | **10** | Other (specify) | |
| **11** | | | **11** | | |
| **12** | | | **12** | | |

Access to market information – From whom or from which organization do you primarily obtain market information?

| | Type of information | Do you receive information? 1 = Yes; 0 = No | What is the source of information? 1 = Other farmers; 2 = Family & friends; 3 = Radio/TV; 4 = Farmer organization/cooperative; 5 = Other non-farmer associations; 6 = Market-place posters/posted bulletins; 7 = Agricultural traders; 8 = SMS; 9 = Internet; 10 = Newspapers; 11 = Extension officer; 12 = Other (specify) | How do you use this price and market information? 1 = Affect purchasing decisions; 2 = Affect sales decisions; 3 = Affect stocking decisions; 4 = Affect contracting decisions; 5 = Affect investment decisions; 6 = Other (specify) |
|---|---|---|---|---|
| **1** | Commodity prices in different markets | | | |
| **2** | List or details of commodities in demand | | | |
| **3** | Alerts on when the commodities are in demand | | | |
| **4** | Prevailing supply in different markets | | | |
| **5** | Availability of services, e.g. transport | | | |
| **6** | | | | |

**Access to credit services**

Do you have access to any of the following sources of credit?

| | Source of borrowed money | Have you ever borrowed? 1 = Yes; 0 = No | Amount borrowed in the last 12 months (Local currency or US$ equivalent) | What was the purpose of borrowing? 1 = Purchase of food; 2 = Purchase of HH assets; 3 = Payment of fees; 4 = Cover medical costs; 5 = Boost agricultural production; 6 = Cover educational costs; 7 = Other (specify) |
|---|---|---|---|---|
| **1** | Relatives and friends | | | |
| **2** | Informal savings & credit groups | | | |
| **3** | Money-lenders | | | |

| | | | | |
|---|---|---|---|---|
| **4** | Government credit schemes | | | |
| **5** | NGO/Church, etc. | | | |
| **6** | Bank | | | |
| **7** | Micro-finance institution | | | |

**Access to agricultural training**

Have you or any member of this HH participated in any agricultural research or extension training in the last 12 months?

**1 = Yes 0 = No**

If Yes, who provided the training, what was the topic and how would you rate it? (use the provided scale)

| | **Service provider** | **Topic**<br>1 = Crop Mgt; 2 = Pest & Disease control; 3 = Livestock Mgt; 4 = Agronomy; 5 = M&E; 6 = AI; 7 = Other (specify) | **What was your perception on the methods/approaches used**<br>1 = Very poor; 2 = Poor; 3 = Indifferent; 4 = Good; 5 = Very good | **Did you or any of the farmers ask for the training?**<br>**1 = Yes; 0 = No** | **How useful was the training?**<br>1 = Not useful; 2 = Somewhat useful; 3 = Indifferent; 4 = Useful; 5 = Very useful | **How timely was the training?**<br>1 = Untimely; 2 = Always provided late; 3 = Indifferent; 4 = Timely; 5 = Very timely |
|---|---|---|---|---|---|---|
| **1** | | | | | | |
| **2** | | | | | | |
| **3** | | | | | | |
| **4** | | | | | | |
| **5** | | | | | | |

## SECTION E: NATURAL CAPITAL

**E1:** What is the land tenure system on which your land is?

**State owned [ ] Private Mailo land [ ] Free hold [ ] Customary [ ] Leasehold [ ]**
**Others (Specify) ……**

**E2:** What is the total land you have? (Probe for how much is rain-fed or irrigated)

a) Total land _____ (Local units) _____ (Ha)
b) Land rain-fed _____ (Local units) _____ (Ha)
c) Land under irrigation _____ (Local units) _____ (Ha)

**E3: Of the total land mentioned above, how much (Ha) is under the following use(s)?**

| Land Use Options | Size (Local Units) | Hectares |
|---|---|---|
| Under Crops | | |
| For Livestock | | |
| Under Fallow | | |
| Under Forest | | |
| | | |
| | | |
| | | |

## SECTION F: PRODUCTION INFRMATION

**F1-4: Which of the following crops have you grown over the past 12 months? What size of land was the crop cultivated (Ha)? How much was produced (Kg)? What type of cropping was used?)**

| Crop | F1: Do you produce this crop? 1 = Yes; 2 = No | F2: How much land was used for the crop? (Ha) | F3: What was the total yield of the crop? (Kg) | F4: What type of cropping did you use? **1** = Mono-cropping; **2** = Mixed cropping; **3** = Shifting cultivation; **4** = Relay cropping; 5 = Mixed crop-livestock production; **6** = Others (Specify) |
|---|---|---|---|---|
| Maize | | | | |
| Sorghum | | | | |
| Millet | | | | |
| Beans | | | | |
| Sweet Potato | | | | |
| Cassava | | | | |
| Banana | | | | |
| Others (Specify) | | | | |

**F5–8: What types of varieties have you grown (for beneficiaries under RP's work) over the past 12 months? (Probe for source of information and the name of the variety grown, Source of planting seed/plating material))**

| Crop | F5: Variety type grown **1** = Hybrid varieties; **2** = New/ improved varieties; **3** = Local varieties; **4** = Don't know | F6: What was your main source of information? **1** = Other farmers; **2** = Govt extension workers; **3** = RP partners; **4** = Other NGOs; **5** = Radio/TV/Newspapers; **6** = Seed companies; **7** = None; **8** = Don't know; **9** = Others (Specify) | F7: What was your main source of seed? **1** = Own harvest; **2** = Other farmers; **3** = ASARECA; **4** = Other NGOs/CBOs; **5** = Local market; **6** = Agro-dealer; **7** = Seed company; **8** = Others (Specify) | F8: What is the name of variety? |
|---|---|---|---|---|
| Maize | | | | |
| Sorghum | | | | |
| Millet | | | | |
| Beans | | | | |
| Sweet Potato | | | | |
| Cassava | | | | |
| Banana | | | | |
| Others (Specify) | | | | |

**F8-14: For the crops mentioned above, and over the past 12 months, what inputs did you use? What was your main source of information about the farm inputs? What was the estimated expenditure on the inputs within the same period?**

| Crop | F8: Farm input<br>**1** = Seed; **2** = Artificial fertilizers; **3** = Manure; **4** = Pesticides and herbicides; **5** = Others (Specify) | F9: Source of input<br>**1** = Purchased; **2** = Free distribution; **3** = Group purchase; **4** = Subsidy; **5** = Own seed; **6** = Other farmers; **7** = Others (Specify) | F10: Expenditure on seed | F11: Expenditure on fertilizers and manure | F12: Expenditure on pesticides, herbicides and spraying | F13: Cost of hired labour | F14: Cost of transport and marketing |
|---|---|---|---|---|---|---|---|
| Maize | | | | | | | |
| Sorghum | | | | | | | |
| Millet | | | | | | | |
| Beans | | | | | | | |
| Sweet Potato | | | | | | | |
| Cassava | | | | | | | |
| Banana | | | | | | | |
| Others (Specify) | | | | | | | |

**F15-19: For the crops mentioned above, and over the past 12 months, how much did you harvest, store for domestic use and sell for generating income?**

| Crop | F15: Quantity harvested | | | F16: Quantity used domestically *(Consumed & Given away)* | | | F17: Quantity sold on the market | | | F18: Revenue from quantity sold on the market | F19: Unit price |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Qty | Local Units | Kg | Qty | Local Units | Kgs | Qty | Local Units | Kg | | |
| Maize | | | | | | | | | | | |
| Sorghum | | | | | | | | | | | |
| Millet | | | | | | | | | | | |
| Beans | | | | | | | | | | | |
| Sweet Potato | | | | | | | | | | | |
| Cassava | | | | | | | | | | | |
| Banana | | | | | | | | | | | |
| Others (Specify) | | | | | | | | | | | |

## SECTION G: LIVESTOCK

**G1-G3: How many of the following livestock did your household own 12 months ago? Approximately how much land was dedicated to rearing the animals? What type of rearing was used?**

| | G1: Quantity | G2: Size (Kg) | G3: Type of rearing<br>**1** = Rotational grazing; **2** = Free hold grazing; **3** = Zero grazing; 4. Others (Specify) |
|---|---|---|---|
| Cattle | | | |
| Goats | | | |
| Sheep | | | |

| | G1: Quantity | G2: Size (Kg) | G3: Type of rearing<br>**1** = Rotational grazing; **2** = Free hold grazing; **3** = Zero grazing; 4. Others (Specify) |
|---|---|---|---|
| Pigs | | | |
| Rabbits | | | |
| Turkey | | | |
| Chicken/Ducks | | | |
| Fish ponds | | | |

**G4-7: What type of breed have you reared in the past 12 months? (Probe for source of information and the name of the breed reared, Source of planting seed/plating material)**

| | G4: Breed type<br>**1** = Local breed; **2** = Mixed breed; **3** = Exotic breed; **4** = Others (Specify) | G5: Source of information<br>**1** = Other farmers; **2** = Government extension workers; **3** = RP Partner; **4** = Other NGOs; **5** = Radio/TV/Newspapers; **6** = Seed companies; **7** = None; **8** = Don't know; **9** = Others (Specify) | G6: Source of breed<br>**1** = Own harvest; **2** = Other farmers; **3** = RP; **4** = Other NGOs/CBOs; **5** = Local market; **6** = Agro-dealer; **7** = Seed company; **8** = Others (Specify) | G7: Name of breed |
|---|---|---|---|---|
| Cattle | | | | |
| Goats | | | | |
| Sheep | | | | |
| Pigs | | | | |
| Rabbits | | | | |
| Turkey | | | | |
| Chicken/Ducks | | | | |
| Fish ponds | | | | |

**G8-11: For the livestock mentioned above, how much (Quantity and income) did you collect in their sales in the past 12 months?**

| | G8: Quantity harvested<br>**(Number, Litres, etc.)** | G9: Quantity used domestically *(Consumed & Given away)*<br>**(Number, Litres, etc.)** | G10: Quantity sold on the market<br>**(Number, Litres, etc.)** | G11: Revenue generated from sales<br>**(US$)** |
|---|---|---|---|---|
| Cattle (Sale/meat) | | | | |
| Milk | | | | |
| Goats (Sale/meat) | | | | |
| Milk | | | | |
| Sheep | | | | |
| Pigs | | | | |
| Rabbits | | | | |
| Turkey | | | | |
| Chicken/Ducks | | | | |
| Fish ponds | | | | |

**G12-18: For the livestock mentioned above, what inputs did you use in the past 12 months? What was your main source of information about the farm inputs? How much have you spent on these inputs in the past 12 months?**

| | **G12 Farm input**<br>**1** = Livestock; **2** = Feeds; **3** = Pesticides; **4** = Others (Specify) | **G13: Source of input**<br>**1** = Purchased; **2** = Free distribution; **3** = Group purchase; **4** = Subsidy; **5** = Own seed; **6** = Other farmer; **7** = Others (Specify) | **G14: Expenditure on seed** | **G15: Expenditure on fertilizers and manure** | **G16: Expenditure on pesticides, herbicides and spraying** | **G17: Cost of hired labour** | **G18: Cost of transport and marketing** |
|---|---|---|---|---|---|---|---|
| Cattle | | | | | | | |
| Goats | | | | | | | |
| Sheep | | | | | | | |
| Pigs | | | | | | | |
| Rabbits | | | | | | | |
| Turkey | | | | | | | |
| Chicken/Ducks | | | | | | | |
| Fish ponds | | | | | | | |

## SECTION H: NUTRITION AND FOOD SECURITY

**H1: In the last 24 hours what foods were consumed in this household?**

| Food Category | Status | Food Category | Status |
|---|---|---|---|
| **Predominantly Carbohydrates** | | **Predominantly Vitamins** | |
| Cassava | | Onion (Vitamins/ carbohydrates) | |
| Sweet Potato | | Fruits (Vitamins) | |
| Irish potatoes | | Tomatoes (Vitamins) | |
| Bananas | | Green vegetables (Vitamins) | |
| Maize | | | |
| Millet/Sorghum (Iron) | | **Fats** | |
| Rice (Carbohydrates) | | Groundnuts / Carbohydrate (Fats) | |
| Honey (Carbohydrates) | | Sunflower | |
| Pumpkins | | Ghee (Fat) | |
| | | Cooking oil | |
| **Predominantly Proteins** | | | |
| Beans (Proteins + Minerals incl. iron) | | **Others** | |
| Soya | | Water | |
| Fish (Protein+ Minerals) | | Tea/Coffee | |
| Chicken/goats/meat (protein; Minerals) | | | |
| Liver/blood (Iron) | | | |
| Milk/Yoghurt/Other diary product | | | |
| | | | |

**H2: Over the past 12 months:**

| | 1 = Yes; 0 = No |
|---|---|
| Were there any months in which you did not have enough food in the house to meet this family's needs? | |
| If yes, for how many months was their insufficient food? | |
| **Please mention factors that could have led to lack of enough food** | |
| **(a)** Poor soils | |
| **(b)** Low incomes of household head | |
| **(c)** Poor farming practices | |
| **(d)** Limited farm implements | |
| **(e)** Limited farm inputs | |
| **(f)** Pests and diseases | |
| **(g)** Poor health of household head | |
| **(h)** Soil erosion | |
| **(i)** Limited technologies, innovations and management practices | |
| **(j)** Limited extension support | |
| **(k)** Limited forage | |
| **(l)** Cattle rustling | |
| **(m)** Insecurity | |
| **(n)** Drought | |
| **(o)** Floods/heavy rains | |
| **(p)** Others (specify) | |
| Over this period, did this household support other families by giving them food rations? | |
| Over this period, did this household receive any food rations? | |

## SECTION UI: ENVIRONMENTAL ASSESSMENT

**I: Which are the top three diseases or pests commonly affecting your crops/livestock?**

| Crop | Disease A | Disease B | Disease C |
|---|---|---|---|
| Maize | | | |

| Crop | Disease A | Disease B | Disease C |
|---|---|---|---|
| Rice | | | |
| Sorghum | | | |
| Millet | | | |
| Beans | | | |
| Groundnut | | | |
| Soya | | | |
| Sweet Potato | | | |
| Irish Potato | | | |
| Cassava | | | |
| Wheat | | | |
| Banana | | | |
| | | | |
| **Livestock** | | | |
| Cattle | | | |
| Goats | | | |
| Sheep | | | |
| Pigs | | | |
| Rabbits | | | |
| Turkey | | | |
| Chicken/Ducks | | | |
| Fish ponds | | | |

Has the local council enacted any bye-laws relating to NRM?

**1 = Yes; 0 = No**

Are there other bye-laws or laws affecting land management in this community?

**1 = Yes; 0 = No**

If the answer to either of the above questions is yes, please describe each bye-law affecting land management in the following table:

| **Bye-laws/provision** | **Year Established** | **L41: Who enacted?** **1** = Village council; **2** = Sub-county; **3** = District; **4** = Central government; **5** = Others (Specify) | **L42: Community awareness** **1** = No one aware of bye-laws; **2** = Up to 50% aware; **3** = 50-75% aware; **4** = Over 75% aware | **L43: Community compliance** **1** = No one compliant; **2** = Up to 50%; **3** = 50-75%; **4** = Over 75% |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**What measures are you taking to manage pests within your enterprise/ farm? Who applies pesticides within your farm/ enterprise? How frequently do you apply your chosen pest management practice?**

| **Crop** | **I1: What measures are you taking to manage pests within your enterprise/ farm?** **1** = Chemicals; **2** = Mechanical means; **3** = Biological; **4** = Combined biological and chemical; **5** = None of the above; **6** = Other | **I2: Who applies pesticides within your farm/ enterprise?** **1** = Female and male Children (< 16 years); **2** = Female Children and Mother; **3** = Male children and mother; **4** = Husband; **5** = Casual labourers (males); **6** = Casual labourers (females); **7** =Labourers (males & females); **8** = Permanent worker (at least 6 months); **9** = Other | **I3: How frequently do you apply your chosen pest management practice?** **1** = Daily; **2** = At least once a month; **3** = More than twice a month; **4** = At least twice a year; **5** = Once every three months; **6** = Other |
|---|---|---|---|
| Maize | | | |
| Rice | | | |
| Sorghum | | | |
| Millet | | | |
| Beans | | | |
| Groundnut | | | |
| Soya | | | |
| Sweet Potato | | | |
| Irish Potato | | | |
| Cassava | | | |
| Wheat | | | |
| Banana | | | |
| | | | |
| **Livestock** | | | |
| Cattle | | | |
| Goats | | | |
| Sheep | | | |
| Pigs | | | |
| Rabbits | | | |
| Turkey | | | |
| Chicken/Ducks | | | |
| Fish ponds | | | |

**I4. What chemical pesticides if any have you used at your farm?**

Please list

……

……

……

**I5. Have you received any training from any Regional Project implementers about Pesticide use/ application?**

**1 = Yes; 0 = No**

**I6. If Yes When did you receive training?**

2008 [ ] 2009 [ ] 2010 [ ]
2011 [ ] 2012 [ ] 2013 [ ]

**I7. What is the distance to the nearest stream/ lake/ river/ pond / seasonal stream?**

0< 200m [ ] 200- 500m [ ] 500m < 1km [ ] 1 < 2km [ ] > 2km [ ]

**I8. Where is your nearest borehole/ hand dug well/ well?**

0< 200m [ ] 200- 500m [ ] 500m < 1km [ ] 1 < 2km [ ] > 2km [ ]

## SECTION J: SOCIAL ECONOMIC CHARACTERISITCS

**J1: Thinking of 12 months back, please indicate the condition of your house in regard to:**

| **Housing characteristic** | | | **Status** |
|---|---|---|---|
| **Roofing** | | **Main source of fuel** | |
| ▪ Grass/thatch/straw | | ▪ Firewood | |
| ▪ Corrugated iron/galvanized iron | | ▪ Charcoal | |
| ▪ Concrete/slate/roof tiles/asbestos | | ▪ Cow-dung | |
| ▪ Other (Specify) | | ▪ Paraffin/kerosene | |
| | | ▪ Gas | |
| **Walls** | | ▪ Electricity | |
| ▪ Un-burnt bricks | | ▪ Other | |
| ▪ Burnt bricks | | | |
| ▪ Corrugated iron sheets | | **Toilet facility** | |
| ▪ Wood/mud and wattle | | ▪ None | |
| ▪ Cement blocks | | ▪ Communal pit latrine (ordinary) | |
| ▪ Other | | ▪ Communal VIP | |
| | | ▪ Own pit latrine (ordinary) | |
| **Source of lighting** | | ▪ Own pit latrine VIP | |
| ▪ Fire/reeds | | ▪ Flush toilet | |
| ▪ Candles/tadooba/wicker lamp | | ▪ Other | |
| ▪ Paraffin/hurricane lamp | | | |
| ▪ Gas lamp | | **Source of drinking water** | |
| ▪ Electricity | | ▪ Well inside compound | |
| ▪ Other | | ▪ Tap inside compound/house | |
| | | ▪ Communal tap/well/borehole | |
| | | ▪ River/stream | |
| | | ▪ Other | |