AGRICULTURAL TECHNOLOGY INNOVATION SYSTEM: A CASE OF TARP II-SUA AND PANTIL BANANA RESEARCH PROJECTS IN TANZANIA

BY

EMMANUEL GABWENDA RWAMBALI

A THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

2012

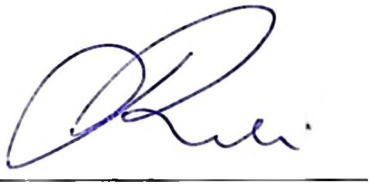
ABSTRACT

In principle the innovation systems approach, examines the interactions and institutions that affect actors to innovate and adapt technology. Roles and functions played by farmers and other actors determine farmers' response to innovation. This study was conducted in the PANTIL and TARP II-SUA project areas in Tanzania, involving 182 respondents to investigate the banana technological innovation system that emerged as a result of the two projects. Technologies and practices developed were examined, various actors and their functions and roles identified, institutional relationships investigated, strategies and approaches for dissemination evaluated and the resultant technological innovation system described. The results indicate that technologies and practices of banana pit size, new planting materials like tissue culture, new high yielding and disease resistant varieties, spacing, de-suckering, mulching, fertiliser application and pests' control were advanced and ultimately adopted by farmers. There were more adoptions among project farmers than it was for non-project farmers and were significantly ($p<0.05$) better in improved banana varieties, spacing, pit management, thinning and in getting new markets. Rungwe farmers did significantly ($p<0.05$) better in fertilising farms because of keeping livestock while Mkuranga significantly ($p<0.05$) better in finding new markets because of their proximity to huge urban markets. Institutional participation was dominated by research and training institutions of PANTIL, TARP II-SUA, ARI-Uyole and local extension agents and less of other components of the innovation system especially marketing, credit, input supply and transportation institutions. Thus, agricultural technology innovation system for banana that was developed during the two projects was impaired due to non-participation of other key institutions. It is thus recommended: (i) Future innovation efforts to accommodate all key elements of the innovation system. (ii) Ensure sustainability by intensively training few farmers in the technologies and relevant extension techniques to better assist their colleagues. (iii) Vary approaches of engagement and methods of dissemination. (iv)

Facilitate farmers to be innovative to address missing institutional roles and functions. (v) Improve agricultural shows through diversification of methods.

DECLARATION

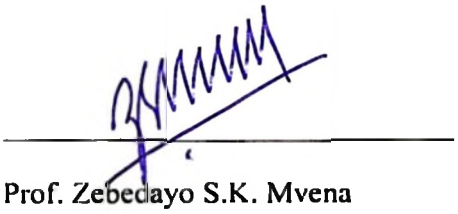
I, **Emmanuel Gabwenda Rwambali,** do hereby declare to the Senate of Sokoine University of Agriculture that this thesis is the result of my own original work and has neither been submitted nor concurrently submitted for a degree award in any other institution.



12.12.2012

Emmanuel Gabwenda Rwambali Date

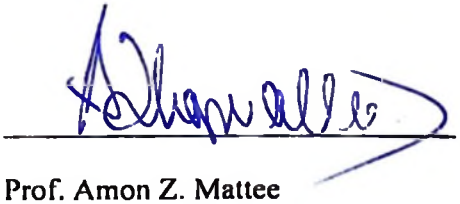
The above declaration is confirmed by:



13/12/2012

Prof. Zebedayo S.K. Mvena Date

(Supervisor)



13/12/2012

Prof. Amon Z. Mattee Date

(Supervisor)

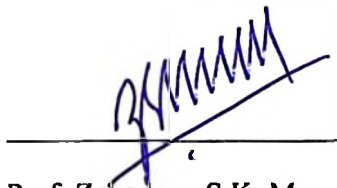
DECLARATION

I, **Emmanuel Gabwenda Rwambali,** do hereby declare to the Senate of Sokoine University of Agriculture that this thesis is the result of my own original work and has neither been submitted nor concurrently submitted for a degree award in any other institution.

12.12.2012

Emmanuel Gabwenda Rwambali Date

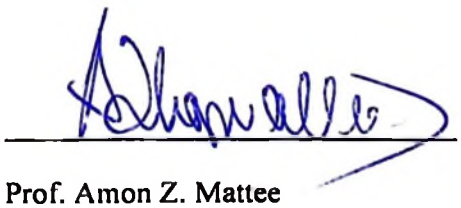
The above declaration is confirmed by:



13/12/2012

Prof. Zebedayo S.K. Mvena Date

(Supervisor)



13/12/2012

Prof. Amon Z. Mattee Date

(Supervisor)

COPYRIGHT

ACKNOWLEDGEMENT

I would like to acknowledge the contributions made by various individuals and institutions that in one way or another made the study a success. First of all I would like to acknowledge the financial support by the Government of the Royal Kingdom of Norway through PANTIL, for providing the scholarship which made this study possible.

I would like also to extend my sincere appreciation to the farmers who agreed to set aside time to participate in the survey as well as in the focus group discussions (FGD). Likewise, it is important to acknowledge the participation of extension agents and agricultural officers in the three districts and banana traders who brought with them various valuable experiences.

Gratitude is extended to my supervisors, Prof. Z.S.K. Mvena and Prof. A.Z. Mattee for guidance and supervision they provided to make this study a reality. Credit is also extended to enumerators and recorders of the FGDs, in particular Mr. N. Mabebe and Mr. J. Kidudu. Similarly, I would like to extend my sincere appreciation to the staff of the Department of Agricultural Education and Extension for the assistance they provided me, but in particular to Dr. K.K. Mwajombe and Dr. F.T. Magayane on data analysis advice. Savera, Evelyn and Gladys Rwambali are appreciated for their encouragements.

It is not possible to mention everybody, but each and everyone's contribution was equally important and I'm indebted to all of them.

DEDICATION

This work is dedicated to my late mother, Perus Nyangere Rwambali and my late father, Thomas Rwambali Manyama for their commitment in educating their children. God bless their souls.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

ARI	Agricultural Research Institute
ASDS	Agricultural Sector Development Strategy
ASLM	Agricultural Sector Lead Ministries
ASDP	Agricultural Sector Development Programme
CBO	Community Based Organisation
CTA	Technical Centre for Agricultural and Rural Co-operation
DADPs	District Agricultural Development Plans
EAHB	East African Highland Bananas
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GDP	Gross Domestic Product
FHIA	Fundacion Hondurean de Investigation Agricola
FFS	Farmer Field School
IDE	International Development Enterprise
KAPMACOS	Kiroka Agricultural Produce Marketing Co-operative Society
MKUKUTA	Mkakati wa Kukuza Uchumi na Kupunguza Umasikini Tanzania
MVIWATA	Muungano wa Vikundi vya Wakulima Tanzania
NGO	Non-Governmental Organisation
NSI	National System of Innovation
PANTIL	Programme for Agricultural and Natural Resources Transformation for Improved Livelihoods
RPF	Resource-Poor-Farmers
RRF	Resource-Rich-Farmers
SACCOS	Savings and Credit Cooperative Society
SIS	Sectoral Innovation System

SNAL	Sokoine National Agricultural Library
SUA	Sokoine University of Agriculture
TaCRI	Tanzania Coffee Research Institute
TARP II SUA	Tanzania Agricultural Research Project Phase II, Sokoine University of Agriculture
TORITA	Tobacco Research Institute of Tanzania
TOT	Transfer of Technology
TRIT	Tea Research Institute of Tanzania
Tshs	Tanzanian Shillings
TSIS	Technology Specific Innovation System

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Increasing the rate of innovation is important since innovation is a key determinant for economic growth and development. Therefore, there has always been a strong need to influence the speed and direction of innovation and technological change by governments, research institutions, change agents and other developmental institutions (Hekkert *et al.*, 2006). Agricultural development is crucial to the Tanzanian national economic development, as it is for many developing countries, since over 80 percent of Tanzanians directly or indirectly depend on agriculture (United Republic of Tanzania - URT, 2003; Spielman, 2005). Thus, there have been deliberate efforts by the Tanzanian government, non-governmental organisations and other institutions to improve the agricultural sector through various innovations and initiatives in order to speed up the process of agricultural growth and development.

One such effort has been in the area of banana production through the Tanzania Agricultural Research Project Phase II, Sokoine University of Agriculture (TARP II SUA) and the Programme for Agricultural and Natural Resources Transformation for Improved Livelihoods (PANTIL). The purpose of TARP II SUA was to introduce the application of the *in vitro* micro-propagation to produce pest and disease free planting materials for farmers and to introduce new cultivars with desirable qualities of high yielding, resistance to diseases such as "Sigatoka" and "fusarium wilt" as well as resistance to pests like banana weevils. In line with that was also the objective of improving banana agronomical and pest management practices (TARP II SUA Project, 2005). Following the new Programme of PANTIL there was an extension of such efforts with an additional objective of establishing

a sustainable system of dissemination and distribution of clean banana planting materials. The term banana in this context refers to the crops of the *Musa spp.*, which include banana and plantain (PANTIL, 2007).

According to an impact assessment study based on the transfer of technology model conducted in 2004, there was an indication of relatively better rates of adoption of banana technologies among farmers in Rungwe District as a result of the TARP II SUA banana project (TARP II SUA Project, 2005). Unfortunately, little is known of the roles and participation of other actors in the development of those technologies. Similarly, little is known of how the technologies were finally integrated into the local farming system.

Lusty (2003), on the other hand, observed that if the aim is to transform a subsistence crop through innovations, one needs to examine both sociological and biological factors. On the biological side one needs to investigate for example, what kind of varieties will be prolific given the climate conditions, weather, soils, water availability and resistance to diseases and pests. The sociological approaches are needed to investigate in detail the links between, for example, labour input and the development of skills and knowledge associated with adoption of new varieties and associated technologies and the most appropriate dissemination pathways.

Similarly, it is observed that influencing technological change towards a desirable direction, especially sustainable technological change, involves other changes such as user practices and regulations and not just technical change. Thus, there has been an increasing recognition within the scientific community that technological development and change can well be understood as the outcome of innovation systems (Gu, 1996; Geels, 2002; Sagar and Holdren, 2002). An innovation system can be defined as a network of actors,

firms and other economic agents together with the institutions and policies that influence their innovative behaviour and performance to bring new products, processes and new forms of organisation into economic use (Mytelka and Goertzen, 2004). This network of actors and institutions is normally constituted from both public and private sectors, and, through their interactions could initiate, adopt or modify and diffuse new technologies (Lundvall, 1992).

Thus, the contemporary understanding based on the innovation systems approach is that the linear transfer of technology model of innovation, which postulates a smooth progression of sequential steps of innovation from basic research, followed by applied research and development, and ends with production and diffusion among farmers is of little value in evaluating the capacity development, relationships of various actors and knowledge production (Velho, 2002; Hall *et al.*, 2003; Godin, 2006; Rajalahti *et al.*, 2008; United Nations, 2010). This is because the development of innovation is normally stimulated and influenced by many actors and factors and not just the developers, disseminators or users of the technology (Doloreux and Parto, 2004; Hekkert *et al.*, 2006). Similarly, as a result of not recognising the roles of other actors, tasks of technology development (research) and technology transfers to farmers (extension) under the linear model are normally performed by two separate organisations with tightly defined and mutually exclusive roles. There is thus little interaction between research and extension since they rarely sit together to share knowledge and experiences between them and even with other actors such as technology users, private companies, Non-Governmental Organisations (NGOs), markets and credit institutions (Sulaiman and Hall, 2002).

Since technological change is a dynamic process that requires a transformation of the innovation system in which changes are taking place, therefore, a dynamic innovation

system approach is also needed to understand, analyse and explain it (Hekkert *et al.*, 2006). Thus, the innovation systems approach, which in principle examines the interactions and institutions that affect heterogeneous agents' strategic efforts to innovate, adopt and adapt technology, becomes appropriate for such an analysis (Spielman, 2005).

The innovation systems approach is built on two major sets of theories. First, are the evolutionary theories of economic and technological change, which conceptualise innovation as an evolutionary and social process that is stimulated and influenced by many actors and factors, both internal and external (Doloreux and Parto, 2004; Iturriagagoitia, 2005; Lundvall, 2007). Second, are the interactive learning theories, which mainly focus on the relations produced among the agents within a system (Iturriagagoitia, 2005; Hekkert *et al.*, 2006). Thus, operationally in the innovation systems approach one needs to examine the interactions between different actors in the innovation process, especially between users and producers, between business and research, the role of institutions and the extent to which innovation processes are institutionally embedded in the settings of systems of production (Doloreux and Parto, 2004).

1.1.1 Theoretical orientation

The innovation system's concept of structure, parts (actors) and their corresponding functions, mainly originates from the sociological functionalists perspective. Functionalists think of a society or an organization similar to a living organism which is made up of structure with different parts. Each part of the structure performs a different function but to the benefit or survival of the entire organism. Therefore, functionalist theory views society or organization with different parts as being in natural state of equilibrium. Each part of the structure plays a certain role which could be different or unique from the other but ultimately it contributes to the balanced functioning and survival of the system as a whole.

The theory's proposition is therefore that the system tends to move toward a state of stability or balance (Schaefer, 2005). This view of the society or organization having a structure with parts that perform different functions of the functionalists' perspective, is the one borrowed into the innovation systems perspective (Iturriagagoitia, 2005; Lundvall, 2007).

Like the functionalists, the innovation systems perspective also recognises the existence of actors like parts in the functionalist perspective, participating in the innovation system and ending up creating a relationship structure. Those actors could be individuals or institutions performing different functions for the benefit of the entire innovation system (Iturriagagoitia, 2005; Hekkert *et al.*, 2006). However, the point of departure between the functionalists and the innovation system perspectives is where the functionalists consider the parts functions to ultimately contribute to the stability of the system or in other words reaching equilibrium and hence stability. Abrupt change for that matter from the functionalist point of view is seen as a disruptive force of the system especially considering that the system is already in equilibrium. Therefore, the functionalists focus on what maintains a system rather than what changes it. Thus, the functionalists' perspective minimizes the importance of change (Schaefer, 2005).

On the other hand the innovation systems perspective focuses on change rather than stability as a positive force to creation of new relations amongst the parts or even attracting into the system new parts to serve for new functions and spearhead the system forward to a higher level of development. From the innovation systems perspective, the system is taken as a dynamic relationship in which change is a constant feature. Change is considered by the innovation system perspective as a positive constructive aspect rather than destructive. Therefore a dysfunctional element which is considered undesirable by the functionalists is

seen as a source of change by the innovation system perspective. It is for this reason that the innovation systems perspective had to look for an alternative explanation of the dynamic nature of the system from the learning theories since that of functionalists could not suffice (Hekkert *et al.*, 2006).

Though the functionalist theory could explain well how systems are formed by different parts and how those parts perform different functions for the benefit of the entire system however, it could not explain how beneficial changes or new parts or even new arrangements could be to a system. The explanation of such dynamism under the innovation systems paradigm had to be provided or adopted from the learning theories (Doloreux and Parto, 2004; Iturriagagoitia, 2005; Lundvall, 2007).

From the learning theories perspectives it is believed that when people come together they share information, exchange ideas and experiences and ultimately result into new ideas, knowledge, and reorganization of thoughts, rearrangement and even creation of new relations or institutions. Constructivist theorists for example, claim that understanding is shaped by personal experience and learning is an interactive process that involves adapting our mental frameworks to accommodate fresh information (Lefrancois, 2011). Facilitation in form of extension or developmental project therefore should often incorporate a variety of techniques to engage a learner's unique learning style, including collaborative learning and direct instruction. The intention is to develop a learner's contextual understanding of issues. Similarly, learning theorists in the constructivism perspective, advocate strategies that actively encourage participation and problem solving among actors or learners.

On the other hand holistic learning theorists take an approach, which seeks to stimulate the learner as a "whole." The models often prioritize learners or actors' interaction at all levels.

The experimental learning cycle is a common technique used to emphasize experience, cognition, perception and behaviour. It outlines how experience is translated into concepts through employing the four sequential stages of "concrete experience," "observation and reflection," "forming new concepts" and "testing new situations." For action learning theorists, learning is inextricably linked with real-world experiences. This approach emphasizes interaction by promoting small cooperative groups, which convene to collectively reflect on the life-issues of each member. According to this theory "action" within the real-world is paramount input to learning. The interrogative nature of action learning helps members to strengthen their problem solving skills (Lefrancois, 2011).

Similarly according to social learning theory, a person's personality consists of a sum of all learning tendencies that he/she has acquired from society though interaction. Social learning theory suggests that you learn from others through modelling, studying and imitating. In other words, people learn through observing other people's behaviour and attitudes, as well as the effects of those behaviours (Lahey, 2001; Schaefer, 2005).

This dynamic force of interaction and resultant learning as proposed by various learning theories is important from the innovation systems perspective point of view because it is the reason for creation of new relations, institutions, technologies and their dissemination and ultimately realizing development that is in tune with the realities of the time. According to Schaefer (2005), social interaction is a key element to development. Learning to behave and act accordingly within a certain context is a fundamental aspect of human socialization. People will interact, learn and come up with new ideas, form new associations or relations as well as invent new technologies or practices to overcome their problems. These interactions create synergism that promotes development.

That being the case, if technology is developed under the innovation systems approach it is possible for researchers to incorporate the concerns of other actors of the system and thus, increase the chance of technology utilisation and its sustainability. Similarly, if one has to evaluate technology use or innovation, using the innovation systems framework, it provides the opportunity to understand what was the nature of interaction among actors, what kind of learning took place, the limitations and functions of various institutions and how they affected the technology or innovation. Such an understanding will assist in incorporating changes or addressing pertinent issues as the innovation takes place (Iturriagagoitia, 2005; Lundvall, 2007). Such a framework may also guide the technology development, dissemination and utilisation process.

It was thus, the interest of this study through the innovation systems framework and specifically the technological innovation system to use the experiences of TARP II SUA and PANTIL projects to investigate the kind of technologies developed, disseminated and utilised. Similarly, to determine the actions and roles of the systems actors in the development, dissemination and utilisation of the technologies, learning that took place, limitations and the kind of linkages various actors of the system created and their influences. For example, what roles did the policy institutions such as the Ministry of Agriculture, Food Security and Cooperatives play? What roles did research institutions like Sokoine University of Agriculture, Agricultural Research Institutes (ARI) of Mikocheni and Uyole Agricultural Centre play? What was the role of the local government extension departments? What roles did the Non-Governmental Organisations that promote innovations and those that provide credit and seek markets for farmers play? It was also important to map out the marketing arrangements that emerged, resource mobilization processes and how they all influenced the nature of the innovation and innovation system that emerged. Such an understanding would not only add to the knowledge base but also

provide lessons to other future research or developmental projects on how best to handle developmental research processes and dissemination efforts.

1.2 Problem Statement and Justification

According to the innovation systems approach, if the innovating project or technological experts fails to recognise the roles and relations played by farmers, other actors and institutions such as the input suppliers, traders, markets, training, credit, research and extension institutions as well as policies that govern the process among many, could jeopardise the way farmers respond to the innovation (Technical Centre for Agricultural and Rural Co-operation - CTA, 2005; Iturriagagoitia, 2005; Lundvall, 2007). One of the most sidelined aspects, which ultimately results into poor utilisation of the agricultural innovation or technology by the recipients has been lack of involvement of other key actors. Sometimes poor impact is observed on the technology that has proved worthwhile by researchers and research institutions, simply because farmers' innovation of the technology and the roles and actions that other actors need to play are normally ignored in the entire process of designing of the technology and dissemination processes (Hekkert *et al.*, 2006).

In the past, little attention has been paid to analysing the innovation system and how actors and institutions interact to shape the innovation or technology. A considerable knowledge gap still exists especially in banana production innovation system under the TARP II SUA and PANTIL banana projects on the actions of various actors and institutions or their non-participation and how that has influenced the actions and decisions of the producers in responding to the innovation. In the TARP II SUA project for example, various aspects of banana production were researched and disseminated such as the application of disease free planting materials, new cultivars with high yielding, disease and pest resistance qualities as

well as improved agronomical and pest management practices (TARP II SUA Project, 2005). Their impacts were assessed on the rate of adoption and implied benefits in terms of income or material assets acquired (TARP II SUA Project, 2005). However, little effort and studies were made by the two projects to check on how the various actors participated in the entire process of development of the innovation.

Similarly, little is known in terms of the limitations and constraints that farmers faced and continue to face in the process of integrating the innovation and which institutional supports were and are available or unavailable. Understanding of such limitations and constraints and resolving them is crucial if you are to develop and maintain a vibrant innovation system. Also little was known of the kind of relationships and communication flows that actors had established with each other. Along that line, it was also important to know which other actors, if involved, would have been instrumental in supporting, moulding and speeding up the rate of innovation process by providing the required services or expertise. It was equally vital to know what kind of entrepreneurial activities actors were undertaking in relation to the innovation such as banana value addition or processing, the knowledge development, the networks that they had established, market formations, resource mobilization and which policies have favoured or hampered the process. Unfortunately, so far most of the research and dissemination efforts under the two projects had been mainly agronomic in nature. This study through the Technological Innovation Systems Approach by analysing the five elements to be found in such a system answers the above-mentioned issues.

The necessity to study and influence innovation processes arise out of the fact that it is possible to create economic growth through understanding and promoting valuable innovation systems through participation of the five key stakeholders categories. This is

especially important since the use of certain technologies can result in serious unintended negative outcomes or side effects. Since technologies use resources, the understanding of the innovation systems will lead into a more efficient use of resources as well as minimising the negative side effects. Similarly, with such an understanding it is possible to make the process more inclusive through involving other actors that can assist in the implementation of the innovation and thus, realise a sustainable technological development in a direction that is desirable (CTA, 2005; Iturriagagoitia, 2005; Wixted, 2006; Lundvall, 2007).

By using the innovation system approach, this study generated knowledge not only on what transpired during the development of the innovation and the extent of adoption of the technologies, but also on which actors/institutions from the farmers' point of view were needed to participate in banana technological innovation system and the kind of roles they should have played. Similarly, the study pinpoints the kind of research activities that need to be undertaken, the mode of dissemination, the kind of relations that need to exist, the type of communication and training needs in order to make such an innovation a viable one. As a result, these issues determine the kind of research objectives that are pursued.

1.3 Objectives

1.3.1 Main objective

To establish the agricultural technological innovation system that has emerged in the banana production system as a result of technologies promoted by TARP II SUA and PANTIL banana projects.

1.3.2 Specific objectives

i) To identify the technologies and practices developed for banana under TARP II-SUA and PANTIL projects.

ii) To identify and map the various actors, their functions and roles in the banana technology innovation system.

iii) To determine and map the institutional relationships, communication and interactions and their effect in shaping the banana innovation technologies.

iv) To evaluate strategies and approaches used by various institutions involved in promoting the banana innovation technologies.

v) To describe the agricultural technology innovation system developed for banana in the Eastern and Southern highlands zones of Tanzania.

1.3.3 Research questions

i) What were the technologies and improved practices developed for banana under TARP II and PANTIL projects?

ii) Which actors participated in the technology development, what were their roles and how were they involved?

iii) What is the relationship between technology utilisation/adoption and the involvement of various actors and institutions?

iv) Which actors and institutions and how were they involved in the process of technology dissemination and with what effect?

v) Based on the findings how can we describe the agricultural technology innovation system for banana in the Eastern and Southern highlands zones of Tanzania?

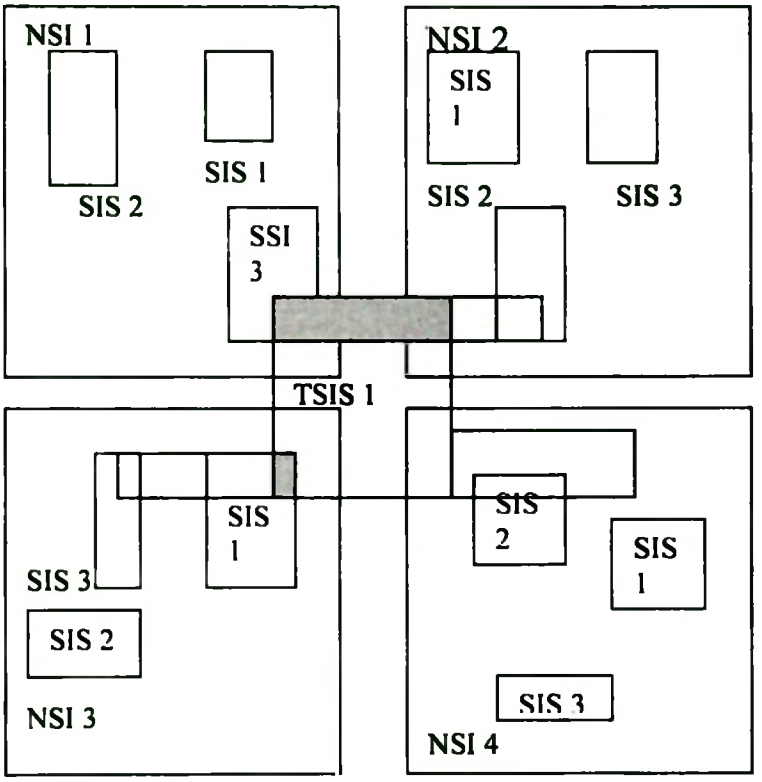
1.4 The Conceptual Framework

Since its emergence about two decades ago the national innovation system paradigm has evolved and other system level analyses have emerged. These include the regional innovation systems, cluster innovation systems, sectoral innovation systems and technological systems of innovation, which together constitute the innovation system framework (Wixted, 2006). However, when innovation systems are studied at a national level, the dynamics are difficult to map because the national innovation system consists of many actors, networks, relations and complex institutional set-ups. Such circumstances compel one not to map the dynamics and instead just focus on the structure (Iturriagagoitia, 2005; Spielman, 2005; Lundvall, 2007).

In order to understand the determinants of change, an insight in the present structure of innovation system is not sufficient. Ideally one needs to capture the dynamics of innovation systems in order to have a better understanding of what really takes place inside these systems. Thus, empirical studies for mapping the dynamics are possible through technology specific innovation system (Hekkert *et al.*, 2006). According to Andersson and Jacobsson (2000), the technology specific innovation system is the most dynamic innovation systems approach.

Conceptually the technology specific innovation system has the advantage of overlapping both in the geographical and sectoral dimensions (Figure 1) since the relevant knowledge base could be originating from various geographical areas or even around the world. The knowledge it embodies is hardly ever embedded in just the institutional structure of a single nation or region (Hekkert *et al.*, 2006). For example, most of the introduced "sigatoka" disease resistant cultivars in the TARP II SUA project originated from International Research Centres like the Fundacion Hondurean de Investigation Agricola of Honduras. Similarly, some of the cultivars collected from Kagera Region at Maruku Agricultural Research Institute came in through Uganda (Maerere *et al.*, 2004).

Illustration of the conceptual framework



NSI = National System of Innovation
SIS = Sectoral Innovation System
TSIS = Technology Specific Innovation System

The figure illustrates how the Technology Specific Innovation System (TSIS) could overlap both in the geographical and the sectoral dimensions. The bigger green blocks represent the different National Systems of Innovation (NSI) of which each could be containing a number of Sectoral Innovation Systems (SIS) represented by white smaller blocks. As indicated in earlier discussion, the relevant knowledge base for most technologies originates from various geographical areas all over the world. A technology, or the knowledge it embodies, is hardly ever embedded in just the institutional infrastructure of a single nation or region. Fortunately, the TSIS approach can overlap both in the geographical (NSI) as well as the SISs of those nations.

Figure 1: Boundary relations between National, Sectoral and Technology Specific Innovation Systems (Source: Adapted from Hekkert *et al.*, 2006).

Since innovation has already been conceptualised as an evolutionary social process, which is stimulated and influenced by many actors and factors (Doloreux and Parto, 2004; Hekkert *et al.*, 2006; Spielman, 2005; Lundvall, 2007), there is need therefore, according to Hekkert *et al.* (2006), to look critically at the entire innovation system. They further suggest taking the innovation project as a starting point as it will allow attention to be paid to the dynamics of innovation processes. Therefore, elements pertaining to banana production innovation system (Figure 2) were analysed to be able to tell the kind of innovation that took place.

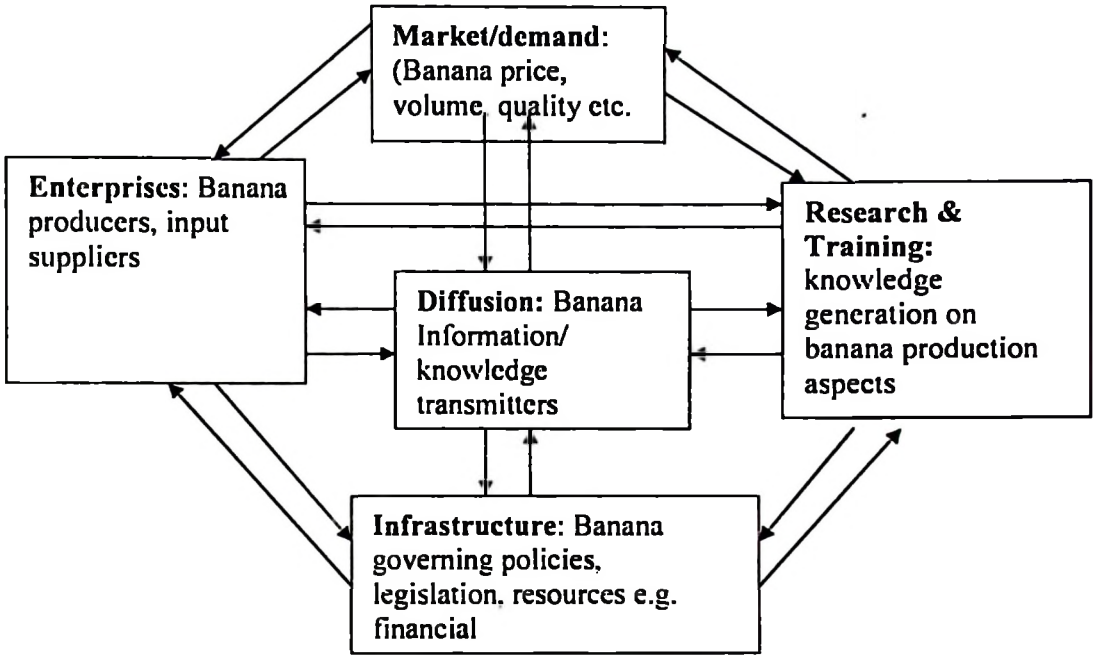


Figure 2: Elements of the Technology Specific Innovation System (Source: Adapted from CTA, 2005)

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

Many factors motivate people to accept new ideas and practices or innovations. These factors could be psychological, sociological, economic or a combination of those (Maunder, 1973). However, the success of the spread of new technology within the resource-poor-farmers (RPFs) will depend on the model used. The commonly known Transfer-of-Technology (TOT) model, according to Chambers (1985) has had immense success in industry and agriculture with resource-rich-farmers (RRFs). But the same had severe shortcomings with RPFs because research is conducted in controlled conditions, with excellent access to inputs, without significant cost or labour constraints, and without the requirement that a crop must be marketed and make a profit.

When RPFs do not adopt "good" new technology it is attributed to their ignorance. However, there is sufficient evidence and understanding that when RPFs do not adopt technology, it is because it does not fit their needs, their physical, social and economic conditions. For example, from the smallholder rice producers' point of view in the Eastern and Southern Highlands zones of Tanzania, availability of credit and marketing arrangements highly influenced whether a rice innovation was used or not and also the inadequacy determined the kind of adaptability undertaken (Mwaseba, 2006).

On the other hand, various institutions and actors, and not just their own discretion, govern farmers' decisions to adopt a technology. Among many other things that influence them include: the resources that are available to them, the kind of relationships that have been created with other actors, the information, knowledge and training that they receive, the

governing policies and laws, the market forces and other infrastructure aspects. Innovations are therefore not solely the product of organised research and development activities within research institutions and universities (CTA, 2005). That is why Sagar and Holdren (2002), suggest the use of innovation systems approach to understand technological development and change. Rajalahti *et al.* (2008) actually points out that declining agricultural productivity in many African developing countries can be reversed through building agricultural innovation systems that provide the enabling framework not only for the adoption of existing technologies but also the development of new ones that are suited to African needs.

2.2 Concepts and Their Relationships

2.2.1 Innovation and technology

According to Rogers (2003), an innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption. If we take a traditional meaning of innovation to be seen as "new combinations" their diffusion, absorption and use, then even interactive learning taking place in connection with production and sales will be part of the source of innovation (Lundvall, 2007). It is clear from this definition that an innovation may involve either technical or social change or both and this might also include organisational and institutional change (Tidd, 2001).

From that sense innovation could be viewed as the ability and processes of assembling new knowledge and technical options to create new policies, institutions, strategies, technologies and practices that would bring both economic and social benefits to people (Goel *et al.*, 2004; Leeuwis and van den Ban, 2004). It can thus be concluded that innovation requires the integration of new ideas, knowledge, experiences as well as creativity and initiatives of various actors including researchers, farmers, policy makers,

service providers like extension and other key stakeholders to make it happen (Leeuwis and van den Ban, 2004).

Technology on the other hand according to Niosi *et al.* (1993), is technical knowledge about the production of goods and services. In other words technology development would be the process of transforming new or existing knowledge into new ways of producing goods and services. Sumberg and Reece (2004) identify two forms of such knowledge: research outputs which are formal knowledge generated through systematic inquiry, while experience and know-how representing informal and generally uncodified knowledge. This highlights the idea that formal knowledge is one important element feeding technology and innovation more generally.

When the two definitions of technology and innovation are combined, then "technical innovation" will be a new or improved product or process that is based on new or a reinterpretation of existing technical knowledge about the production of goods or services. Therefore it can be conceptualised as a bundle comprised of the benefits that are expected to accrue to a user and the physical and management of resources required making use of it (Sumberg and Reece, 2004). Thus, the value of any particular technology or technical innovation will depend on how well the benefits and resource requirements match the interests and available resources of potential users.

2.2.2 The concept of innovation systems

If innovation is seen as technical or social change or organisational and institutional change accompanied by their diffusion, absorption and use, then, the concept of "innovation systems" would be an attempt of analysing societal subsystems, actors and institutions contributing in one way or the other, directly or indirectly, intentionally or not, to the

emergence or production of innovations (Hekkert *et al.*, 2006; Hall *et al.*, 2003; Lundvall, 1992). The concept recognises that innovations emerge from systems of actors. These systems are embedded in an institutional context that determines how individual actors behave and how they interact with other elements of the system. It is further argued that learning is an interactive and thus socially embedded process, which cannot be understood without reference to its institutional and cultural contexts (Lundvall, 1992).

If a position to know the kind of communication and interactions that are taking place among actors is reached and also be able to delineate which ones are enhancing or impinging the innovation, then it is possible to intentionally shape the innovation processes. In other words if we are able to know how innovation systems are "functioning," it is possible to influence innovation processes in the direction that we want (Hekkert *et al.*, 2006).

Similarly, knowing the actors and their roles, resources and limitations in the banana innovation systems, the kind of interaction they have and the functions of various institutions, it is possible to understand and explain the nature of innovation in that system. With such an understanding then it is possible to decide or determine the direction of technological innovation that needs to take place in order to make banana a viable crop that can significantly contribute to people's livelihoods as well as the nation's foreign exchange earnings. It is thus from such an understanding that the innovation systems approach regards reflection on process and institutional learning as key elements for success (Hall *et al.*, 2003).

Since it is important to understand innovation as an interactive learning process (Lundvall, 2002), then at the core of all innovation systems is the flow of knowledge and information

that link economic actors and institutions and provides stimulus to innovation (Mytelka and Goertzen, 2004). The understanding of institutions in this regard go beyond the formal structures or organisations to include sets of common habits, established practices, rules and regulations that govern relations and interactions among individuals and groups that prescribe behaviour roles and shape expectations (Edquist, 1997). Similarly, indicators for such interaction can include joint training, sharing of knowledge, joint research or joint publications (Iturriagagoitia, 2005).

The innovation systems analysis framework is also based on the interactive learning theory; it thus allows studying the socio-economic structure of a territory, its actors and their main competences as well as the relations produced among the agents within the system (Iturriagagoitia, 2005; Spielman, 2005; Lundvall, 2007). Thus, taken in its totality, the innovation systems approach demonstrates the importance of studying innovation as a process in which knowledge is accumulated and applied by heterogeneous agents through certain interactions that are conditioned by social and economic institutions (Spielman, 2005). Therefore the decisions by farmers on how to integrate the innovation are determined by such prevailing conditions.

2.3 The Innovation-Decision Process

The innovation-decision process is a process, which an individual or any other decision-making unit, passes through from acquiring knowledge, to forming an attitude, to decision to adopt or reject, to implementation of the new idea probably with modifications (Rogers, 2003). It is thus observed that through innovation systems approach due to its nature of interaction and participation, the innovation decision process can be hastened since farmers right from early stages get opportunities to learn and receive reinforcements from various actors (Hall *et al.*, 2003; Spielman 2006; Agwu *et al.*, 2008).

Reece and Sumberg (2003) on the other hand noted that making a decision is just half way of the process. A farmer needs to implement that decision to have the anticipated or desired effect. They further note that a farmer who has a high degree of control over key resources such as land and labour generally will be better able to implement consistently and successfully his/her decisions than a farmer with less control. Similarly, they highlighted wealth to be an important factor accounting for variation in implementation as well as age and gender since they affect one's access to and control over productive resources including time. These factors will also influence technology choice since farmers with less control over such resources are unable to meet the more stringent management requirements of some technologies.

Decisions related to crop production as observed by Sumberg and Reece (2004), are motivated by a combination of objectives which include to produce more, better quality or different products, to increase efficiency and competitively do better. Thus, farmers are viewed like any other entrepreneur or manager who seeks innovation to increase efficiency, market share, competitive advantage and range and quality of products. This strive for advantage includes both 'product innovation' meaning change in the type, range or quality of products produced or services offered and 'process innovation' which refers to change in the way products or services are created or delivered.

However, one of the important aspects within the process and especially at an early stage of knowledge acquisition, which also determines the kind of decisions that are going to be made further at later stages through the process, are the characteristics of the decision making unit. The socio-economic characteristics, personality and communication behaviour can determine how the characteristics of the innovation in terms of relative advantage, compatibility or even complexity are going to be perceived, adopted and

ultimately adapted. For example, a study in Kagera Region on vanilla production found that access to manure and labour through owning cattle or goats led to acceptance to fertilise the farm and therefore increase productivity (Rweyemamu *et al.*, 2007).

Thus, from the innovation systems perspective it is not just the socio-economic characteristics that need to be examined in determining their decisions but also their habits and practices in learning, linkages with other actors, investment capacity, their competencies in terms of accessing information, technology and finances as well as their understanding of policies that govern these processes (Hall *et al.*, 2003; CTA, 2005).

2.4 Main Tanzanian Agricultural Sector Policies and Strategies and Their Implications to Banana Production

As reflected in Tanzania's Development Vision 2025, the agricultural sector should be productive, profitable and commercialised by 2025. According to The Tanzania National Strategy for Growth and Reduction of Poverty (NSGRP) of June 2005 popularly known by its Kiswahili acronym as "*Mkakati wa Kukuza Uchumi na Kupunguza Umasikini Tanzania*" (MKUKUTA), agriculture is the leading sector in the Tanzanian economy. Agriculture provides income to about 82% of the population which are mainly rural and it contributes about 45% of the GDP (URT, 2005a). Thus, the NSGRP gives high priority to agriculture and rural development in order to eradicate poverty. The Tanzania Agricultural Sector Development Strategy (ASDS) of 2001 and The Rural Development Strategy of 2001 on the other hand have defined the approaches to undertake in order to achieve that goal (United Republic of Tanzania- (URT) 2003; 2005b). The Tanzania Agricultural Sector Development Programme (ASDP) that was put into operation since 2005 provides the overall framework for implementing the ASDS. Activities at national level are implemented by the Agricultural Sector Lead Ministries (ASLM), while activities at district

level are implemented through their District Agricultural Development Plans (DADPs) (United Republic of Tanzania, 2003).

Since the mid nineteen eighties when the macroeconomic reforms started, there have been changes in the Tanzanian public policies in relation to agricultural sector. Some of the important ones include: The Tanzania Agricultural and Livestock Policy of 1997, The Co-operative Development Policy of 1997, The Land Policy of 1995, The Microfinance Policy of 2000 and of 2005, The Rural Development Strategy of 2001, The Agricultural Sector Development Strategy of 2001 and The Small and Medium Enterprise Policy of 2002.

The Tanzania Agricultural and Livestock Policy of 1997 intended among many things to liberalise agricultural markets, involve the private sector in the production and provision of services like extension and ensure food security at household and national levels. The ASDS of 2001 builds on the Agricultural and Livestock and Cooperative Development policies to improve farm incomes and food security. The Rural Development Strategy of 2001 on the other hand targeted stimulation of rural economy in order to combat poverty through increasing opportunities and access to services, reducing risk and vulnerability, and good governance (United Republic of Tanzania 1997; 2003).

The Tanzania Agricultural and Livestock Policy covers important crops in the category of cash crops such as coffee, cotton, cashewnut, tobacco, tea, sisal and pyrethrum (United Republic of Tanzania 1997; Mpagalile *et al.*, 2009). Banana is never considered in this cash crop category despite Tanzania being the second producer in Africa after Uganda and among top ten in the world. The policy recognises banana under the category of horticultural crops as a fruit, and under the category of food crops. However, under the food crops, the first priority category consists of cereals (maize, rice and wheat) and the

second priority category is drought resistant crops (sorghum, millet and cassava). Banana is classified under the third priority food crops category as other staple crops after Irish potato and sweet potato despite being a staple food for more than 15% of the Tanzanian population. Also, despite banana and plantains being mentioned in the policy, amazingly they are never reported in national food crops production statistics (Maerere *et al.*, 2007b).

Since among the intentions of the Tanzania Agricultural and Livestock Policy of 1997 were to liberalise agricultural markets, involve the private sector in the production and provision of services in order to ensure food security at household level, the expectations would have been for the policy to give banana the priority it deserves. Since banana can serve as food and cash crop, such recognition would have helped to attract investment into the banana sector as it has been with other crops such as maize and rice or even cash crops such as cotton or coffee. Such acknowledgement would have also helped banana to be appropriately addressed in the ASDS of 2001 as a product that could be used to improve farm incomes and address the issue of food insecurity at household level. This would have been important since as it has been noted, banana caters as a food crop for slightly over 15% of the Tanzanian population. Similarly, this would have attracted services and investments in the banana sector by the private sector to a point of value addition activities or massively exporting banana.

Banana in Tanzania is mainly grown by small scale farmers and in some areas like, Kilimanjaro, Kagera and Mbeya is actually a staple food (Maerere *et al.*, 2007a; 2007b; Mpagalile *et al.*, 2009). Even in Uganda, the African biggest banana producer, banana is mainly produced by smallholder farmers who grow different varieties, for brewing, eating (apple bananas) and cooking which they call 'matooke'. Whereas most bananas in Uganda are consumed in the cooked form, they also produce other products such alcoholic

beverages, juice and banana chips (Kibwika *et al.*, 2009). Similarly in Tanzania, most of the bananas go directly from the field to the market without value additions. The little value addition in Uganda comes from processing banana chips or alcoholic beverages and juices while in Tanzania it is mainly alcoholic beverages (Maerere *et al.*, 2007b; Kibwika *et al.*, 2009). Most stakeholders in the banana industry had the opinion that there is less use of technology in the farming practices and in post harvest handling of banana that is why it is not very profitable. Similarly, they observed the fact that there were very few value addition activities in the banana value chain process which could have translated into increased income (Maerere *et al.*, 2007b).

In some parts of Tanzania however, banana crop is also used as animal feed by feeding animals with leaves, stems, excess green and ripe banana fruits as well as banana fruit peels. Similarly, after crop harvest, the crop remains are used as mulching materials to conserve moisture as well as to suppress weed infestation. In Kagera and Kilimanjaro areas for example, banana plants are also used as shade providers to shade-loving crops such as vanilla and coffee (Maerere *et al.*, 2007b).

As mentioned earlier, Tanzania ranks second to Uganda in banana production in Africa and seventh in the world, producing about 4% of the world production on approximately 250 000 hectares, while in Uganda banana production occupies about 1.4 million hectares (Edmeades *et al.*, 2006). Yet banana has never been given its due weight in the Tanzanian agriculture and in the economy at large. Banana crop is a big world wide business which Tanzania could advantage of and earn a lot of foreign exchange that is desperately searching for. Instead, Tanzania has contributed very little to the world's banana trade compared to other tropical countries of Latin America (FAO, 1995; Maerere *et al.*, 2007a; 2007b).

The low priority accorded to the banana crop has resulted into less investment into banana research by the government. Despite the Agricultural Policy of 1997, stipulating the aim of research as being to promote sustainable food security, income generation, employment growth and export enhancement through appropriate technology packages yet the implementation of that motive overtime by the government has been inclined towards cash crops. Just to illustrate, despite having Agricultural Research Institutes (ARI) in every zone that could cater for all crops including cash crops, because of giving more priority to cash crops, specific commodity research institutes were created for them with the support of the government. Such institutes include the Tanzania Coffee Research Institute (TaCRI), Tea Research Institute of Tanzania (TRIT) and the Tobacco Research Institute of Tanzania (TORITA) (Maerere *et al.*, 2007b).

What the Tanzanian government has done so far with banana is for the Ministry of Agriculture, Food Security and Cooperatives to just identify several opportunity areas for investment in the banana sector. One such area is the expansion of banana production in Kagera, Kilimanjaro, Morogoro and Mbeya Regions, involving investment in production and marketing of banana planting materials of desirable cultivars (Maerere *et al.*, 2007b). According to banana trials it is estimated that under good crop management and appropriate environment, yield of green banana can be as high as 60 tonnes per hectare per year. In Tanzania the average yield is about 30 tonnes per hectare (Ngeze 1994; Nkuba *et al.*, 2002, 2006; Edmeades *et al.*, 2006). This however is not that small if translated into food or monetary terms and therefore if properly attended to it could address issues of food insecurity and poverty in the country.

In order to realise significant change in any crop production, investment in research is inevitable. Research is one of the key elements of any agricultural innovation system since

that is where improved technologies are facilitated (Figure 2). Poor investment in banana research as it has happened in Tanzania has consequences to the development of banana sector as well as the nature of innovation system that will emerge. In order to change banana production and productivity especially for small scale farmers, a vibrant well financed participatory adaptive and applied banana research is necessary.

Despite the good intentions of Tanzania Agricultural and Livestock Policy of 1997 to involve the private sector in the production and provision of services like extension, the implementation outcomes so far are disappointing. Studies that have been carried so far indicate that very little has actually been done to engage the private sector both in agricultural production and in extension (Mattee *et al.*, 2008a, 2008b; CONCERN Worldwide, 2008; RAS/DADS Mbeya, 2008; European Union, 2007).

There have been some efforts in certain regions and districts of Tanzania such as Hai and Moshi districts to engage the private sector, agro-enterprises, NGOs and CBOs in provision of various services. However, in most other districts like Bukombe, Kilosa, Kilombero, Mbozi and Kahama, the engagement has mainly been confined to input supply (Mattee *et al.*, 2008a, 2008b; CONCERN Worldwide, 2008; RAS/DADS Mbeya, 2008).

In some districts there is a very limited involvement of other service providers in planning and implementation of the District Agricultural Development Plans (DADPs) especially the private sector, since some of the districts have not even carried out a detailed inventory of private agricultural service providers and their roles. Thus, the private sector participation in the agricultural sector has been low. Furthermore, the districts have not initiated the process of establishing district stakeholders' forums on agricultural development (Mattee *et*

al., 2008a, 2008b) and as a result other service providers especially the private sector find it difficult to locate the entry point.

Engagement of private sector could actually be quite beneficial to both sides between the private sector and the farmers since apart from business they could forge new relationships and also assume responsibilities that they never considered to be their mandate. For example, in the cassava industry (cassava value chain) a privately owned firm that processes and markets cassava products by the name Power Foods Company in Dar-es-Salaam found it necessary to establish a system of training farmers groups on better cassava handling and processing techniques. It embarked on techniques from harvesting stage to processing stage to minimise cyanide and reduce aflatoxins just to ensure it gets better products from farmers for its' own market. As a result of this initiative by the company, farmers benefited from better prices while the company got quality products (Mpagalile *et al.*, 2009).

If the private sector is engaged in the production of banana especially by opening up large commercial farms, it could be beneficial both to the country's economy as well as to the small scale farmers. Such investment normally compels one to use the recommend practices in order to realise returns that offsets the costs. Similarly, because of the need to access foreign markets, production process has to follow certain procedures and quality standards. Similarly, through export a country can earn foreign exchange out of banana. On the other hand, in order to meet the market demands sometimes the private sector is compelled to engage the surrounding small farmers and in the process pass on the required knowledge and skills to meet the standards as it was the case with Power Foods in the cassava value chain as reported by Mpagalile *et al.* (2009). In such relationship the private sector becomes not only the skill facilitator but also the market for small farmers. The

private sector can also play a key role in the banana value chain in terms of adding value such as processing banana into products like banana chips or juice.

As far as extension is concerned, to some extent projects and activities under DADPs have improved farmers' access to extension services. However, with few exceptional districts like Moshi and Hai where you have an extension agent in every village, other districts are only guaranteed an extension agent at the ward level where an extension agent serves several villages. In Kahama District for example with 221 villages in 34 wards, had only 85 field staff at ward and village levels a ratio of 1 extension staff to 3 villages (Mattee *et al.*, 2008b). From such observations and extension agents' own accounts it was obvious that extension contact and coverage was low because most extension agents had huge areas under their jurisdiction.

There is as yet no vivid evidence of significant changes in extension coverage as a result of DADPs where group methods are not used. However, it can generally be taken that where you have DADP community and group projects, there is now more intensive involvement of the extension staff with farmers than was the case before (Mattee *et al.*, 2008a, 2008b; CONCERN Worldwide, 2008; RAS/DADS Mbeya, 2008; European Union, 2007). Furthermore, most extension staff depends mainly on home and farm visits and rarely practises group extension methods such as FFS. The few exceptions are where groups have (funded) projects that call for a group extension approach (Mattee *et al.*, 2008b).

The Tanzanian Co-operative Development Policy of 1997 was meant to provide opportunity for voluntary economically viable co-operatives to run independently, with respect to good governance and management (United Republic of Tanzania-URT 2003; Mpagalile *et al.*, 2009). Based on the past post-independence co-operative mismanagement

and government interferences within co-operatives, farmers have been sceptical to revive vibrant viable co-operative societies with the fear that the government might intervene in their ventures and face the same consequences.

However, there have been some initiatives by farmers to form associations and co-operatives to address their needs. For example, farmers in the sunflower industry (sunflower value chain) as reported by Mpagalile *et al.* (2009), have organised small co-operative groups which have enabled them to access inputs and other services, jointly market and improve sunflower crop and to have close supervision from other organisations in terms of farming practices and thus, improve quantity and quality of sunflower products. However, this was possible because other stakeholders within the sector such as the processors who were at the same time simultaneously innovating on value addition processes and facilities.

Similarly, a fair trade company, AgroFair looked at the value chain of export bananas in East Africa and realized that small-holder farmers cannot reap any significant benefits. They often have to bear high costs due to low yield and efficiency. On the price side, global banana markets play a balancing role in that they fill on a spot basis the difference between supply and demand. However, since small-holder farmers often lack the means to access these markets, their position becomes insecure if prices are low and/or fluctuating and therefore not covering the real costs. AgroFair has changed that by pooling the small volumes of small producers into a stable, marketable offer (Rajalahti *et al.*, 2008).

The Tanzania Government Land Policy of 1995 provided for more local control of land resources to establish the basis for more effective land market (United Republic of Tanzania 2003; Mpagalile *et al.*, 2009). However, as the Tanzania Government itself

observed, there is a great deal to be done for the application of the legislation in the field (United Republic of Tanzania, 2003). In recent years land conflicts have been reported in the media to be on the increase.

The Tanzania Government Microfinance Policy of 2000 on the other hand intended to establish an efficient and effective micro-financial system to serve the low income population to boost economic growth and poverty reduction (United Republic of Tanzania 2003, 2005). However, it was observed that farmers and especially smallholders rarely benefit through bank loans instead, they use other means such as personal savings, member contributions within groups and SACCOSs. It was further observed that even among agricultural related agribusiness firms, 74% of them, innovation finance does not provide sufficient funds for entrepreneurship. Generally public-private sector interactions are still low because there are no incentives for collaboration (Mpagalile *et al.*, 2009).

The Tanzania Government Small and Medium Enterprise Policy of 2002 aimed at promoting income generating activities and support diversification of private sector activities especially in creating commercial opportunities in marketing and processing of agricultural produce (United Republic of Tanzania 2002, 2003). Although this was an attempt to establish a better environment and opportunities for higher income generation and employment, yet the level of implementation is still very low (Mpagalile *et al.*, 2009).

Enabling banana policies is one of the key elements of the banana production innovation system (see Figure 2). If policies do not give banana the priority it deserves as indicated for example under the Tanzania National Agricultural and Livestock Policy 1997, then its consequences will manifest in the nature of the innovation system that ultimately develops. Similarly, if policies do not guide investments into banana research and extension and in

facilitating the private sector to invest in banana sector especially in value additions, it will have negative effect to the banana innovation system.

2.5 Challenges to Research and Extension

Although many technologies and practices have been widely proven in research stations to be productive, the total number of farmers using them is still small (Roling and Pretty, 1997). The problem being that this conventional approach to agricultural research and extension continues to ignore the role that other actors play.

2.5.1 Utilisation and communication of research outputs

Different media as well as methods of communication could be used to enable people share knowledge and information. When it comes to the concept of communication, Rogers (2003), describes it as a process through which different actors or participants create and share information. This is one of the aspects that innovation systems approach tries to address in the sense that instead of making these responsibilities the mandate of one institution, instead, all actors who interact together create the innovation and share the information among them. This will include identifying constraints and the means to address them. When other actors are involved in the development of technologies and improved practices the situation changes positively and get a better adoption rate.

For example, the International Development Enterprise (IDE), an NGO that promoted treadle pumps in Eastern India and Bangladesh succeeded in their adoption by clients only because it established relationships and developed the capacity of the manufacturers, dealers and service and repair firms in addition to creating demand through appropriate communication strategies. Similarly, on developing a packaging technology for tomatoes it

established a series of relationships with other NGOs, cardboard manufacturers, commission agents and farmers themselves (Sulaiman and Hall, 2002).

Thus, it is more likely that future gains in agricultural productivity through technological innovation will have to be participatory through directly involving farmers and other actors in the development of the technology itself. The technologies will need to be locally specific and directly geared towards specific farmer and other actors' constraints (Scarborough *et al.*, 1997).

Similarly, CTA (2005), using the Innovation Systems Framework noted that if one has to analyse and assess the habits, practices, competencies and performance of actors in the agricultural science, technology and innovation system, must pay attention to what they learnt, how they interacted, what they invested, what they innovated and the reasons behind the way they acted. Such an analysis will provide a better understanding of what could be done to reinforce behaviour that is positive for innovation or to create new incentives and reward system that supports a change in old habits and practices.

2.5.2 Extension and dissemination of proven technologies

Spielman (2005) suggests that new applications of the innovation systems approach to developing country agriculture should include more analysis of agents and agent behaviour, the institutions that condition their behaviour, and the diverse interactions that characterise their behaviour. He further noted that the innovation system perspective argues against the perception that technological change drives social and economic development (technological determinism); instead it suggests that the institutional context in which technological change occurs drives development (social constructionism).

Thus, this goes against the conventional conception of technology transfer which implies a one way process where the results of basic and applied research are put into use by the receptors (Rogers, 1983). However, Rogers (2003) has also currently acknowledged that it involves a two way communication between two entities unlike his earlier suggestions of a linear model of innovation (Godin, B. 2006). It is apparent that most participatory action research tends to complement the adoption-diffusion model in the sense that diffusion starts taking place right at early stages of the process. There is knowledge sharing and communication processes right from the beginning of the innovation process (Spielman, 2005)

When examining the promotion of research outputs, in her research on strategies for scaling up outputs of research, Shetto (2008), identified factors that constrain promotion of research outputs at different levels from the researchers' perspective. At farmers' level the prominent ones were inadequate finances, poor communication tools, low literacy levels, poor division of roles and language barriers. Similarly, communication of research products was wrongly perceived to be solely the role of extension services and not that of researchers as well, and thus researchers limited themselves to training.

From the input stockists and market traders' perspectives, the main constraints were lack of time and interest to interact, no forum to interact and their information needs were not known. They thus, suggested the use of participatory methods; improved communication skills as well as creation of farmers groups as contact points, as a remedy to the above constraints. Similarly, they suggested the creation of strong market linkages to benefit both the farmers and input stockists. Whereas for district level officials they suggested collaborations and involving them in setting research agenda as well as making them aware of the available technologies. With national level policy makers, brief and simple

packaging of scientific findings using multimedia and creation of forum for interaction were suggested as the best way to catch their attention and participation (Shetto, 2008). It is thus important that when disseminating research technologies such factors have to be taken into considerations.

2.6 Background to Banana Technologies Development by the Projects

Although bananas are among the major food and cash crops in the Eastern and Southern zones of the Tanzania, the yields and quality of bananas produced in these areas according to Maerere *et al.* (2007a) are very low. This is attributed to poor production practices, declining soil fertility since bananas are grown on the same fields for long periods and also the banana cultivars grown are susceptible to major pests and diseases prevalent in the areas. Similarly, the common planting materials used by smallholder farmers are suckers obtained either from the same farmer's fields or from neighbours. Such suckers carry disease and pests and at the same time they are usually not available in adequate quantities to enable farmers establish new fields or large plantations of specific cultivar(s) (Maerere *et al.*, 2007a).

It was thus, the interest and the objectives of TARP II SUA and PANTIL projects to establish the use of *in-vitro* propagated banana planting materials to facilitate or ensure the availability and adequate banana propagules in the shortest possible time and the production of clean disease free planting materials. The application of *in vitro* micro-propagation techniques on banana production was expected to widen the genetic base of banana grown in the country through rapid multiplication and the introduction of new cultivars. The intention was also to establish a sustainable system for dissemination and distribution of clean banana planting materials, improve the banana agronomic and pest

management practices (TARP II – SUA Project, 2005; PANTIL, 2007). The envisaged sustainable system of dissemination of planting materials depended on the availability of private sector that would take this as a business. Unfortunately, the private sector was not engaged from the beginning and therefore this function never materialised and it was left to SUA to undertake it which ceased with the end of the projects.

Because there was a need to establish a sustainable system for dissemination and distribution of clean banana planting materials, under TARP II – SUA a banana germplasm collection was established at SUA, constituting of 26 local cultivars and five new cultivars introduced from international banana research centres. Protocols for *in vitro* regeneration using the shoot tip (meristem) culture technique; rooting and acclimatization of all local banana genotypes were successfully developed. Over 11,000 plants were regenerated *in vitro*, acclimatized and disseminated to project target farmers and institutions. On station evaluation recorded two of the introduced cultivars to be superior over local cultivars in terms of higher yields and resistance to sigatoka and fusarium wilt diseases and banana weevils. Similarly, banana demonstration plots were established to serve as learning points for farmers on banana management, and introduced banana cultivars (TARP II – SUA Project, 2005; PANTIL, 2007).

On the basis of utilisation banana could be classified as banana for dessert, cooking, roasting or for brewing purposes. Dessert banana types are normally consumed raw when ripe and they are known for their sweet taste. The cooking types include plantains and the East African Highland Bananas (EAHB). Unfortunately, plantains are usually unpalatable to eat raw even when they are ripe and as a result they have to be fried or cooked. The EAHB are normally cooked when still green and they are a famous starchy staple food in

the traditionally banana growing areas of Tanzania. The bananas used for brewing are part of the EAHB whose pulp is bitter and astringent. They are neither eaten raw nor cooked that is why they are used for brewing alcohol (Macrere *et al.*, 2007a; TARP II – SUA Project, 2005; PANTIL, 2007).

2.7 Summary of Emerging Issues

The success of the spread of new technology depends on the research and dissemination model used and the type of clientele that are being targeted. Apparently, with resource poor farmers a more participatory research approach conducted in collaboration with them in their environment yield better results in terms of adoption of the technologies being researched than a research conducted on station under controlled conditions. Thus, the linear model of research and technology development does not suffice with resource poor farmers because they are normally influenced to adopt a certain technology depending on the available resources, supporting service and the market availability of the product if it involves a certain commodity. Hence the use the innovation systems analysis to check which actors participated, their roles, and relationships established and how that ultimately shaped the innovation system sounds appropriate.

The value and ultimately the adoption of a certain technology or innovation depends on how well it fits in the farmers' environment in terms of knowledge, skills, resources and expected or demonstrated benefits. Similarly, factors like wealth, age and gender become important because they affect the farmers ability to utilize certain technologies depending on their access and control of the available resources. In other words innovation calls for the integration of knowledge, skills, experiences and ideas of various stakeholders for it to happen and spread among the intended beneficiaries. The innovation therefore will end up

being a new or improved product, process or service based on new or reassessment and reinterpretation of existing technical knowledge about the production of goods or services that are required by the society. Thus, the innovations systems approach becomes an appropriate mechanism for understudying such a dynamic system.

Socio-economic characteristics, personality and communication behaviour determines how the innovation can be perceived by farmers especially in terms of its compatibility with what they are currently doing as well as the resources that are at their disposal. Similarly for the other stakeholders like the government, their active participation and support for the innovation development depends also on the priorities that they have as well as the guidance that is contained in the policies. For example, Tanzania ranks second in Africa and among top ten banana producers in the world however, policy wise banana is just considered as a horticultural crop and therefore it cannot be given the attention of a major food crop which it deserves. Similarly, it cannot be promoted as foreign exchange earning crop despite the trade potential it has. It is thus not surprising due to policy that it is rarely considered among the DADPs as a commodity that can generate income and ultimately alleviate poverty.

Research is one of the important components of any agricultural innovation system because that is where most of the new ideas and technologies originate or are initiated. With an innovation system perspective in mind the need to transform banana production among the resource poor farmers necessitates a stern participatory adaptive and applied research to be in place. It is important under the innovation system perspective to check how various stakeholders including farmers and the private sector are involved in the research process and how their concerns are accommodated. The involvement of the private sector could be

beneficial both as a service provider for example in terms of capital, value additions but also as a market or a linkage to external market.

Extension and communication channels are important in terms of informing the stakeholders of the innovation developments. In situations where this has been weak farmers have resorted to forming their own associations in order to cater for information needs. Sometimes such associations go beyond information to capital generation for credit purposes. However, participatory action research has advantage over the adoption–diffusion model in the sense that diffusion starts taking place right at the initial stages of the research process.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Area

Since the best starting point into the technological innovation system analysis is the innovation project (Hekkert *et al.*, 2006), the study area constituted the PANTIL Banana Project and TARP II SUA Banana Project research areas. These project areas include: Mkuranga District – Pwani Region; Morogoro District (part of it is now Mvomero District) – Morogoro Region; which are in the Eastern Zone and Rungwe District – Mbeya Region in the Southern Highlands Zone of Tanzania (Figure 3).

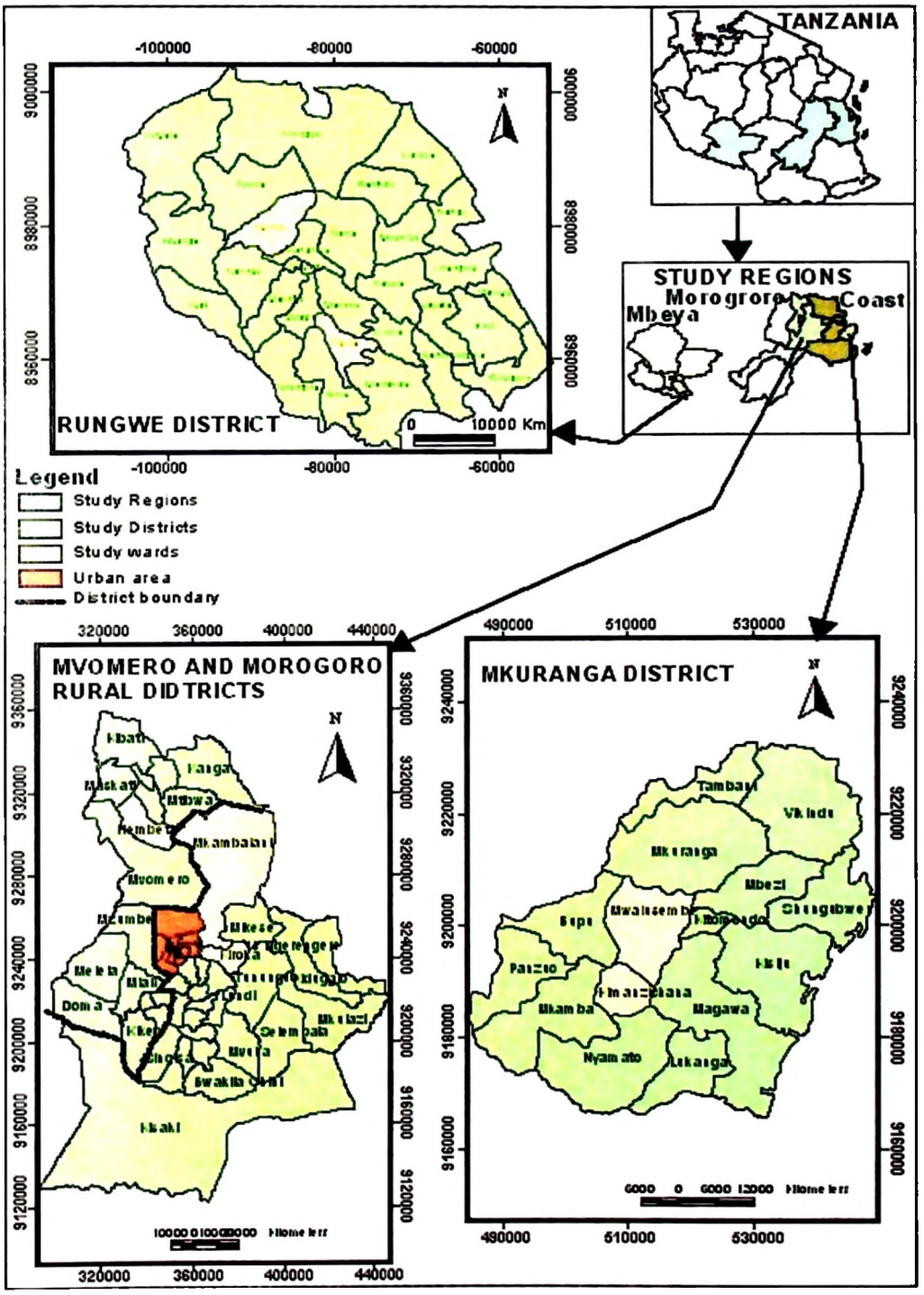


Figure 3: Map of Regions, Districts and Wards of surveyed research sites.

3.2 Research Design

A one time study as opposed to a longitudinal study was undertaken of which according to Thakur (1993) and Fowler (1993), with such a cross-sectional design in hand it is possible to gain insights into the problem, relationships between variables and to get a fairly accurate picture of current practices. It is thus possible to find out what kind of technological development took place, actions of adopters like farmers, the roles that other actors and institutions played as well as the relationships and interactions that have resulted.

3.3 Population and Sampling Procedure

Since the study was dealing with two specific projects then the banana farmers within the project villages constituted the population of the study. Thus, nine villages in three regions of Mbeya, Morogoro and Pwani where TARP II SUA and PANTIL banana projects were operating were selected for the study. All projects' villages (9) except that of Tangeni which was used for questionnaire pre-testing were covered in this study. In that case all three regions under which the projects were operating were covered in the study, which was also important for comparison purposes since they represent different agro-ecological conditions, socio-economic and cultural aspects.

Given that the technological innovation was mainly targeting farmers; two sets of farmer respondents were drawn. One set constituted a selection of all banana farmers who were project members under the TARP II SUA and PANTIL banana projects except 10 project members from Tangeni, Morogoro who were used in the pre-testing of the questionnaire. The target was to reach at least all the initial banana farmers project members who were 10 from each village and hence at least 30 from each district making a total of 90 respondents. However, during the survey some groups had grown beyond 10 members and thus resulting

into more than a total of 90 expected respondents. Still all project members were given chance to be part of the study. Ultimately those efforts managed to reach 95 of the project participants (Table 1). This first set was intended to assist in identifying the technologies developed, the role of farmers and other actors, the adoption and the various interactions that took place.

The second set was supposed to be constituted by 90 non-project banana farmers simple randomly picked from a list prepared by extension agents and project members within the TARP II SUA and PANTIL sampled villages. There were fewer non-project banana farmers within the villages in Mkuranga and Mvomero/Morogoro districts since there are few banana farmers as compared to those of Rungwe. Ten non-project banana farmers from each village were picked from a prepared list and thus amounting to 30 non-project respondents from each region and making a total of 90 respondents for the three regions. During the survey only 87 selected respondents could be reached (Table 1). This second set of non-project banana farmers was to assist in determining which technologies really originated from the projects and what kind of farmer characteristics are important for the innovation as well as how far did the innovation diffuse. It was also intended to assist in determining the existing farming system as opposed to the emerging one as a result of the improved banana technologies.

Table 1: Summary of farmer respondents sampled for the study and their corresponding villages and districts

Region	District	Village	Number of respondents		
			Project member	Non-project member	Total
Mbeya	Rungwe	Katabe	11	10	21
		Kyimo	14	10	24
		Bujela	11	10	21
Pwani	Mkuranga	Mwalusembe	11	9	20
		Mkenge	10	9	19
		Kimanzichana	9	9	18
Morogoro	Mvomero/	Hembeti	10	10	20
	Morogoro	Pangawe	9	10	19
		Kiroka	10	10	20
Total			**95**	**87**	**182**

Other respondents for innovation systems analysis included researchers and extension agents as key informants and those identified by farmers such as banana traders. Three FGDs were conducted one in each district. Five farmers from each village were invited making a total of 15 farmers per FGD. Similarly, village and ward extension workers were invited. Rungwe District Extension Officer responsible for horticultural crops had the opportunity to attend the Rungwe FGD.

3.4 Data Collection

Primary data were collected using both quantitative and qualitative methods (Appendix 1&2). Most of the data on identification of technologies, socio-economic characteristics, farming systems aspects, institutional social services and various actions and roles of various actors in the development of the innovation or technologies were collected from individual farmers using a structured questionnaire. Similarly, data on strategies and approaches used were collected from the same farmers. The above data were

complemented and checked through FGDs, key informants and observations as a triangulation strategy. FGDs and observation checklists were used to ensure that they are done systematically and that comparisons from different sites could be made. Information on norms, traditions, values, beliefs, natural resources and community farming system aspects was collected through FGDs and key informants.

Secondary data especially on climate and weather, developmental policies and laws were collected from the national governmental authorities, district offices and relevant official websites, the Sokoine National Agricultural Library (SNAL) and from other resource centres. However, the knowledge and application of policies, regulations and laws were checked through FGDs and key informant interviews.

3.5 Data Processing and Analysis

Descriptive analysis on socio-economic aspects using SPSS version 12.0 software for windows was performed to explain the distributions on variables and for comparison between the groups. Socio-economic variables that were examined through descriptive analysis included age, educational levels, gender, family size, family labour, farm size and income generating activities. Standard deviations, means modes and variances were used in explaining variations between groups as well as between districts. Cross-tabulations and Chi-square tests were made to check whether there were any statistical differences between project members and non-project members.

Survey information on banana cropping systems and other crops that are grown and livestock kept and their relationship to banana production were descriptively analysed while similar information from the FGDs was analysed through content analysis. Through frequencies farmers responses on technologies and practices developed under the two

projects of TARP II SUA and PANTIL banana projects and sources of information for those technologies and the qualities of such information were identified. Similarly, through content analysis of the FGDs the same information was crosschecked.

Descriptive analysis on the adopted technologies and improved practices was made while Cross-tabulations and Chi-square tests were run to check whether there were any significant differences between project farmers and non-project farmers in terms of adopting those technologies. Similarly, through content analysis of the FGDs and observations a general picture on the adoption was drawn. Relationships and strengths between elements of the innovation system were determined through content analysis and determinant diagrams of the FGDs and key informants. The actor and institutional linkage matrix and mapping were used to explain relationships between the innovation system elements and to explain the existing innovation system structure and the anticipated ideal innovation system structure.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of Sample Respondents

Many factors influence farmers' decisions to adopt a technology or innovation such as the resources that are at their disposal, the working relationships that they have with other actors and institutions, the availability of information, knowledge and training that they receive from other sources, the governing policies and laws, the market forces and other infrastructure aspects (CTA, 2005). In other words, psychological, sociological, economic or combinations of those factors normally motivate people to accept new ideas, practices or innovations.

There is sufficient evidence to show that when resource poor farmers do not adopt a technology, it is because it does not fit their needs, their physical, social and economic conditions (Rogers, 2003). Therefore their socio-economic characteristics sometimes become important in terms of explaining some of the decisions or actions that they take. It is thus logical to examine the farmers' socio-economic characteristics in relation to banana production innovation system that they participated in so that one is able to explain some of the behaviour that they depicted.

4.1.1 Age, educational levels and gender

The sample for this study was made up by 182 respondents of whom 95 were project members while 87 were non-project members. Within this sample 66.5% were males while the remainder 33.5% were females. Their education levels varied from 76.9% having primary education, 7.7% secondary education and the rest 15.4% without formal education. Generally these educational figures tally with the national figures by other studies conducted (Maerere *et al.*, 2007b). The only noticeable aspect is the fact that

close to 8.0% of the respondents were actually secondary school leavers something that would have been unusual in the past. Although among tobacco smallholder farmers in Urambo District just a few years ago only 2.0% were secondary school leavers (Kalamata, 2006), among banana growers countrywide without excluding progressive farmers about 14.1% had actually attained secondary school education and about two people among the sampled farmers were actually university graduates (Maerere *et al.*, 2007b). This is a clear indication that there is a trend among educated people engaging in agricultural production as an occupation than was the case before.

In the past such secondary school leavers would have tried to seek employment in the urban centres. Currently job opportunities for them are minimal in urban centres and poorly paid as compared to high value agricultural crops such as banana. However, despite the emergence of high value products rural-urban migration has continued something that the study on urban agriculture also portrayed that about 69.6% of urban agriculture farmers were actually migrants to the urban centres seeking employment (Mwajombe, 2011). This might also explain why in this study there were fewer (6%) single people and also the majority of the respondents being above 35 years of age. About 84.6% of the respondents were married individuals, 6.6% widowed and 2.7% divorced (Table 2). The rural-urban migration is important in the sense that it is depriving the rural communities of an important labour force and therefore crippling agriculture and at the same time adding pressure on the already overstretched urban services.

Table 2: Percentage distribution of respondents on the basis of their sex, education levels and marital status (n= 182)

Characteristics	Percentage distribution					
	Whole sample (n= 182)		Project members (n= 95)		Non-project members (n= 87)	
	Freq.	%	Freq.	%	Freq.	%
Sex						
Male	121	66.5	66	69.5	55	63.2
Female	61	33.5	29	30.5	32	36.8
Total	**182**	**100.0**	**95**	**100.0**	**87**	**100.0**
Education levels						
No formal ed.	28	15.4	12	12.6	16	18.4
Primary ed.	140	76.9	74	77.9	66	75.9
Secondary ed.	14	7.7	9	9.5	5	5.7
Total	**182**	**100.0**	**95**	**100.0**	**87**	**100.0**
Marital status						
Single	11	6.0	2	2.1	9	10.3
Married	154	84.6	87	91.6	67	77.0
Divorced	5	2.7	2	2.1	3	3.4
Widowed	12	6.6	4	4.2	8	9.2
Total	**182**	**100.0**	**95**	**100.0**	**87**	**100.0**

Respondents' ages ranged between 19 years to 80 years with a mean of 46 years. This is a clear indication that although there are young people engaged in agriculture it is also a fact that there are still quite a number of old people above 60 years of age who are still shouldering this responsibility. Similar findings were reported of having in the sample 7.8% of respondents who were above the age of 60 years engaged in highly labour demanding tobacco farming in Urambo District (Kalamata, 2006).

The respondents' family sizes had an average of three able bodied people among adults and a mean and mode of three young children below the age of 18 years (Table 3). According to 78.0% of respondents one to three people provide labour to all agricultural activities as well as domestic ones. That seems to be a lot especially considering that most

of the activities are manual. To be precise, 43.4% of the respondents had only two able bodied people in the family and were the ones responsible to feed and generate income to cater for other family needs.

Banana production by small farmers is manual labour demanding since it is only the initial farm preparation that can be mechanised, the rest of the operations have to be done manually. According to FGDs farmers said sometimes they are forced to hire labour especially in digging the planting pits since it is quite labour demanding while at the same time labour is limited. This explains why it was difficult for many farmers to expand banana farms even in areas where land was not limiting because the same labour (average of three and mainly two able bodied people per family) had to be shared among many subsistence activities (Table 3). Similar accounts were reported in the countrywide banana sector study that in most parts of Tanzania where banana is grown one of the most challenging factor is the competition between crops. There is competition for both land and labour between banana and other crops such as maize, cassava, potatoes, vanilla and coffee (Maerere *et al.*, 2007b).

Table 3: Distribution of respondents on the basis of their age, labour and farm sizes (n= 182)

Characteristic	Measure	Distributions		
		Whole sample (n= 182)	Project members (n= 95)	Non-project members (n=87)
Age	Mean	46.1	48.1	44.0
	Median	45.0	46.0	45.0
	Mode	35.0	35.0	35.0
	Minimum	19.0	20.0	19.0
	Maximum	80.0	80.0	73.0
Number of able bodied people among adults	Mean	2.7	2.9	2.5
	Median	2.0	3.0	2.0
	Mode	2.0	2.0	2.0
	Minimum	1.0	1.0	1.0
	Maximum	8.0	8.0	8.0
Number of young children below 18 years	Mean	3.1	3.6	2.5
	Median	3.0	3.0	2.0
	Mode	3.0	3.0	2.0
	Minimum	0.0	0.0	0.0
	Maximum	12.0	12.0	8.0
Total farms size in acres	Mean	6.7	6.5	6.9
	Median	4.0	5.0	4.0
	Mode	2.0	6.0	2.0
	Minimum	0.3	0.3	0.5
	Maximum	50.0	50.0	50.0
Total banana farm size in acres	Mean	1.1	1.2	1.1
	Median	1.0	1.0	0.8
	Mode	0.5	0.5	0.5
	Minimum	0.0	0.3	0.0
	Maximum	10.0	5.0	10.0
Banana farm size under old practices in acres	Mean	0.7	0.6	0.7
	Median	0.3	0.3	0.5
	Mode	0.0	0.0	0.0
	Minimum	0.0	0.0	0.0
	Maximum	10.0	4.5	10.0
Banana farm size under improved practices in acres	Mean	0.5	0.6	0.3
	Median	0.3	0.5	0.0
	Mode	0.0	0.5	0.0
	Minimum	0.0	0.0	0.0
	Maximum	5.0	5.0	2.5

4.1.2 Farm size

Most of these banana growers were basically peasants with an average total farm of about 6.7 acres with a mode of two acres. The observed mean was actually skewed by very few individuals who had total farm acreages above ten acres. The pieces of land that are devoted to banana cultivation are even smaller with an average of 1.13 acres and a mode of half an acre (Table 3) which is not far from country wide average of 1.4 acres as found by Maerere *et al.* (2007b). There were exceptions of a few individuals who had above three to ten acres that are devoted to banana production and this was mainly in Rungwe District where banana is also considered as a staple food. Although, the majority of the respondents with above three to ten acres devoted to banana production came from Rungwe, however, the very few topmost among those (close to ten acres) came from Mkuranga and Mvomero.

A countrywide study on the banana sector set the overall total farm size owned by banana farmers to be four acres on average while this study found an average of about 6.7 acres (Table 3). It seems to be slightly higher than the country average of four acres as found by Maerere *et al.* (2007b) since in other parts of the country where banana is grown due to high population densities land has become scarce and thus, most farmers have small pieces of land and as a result it affected the national average. However, when compared to the zones averages it is quite comparable to the Southern Highlands (7.88 acres) and Eastern (5.06 acres) zones in which this study was conducted. These results indicate however that proportion wise, the total farm area allocated for banana production was about 17% of the total farm holding. These results are slightly close to those found in the Eastern (25%) and Southern Highlands (29%) zones by Maerere *et al.* (2007b) but far different from the Northern (53%) Maerere *et al.* (2007b) and Lake (52%) zones by

Nkuba *et al.* (2006) and Maerere *et al.* (2007b) and those found by Edmeades *et al.* (2006) in Uganda.

These results were not that different from the Eastern and Southern Highlands since the research actually took place in the two zones of the Eastern and Southern Highlands. However, total farm size and traditional staple foods seem to have significant influence on the proportion of the farm land that is allocated to banana production. For example, in areas where total farm land is small and there is little room for expansion and staple food is banana, there is a tendency for a bigger proportion of that land to be devoted to banana production, a typical scenario of Rungwe and the Northern and Lake zones.

Similarly, banana cultivation under improved practices was even smaller with an average of 0.4 acres (Table 3). Very few individuals had two acres to the topmost five acres of improved banana production farms and these were mainly in Mkuranga and Mvomero districts where the crop is being re-established after many years of neglect and also easy availability of land for expansion.

Since many banana farms in Mkuranga and Mvomero are relatively new it was much easier on their part to implement improved practices right from the beginning of the establishment of the new farms. Similarly, it was much easier for Mkuranga and Mvomero farmers to implement improved practices on the expanded portion of the field along side the old farm while making efforts to transform the latter. In Rungwe on the other hand where land is scarce for expansion or even for new establishments, they had to rely more on transforming the old farms. It demands much more physical and planning efforts of several years to re-align the old farm to meet the improved practices requirements.

4.1.3 Income generating activities

Most respondents did not engage in any income generating activities. Only a few individuals, about two to four percent were either doing carpentry, masonry or owned a shop. In the same token 62.1% kept livestock as an income generating activity. This was however positive considering the expected complementarities in banana production where manure is used for fertilisation of the farm and the plant residues used as animal feed.

Animal keeping was significantly important in Rungwe district where the majority kept livestock, especially dairy cattle for production of milk but at the same time complimenting banana production in terms of manure. For, example, while 90.9% of Rungwe respondents kept cattle, only 5.3% and 5.1% of Mkuranga and Mvomero respondents kept cattle respectively. Similarly, even in poultry keeping, Rungwe still outnumbered the other Districts by having 89.4% of its respondents keeping poultry, while Mkuranga and Mvomero with 73.4% and 74.6% respectively. As far as pig keeping is concerned there was none in Mkuranga and only one in Mvomero, whereas Rungwe had 37.9% of the respondents keeping pigs (See also Tables 7, 9 and 10).

It is important to note that among those who had income generating activities including those who kept livestock for that same purpose, 53.3% admitted to have invested some of that generated income into banana production activities. Generally, there were no significant differences ($p > 0.05$) between project members and non-project members in terms of the type and numbers of income generating activities.

4.1.4 Banana cropping systems

According to FGDs most farmers are producing several agricultural crops sometimes of different nature on the same pieces of land. According to these farmers that kind of practice was beneficial especially in saving labour. For example, if one was intercropping banana and beans, when weeding for beans automatically the bananas are covered as well. Thus, 42.9% of the respondents pointed out that they practiced intercropping in their farms while 37.9% practiced mixed farming, which is a mix of various crops and livestock. It was just a few (19.2%) who were inclined towards monoculture practices in their farms (Table 4).

There were also some differences between districts. While Rungwe inclined more towards mixed farming, Mkuranga inclined towards intercropping whereas for Mvomero it was a mix of intercropping and monocropping. There were significant differences among those patterns ($p< 0.05$). As far as farmers were concerned, there was a similar pattern depicted by both project and non-project farmers and thus, there was no significant difference between the two groups of farmers (Table 5).

Table 4: Percentage distribution of respondents by cropping system and by district (n= 182)

District		Banana farm cropping system			
	Descriptions	**Mono culture**	**Inter cropping**	**Mixed farming**	**Total**
Mvomero	Count	19.0	25.0	15.0	59.0
	% within District	32.2	42.4	25.4	100.0
	% of Total	10.4	13.7	8.2	32.4
Mkuranga	Count	6.0	34.0	17.0	57.0
	% within District	10.5	59.6	29.8	100.0
	% of Total	3.3	18.7	9.3	31.3
Rungwe	Count	10.0	19.0	37.0	66.0
	% within District	15.2	28.8	56.1	100.0
	% of Total	5.5	10.4	20.3	36.3
Total	**Count**	**35**	**78**	**69**	**182**
	% of Total	**19.2**	**42.9**	**37.9**	**100.0**

The difference between project and non-project farmers had to do with the fact that more of the project members had received training in banana production which included the best way to intercrop or mix farming. For example 93.7% of the project members received such training as opposed to only 25.3% of the non-project members. While the project members mainly received such training from the two projects of PANTIL and TARP II-SUA, the non-project members who received training relied heavily on their fellow farmers (63.6%) and only very few had an opportunity to directly get such training from the projects (18.2%) (Table16).

Table 5: Percentage distribution of respondents by cropping system and by farmer type (n= 182)

Farmer type	Description	Banana farm cropping system			Total
		Mono culture	Inter cropping	Mixed farming	
Non project member	Count	19.0	40.0	28.0	87.0
	% within farmer type	21.8	46.0	32.2	100.0
	% of Total	10.4	22.0	15.4	47.8
Project member	Count	16.0	38.0	41.0	95.0
	% within farmer type	16.8	40.0	43.2	100.0
	% of Total	8.8	20.9	22.5	52.2
Total	**Count**	35.0	78.0	69.0	182.0
	% of Total	19.2	42.9	37.9	100.0

4.1.4.1 Other crops grown and their relationships to banana production

Other crops that are grown by these respondents and mainly intercropped with banana include coffee in Rungwe, cashewnut in Mkuranga, pineapples and vegetables in all three districts, tea in Rungwe, groundnuts and beans mainly in Rungwe and Mvomero districts and cocoyam mainly in Mvomero and Rungwe districts (Table 6). According to survey and FGDs coffee is mainly intercropped with banana and the income is beneficial to banana production since it is used as a source of capital for banana farm operations. Cashewnuts are also intercropped with banana though discouraged by agronomists because of its' huge canopy however, the income is beneficial to banana production as a source of capital for banana farm operations. Pineapples apart from being intercropped with banana they are also used as a ground cover crop and also serve as a source of capital for banana farm operations (Table 6).

Table 6: Percentage distributions of respondents by other crops grown and their relationships to banana production

Crop	No.*	Relation to banana		Total	No.#			Benefits to banana		Total
		Inter cropped	Ground cover			Source of capital	Source of fertility	Controls weeds	Controls erosion	
Coffee	26	25	1	26	26	23	3	-	-	26
		(96.2)	(3.8)	(100)		(88.5)	(11.5)			(100)
Cashew	44	25	9	44	47	44	2	1	-	47
		(79.5)	(20.5)	(100)		(93.6)	(4.3)	(2.1)		(100)
Pineapple	26	8	18	26	25	23	1	1	-	25
		(30.8)	(69.2)	(100)		(92.0)	(4.0)	(4.0)		(100)
Vegetables	15	3	12	15	20	15	2	2	1	20
		(20.0)	(80.0)	(100)		(75.0)	(10.0)	(10.0)	(5.0)	(100)
Tea	1	-	1	1	31	30	-	1	-	31
			(100)	(100)		(96.8)		(3.2)		(100)
Groundnut	26	5	21	26	33	18	10	5	-	33
		(19.2)	(80.8)	(100)		(54.5)	(30.3)	(15.2)		(100)
Beans	30	11	19	30	34	18	9	7	-	34
		(36.7)	(63.3)	(100)		(52.9)	(26.5)	(20.6)		(100)
Bambaranut	-	-	-	-	1	1	-	-	-	1
						(100)				(100)
Cocoyam	25	17	8	25	28	16	8	4	-	28
		(68.0)	(32.0)	(100)		(57.1)	(28.6)	(14.3)		(100)

*Intercropped or used as ground cover in same field. # includes even those who grow in separate fields

Vegetables, groundnuts, cocoyam and beans are mainly used as ground cover crops and also to maximise the utilization of land. They also serve as a source of cash for some operations in the banana farm operations such as weeding and transporting the produce. Farmers in the FGDs further indicated that with beans and groundnuts they also serve as source of fertility in the soils and capital to banana farm operations, but also more importantly such crops suppression weeds (Table 6).

Source of capital in banana production is a thorny issue since most banana varieties grown in Tanzania take 90-100 days after flowering to mature and that is beside the vegetative growth period. Thus, other sources have to be sought to facilitate farm operations before the crop itself generates income. That is why, according to survey and FGDs most intercropped crops were considered to be a source of capital to banana. A similar account was given in the banana sector study where most farmers indicated that the source of working capital was mainly from self-generated funds (44.1%), followed by remittances that they received from relatives working elsewhere (Maerere *et al.*, 2007b). This underscores the importance of having credit institutions around when innovations like these are implemented.

4.1.4.2 Livestock kept and their relationships to banana production

Livestock that farmers kept included cattle especially dairy cattle, goats and sheep, pigs and poultry. Cattle production was more conspicuous in Rungwe District than it was in the other districts since over 90% of the cattle keepers respondents came from Rungwe (Table 7). As far as the benefits to banana production were concerned, most of them benefited as a source of manure (72.7%) and to some (21.1%) as both a source of manure and capital for banana farm activities (Table 7). It is only a few farmers who owned cattle (3.0%) and these were from Mvomero District that actually used cattle as a source of

draught power. This could also explain why many of them had small size banana farms or even total farms, because their operations on land were limited to the use of hand-hoe which is extremely inefficient.

The use of animal power could be quite beneficial as reported by the Draught Animal Power project under TARP II SUA programme (TARP II SUA, 2005). In this project it was possible for 72.4% of respondents to decrease women's working time by 6.7 hours a day in 3.4 months, due to the use of animal draught technologies. Similarly, 74.1% of respondents reported that men saved on average 6.65 hours per day in 3.86 months as a result of the same technologies (TARP II SUA, 2005).

Table 7: Percentage distribution of respondents by cattle production and benefits to banana production by district (n= 66)

District	Description	Benefits to banana production				Total
		Power	Capital	Manure	Source of Capital & manure	
Rungwe	Count	0.0	0.0	46.0	14	60.0
	% within District	0.0	0.0	76.7	23.3	100.0
	% within Benefits	0.0	0.0	95.8	100.0	90.9
	% of Total	0.0	0.0	69.7	21.2	90.9
Mkuranga	Count	0.0	1.0	2.0	0.0	3.0
	% within District	0.0	33.3	66.7	0.0	100.0
	% within Benefits	0.0	50.0	4.2	0.0	4.5
	% of Total	0.0	1.5	3.0	0.0	4.5
Mvomero	Count	2.0	1.0	0.0	0.0	3.0
	% within District	66.7	33.3	0.0	0.0	100.0
	% within Benefits	100.0	50.0	0.0	0.0	4.5
	% of Total	3.0	1.5	0.0	0.0	4.5
Total	**Count**	**2.0**	**2.0**	**48.0**	**14.0**	**66.0**
	% of Total	**3.0**	**3.0**	**72.7**	**21.2**	**100.0**

Sheep and goats were kept by even fewer farmers just about 16 out of 182 farmer respondents and these were mainly in Mvomero District. Those who kept sheep and goats benefited as a source of capital and manure to banana production. Sheep and goats were almost non-existent in Rungwe District the reason behind being lack of grazing land, since even for cattle they mainly practice zero grazing (Table 8).

Table 8: Percentage distribution of respondents by goats/sheep production and benefits to banana production by district (n= 16)

District	Description	Benefits to banana production				Total
		Source of power	Source of capital	Source of manure	Source of capital and manure	
Rungwe	Count	N/A	0.0	1.0	0.0	1.0
	% within District	N/A	0.0	100.0	0.0	100.0
	% within Benefits	N/A	0.0	8.3	0.0	6.3
	% of Total	N/A	0.0	6.3	0.0	6.3
Mkuranga	Count	N/A	2.0	2.0	1.0	5.0
	% within District	N/A	40.0	40.0	20.0	100
	% within Benefits	N/A	66.7	16.7	100.0	31.3
	% of Total	N/A	12.5	12.5	6.3	31.3
Mvomero	Count	N/A	1.0	9.0	0.0	10.0
	% within District	N/A	10.0	90.0	0.0	100.0
	% within Benefits	N/A	33.3	75.0	0.0	62.5
	% of Total	N/A	6.3	56.3	0.0	62.5
Total	**Count**	N/A	**3.0**	**12.0**	**1.0**	**16.0**
	% of Total	N/A	**18.8**	**75.0**	**6.3.0**	**100.0**

Poultry keeping was the most widespread activity in all the study districts. About 145 out of 182 respondents kept poultry. In relation to banana production they benefited as being a cheap source of manure since they rarely fed the birds. Similarly, the sales of birds served as a source of capital for banana farm operations (Table 9).

Table 9: Percentage distribution of respondents by poultry production and benefits to banana production by district (n= 145)

District	Description	Benefits to banana production				Total
		Power	Source of Capital	Manure	capital & Manure	
Rungwe	Count	N/A	0.0	55.0	4.0	59.0
	% within District	N/A	0.0	93.2	6.8	100.0
	% within Benefits	N/A	0.0	52.4	16.7	40.7
	% of Total	N/A	0.0	37.9	2.8	40.7
Mkuranga	Count	N/A	6.0	16.0	20.0	42.0
	% within District	N/A	14.3	38.1	47.6	100.0
	% within Benefits	N/A	37.5	15.2	83.3	29.0
	% of Total	N/A	4.1	11.0	13.8	29.0
Mvomero	Count	N/A	10.0	34.0	0.0	44.0
	% within District	N/A	22.7	77.3	0.0	100.0
	% within Benefits	N/A	62.5	32.4	0.0	30.3
	% of Total	N/A	6.9	23.4	0.0	30.3
Total	**Count**	N/A	**16.0**	**105.0**	**24.0**	**145**
	% of Total	N/A	**11.0**	**72.4**	**16.6**	**100**

Pig production, like cattle production, was mainly confined to Rungwe farmer respondents. Among 26 respondents who identified themselves with the activity only one came from outside Rungwe. However, these farmers conceded to have benefited through

pig manure for fertilising their banana farms as well as securing cash out of pork sales for the banana farm operations (Table 10). With Mkuranga and Mvomero districts the majority of the respondents and especially the project members were mainly Moslems and therefore that explains as to why such an activity was uncommon in those areas.

Table 10: Percentage distribution of respondents by pig production and benefits to banana production by district (n= 26)

District	Descriptions	Benefits to banana production				Total
		Feeding on banana remains	Source of capital	Source of manure	Source of capital and manure	
Rungwe	Count	0.0	2.0	19.0	4.0	25.0
	% within District	0.0	8.0	76.0	16.0	100.0
	% within Benefits	0.0	100.0	100.0	100.0	96.2
	% of Total	0.0	7.7	73.1	15.4	96.2
Mkuranga	Count	0.0	0.0	0.0	0.0	0.0
	% within District	0.0	0.0	0.0	0.0	0.0
	% within Benefits	0.0	0.0	0.0	0.0	0.0
	% of Total	0.0	0.0	0.0	0.0	0.0
Mvomero	Count	1.0	0.0	0.0	0.0	1.0
	% within District	100.0	0.0	0.0	0.0	100.0
	% within Benefits	100.0	0.0	0.0	0.0	3.8
	% of Total	3.8	0.0	0.0	0.0	3.8
Total	**Count**	**1.0**	**2.0**	**19.0**	**4.0**	**26.0**
	% of Total	**3.8**	**7.7**	**73.1**	**15.4**	**100.0**

According to Rogers (2003) socio-economic characteristics of the farmers can explain some of the decisions or actions that they take. It is therefore important to examine such characteristics and relate them to what transpired. The examination of the farmers'

characteristics in this study indicated the fact that over 70% respondents had primary education and above and thus had fairly sufficient education to cope with the requirements of the technologies implementation. Therefore education levels would not have been the limiting factor to the adoption of the technologies since some of those who adopted had the same education levels. One of the limiting factors according to the farmers had to do with labour shortages since most banana farm operations are manual and it is not easy to mechanise. With an average of three and mostly two able bodied persons per family labour supply was normally insufficient especially in farm preparations and in the digging of planting pits.

With an exception of Rungwe areas where farm land is becoming scarce, farming, expansion of farming and new farming areas were not a limiting factor to the adoption of the improved banana production technologies. The limiting factors associated with inability to expand or to open up new farms where improved practices could have been implemented had to do with lack of capital or sources of capital, labour shortages and to some extent lack of reliable markets. The situation was made even worse by the fact that very few farmers had income generating activities that could have assisted in financing some of the labour or input demanding operations. Similarly, livestock keeping that could have lessened the demand of fertilizers and also serve as a motivation to implement improved banana farming practices was mainly conspicuous in Rungwe areas. In other areas sources of manure were difficult to find and thus could not fertilise their farms and thus it impaired the adoption of that technology.

Therefore despite the efforts of TARP II SUA and PANTIL banana projects and other stakeholders to train, encourage and assist farmers to adopt the various improved banana technologies and practices, their efforts were weakened by the fact that certain socio-

economic characteristics such as those mentioned above were working against those efforts. That is why it is important from the innovation systems perspective, to have various stakeholders working together in the process in order to address some of such issues. For example, if the problem is education, then one of the stakeholders or even several can take the responsibility of educating them. If the problem is capital, financial stakeholder institutions would address that, similarly for input supply.

4.2 Technologies and Practices Developed for Banana under TARP II-SUA and PANTIL Projects

TARP II-SUA and PANTIL projects in collaboration with farmers and other stakeholders advanced a number of technologies and practices that were thought to be critical in order to improve banana production. Such technologies and practices included pit size, type of planting materials like tissue culture, new varieties, spacing, de-suckering, mulching, fertiliser application and pest control.

4.2.1 Sources of information on banana technologies developed

Based on the farmers' survey conducted under this study, it was clear that most of the TARP II-SUA and PANTIL project farmers sourced information on improved banana production technologies from external sources of SUA and its' Agricultural Research Institutes (ARI) partners such as ARI – Uyole and which most farmers found to be useful (Table 10).

However, from the innovation systems perspective it was anticipated that there would be the existence of various external sources of information to farmers since those different stakeholders should have been part and parcel of the technology development initiation

and implementation. Unfortunately, based on the results these efforts were concentrated in just a few institutions which are SUA and ARI-Uyole a clear indication that other stakeholders were not highly involved from the beginning. For example, only 26.3% of the project members and 20.6% of the non-project members sought such information from the input suppliers and they never considered the information received to be useful in their endeavour to improve banana production and such consultations were done on their own initiative rather than coordinated efforts by the project.

Table 11: Percentage distribution of respondents by farmer type on the basis of their source and quality of information (n= 182)

Information Source	Farmer type	Seek from source	Number	Assessment % Not useful	% Average	% Useful
SUA and ARI	Project	Yes	85	1.2	22.4	76.5
		No	10	-	-	-
	Non Project	Yes	36	0.0	27.8	72.2
		No	51	-	-	-
Radio	Project	Yes	55	5.5	83.6	10.9
		No	40	-	-	-
	Non Project	Yes	48	2.1	79.2	18.8
		No	39	-	-	-
Fellow farmers	Project	Yes	78	0.0	53.8	46.2
		No	17	-	-	-
	Non project	Yes	73	1.4	64.4	34.2
		No	14	-	-	-
Extension agents	Project	Yes	72	8.3	54.2	37.5
		No	23	-	-	-
	Non project	Yes	43	11.6	65.1	23.3
		No	44	-	-	-

Similarly, looking at other sources, only 35.7% of the project members and 25.3% of the non-project members sought such information from the newspapers and 25.2% of the project members and 19.5% of the non-project members sought such information from the

government researchers and most of them like in the case of the radio they never considered the information to be useful. Interestingly, although the majority of both categories of farmers never considered information from agricultural shows to be that useful, however, the majority of the non-project farmers (51.7%) used it as one of their major sources for such information. The improvement of agricultural shows as a learning point is critically important since in the absence of projects it seems it is the most preferred source of information.

It is important at this juncture to point out the fact that there was considerable exchange of information among farmers (Table 11) which is a positive aspect as far as innovation systems are concerned. A similar observation was made by Maerere *et al.* (2007b), that most farmers rated the exchange of information among themselves individually or farmers groups' level to be the best source of information followed by radio usage, attendance of meetings, seminars or agricultural shows. This exchange of information was considered to be useful by a significant number of farmers (46.2% of non-project and 34.2% project farmers), a clear indication that in such situations there is need to intensively train some of the farmers to become a reference source of information to their colleagues. Similarly, there was an attraction to attend agricultural shows especially among non-project farmers (51.7%), suggesting the need to properly plan the agricultural shows to capture and build upon the interests of farmers.

4.2.2 Technologies and practices developed

Several technologies and practices were researched upon, developed or made available to the farmers for testing and ultimately adoption. This was made possible through Farmer Field Schools (FFSs) and demonstration plots that were established in the project villages. The FFSs were meant to assist farmers test and ultimately decide what technologies and

practices were appropriate for their conditions as well as which ones matched with the resources at their disposal. Such technologies included pit size, type of planting materials such as those originating from banana "tissue culture", new varieties, spacing, de-suckering, mulching, fertilising and pest control (Table 12).

Table 12: Percentage distribution of respondents on the basis of their responses to the introduced technologies (n= 182)

Technology introduced	Percentage of respondents acknowledging introduction of technologies		
	Whole sample (n= 182)	Project members (n= 95)	Non-project members (n= 87)
Pit size	78.8	97.4	58.7
Type of planting materials	72.9	91.6	49.3
New varieties	74.1	93.7	49.3
Spacing	76.5	95.8	52.0
De-suckering	78.8	92.6	61.3
Mulching	77.1	93.7	56.0
Fertilising	72.5	91.6	51.7
Pest control	65.9	90.5	34.7

4.2.2.1 The planting pit size

The majority of farmers acknowledged the fact that the planting pit size was introduced in their communities and this was echoed by about 97.4% of the project members and 58.7% of the non-project members (Table 12). The reasons advanced for its introduction was mainly to increase yield, conservation of moisture and improve soil fertility. It is however, interesting to note that generally the prominent responsible institutions or individuals for introducing this technology were the two projects of TARP II-SUA and PANTIL accounting for 68.6% and fellow farmers responsible for about 23.9%.

Further analysis indicated that among the project members. the projects were responsible for about 90% of the introduction of this technology to the farmers and the remainder by extension agents, ARI-Uyole and fellow farmers. Whereas among the non-project members, fellow farmers especially from the project accounted for over 59% of the pit size introduction while the projects initiatives were only responsible for about 25%. This analysis underscores the importance of using other farmers in terms of introducing technologies since farmers were able to reach more of their fellow non-project members than it was by the direct projects' initiatives.

4.2.2.2 Banana planting materials

As indicated earlier, the projects also were interested in introducing planting materials that were disease and pest free in order to guarantee a quick and vigourous establishment of the plants. Thus, the tissue culture mechanism was used to generate such banana seedlings for distribution to the farmers. About 91.6% of the project members and only 49.3% of the non-project members acknowledged the introduction of tissue culture banana planting materials (Table 12).

As anticipated, among the project members 91% were introduced to tissue culture banana planting materials by the project and only 5.6% by their fellow farmers. Among the non-project members who had access to such materials, about 62.2% of them were introduced to such materials by their fellow farmers and only 27% by the projects. However, the majority of farmers who had access to banana tissue culture planting materials from both groups acknowledged the fact that such materials were useful in combating pests and diseases because they could establish themselves very quickly and hence increasing yield.

4.2.2.3 Banana varieties

As far as the banana varieties were concerned, a combination of local varieties, varieties grown elsewhere in Tanzania as well as those brought in from international banana research centres were used for this purpose. About 93.7% of the project members and 49.3% of the non-project members acknowledged the introduction of new banana varieties (Table 12). Among the project members 87.8% were introduced to new varieties by the projects, 4.4% by ARI-Uyole and only 6.7 % by their fellow farmers. Among the non-project members who had access to new varieties, about 64.9% of them were introduced to such varieties by their fellow farmers, 8.1% by extension agents, 2.7% by NGOs and only 24.3% by the projects.

An important observation to be made here is that although almost all the new varieties were actually originating from SUA and basically under the two projects, yet other institutions like the Local Government extension agents and NGOs like Caritas-Tanzania had contributed in their dissemination. Underscoring the importance of engaging various stakeholders and key players right from the beginning since some of them usually would have already established rapport with the targeted population or communities. If stakeholders of the innovation system were sufficiently fully engaged probably better understanding and adoptability would have been observed. However, based on varieties adaptability to local conditions, appearance, vigour, marketability and other preferences such as taste, several varieties both local and international ones were actually adopted.

The international varieties widely adopted included those that are named after a Honduran institute, Fundacion Hondurean de Investigation Agricola (FHIA), which are FHIA 17 and FHIA 23, Yangambi and Pelipita. The variety FHIA 23 was preferred in all the three districts of Rungwe, Mkuranga and Mvomero because of the bigger size of bunches as

well as marketability. FHIA 17 was mainly adopted in Rungwe and Mkuranga districts for similar reason as those of FHIA 23. However, the main drive for the two varieties according to the farmers was actually their acceptability and preference in the market. Yangambi though adopted was confined to local consumption and as a replacement to a local variety known as "Kisukari" since they have a number of resemblances such as appearance and size of the banana.

However, Yangambi variety had added advantage over "Kisukari" on the fact that it is resistant to diseases and its banana has a distinctive sweet aroma. Similarly, Pelipita variety that was mainly adopted in Mvomero District of Morogoro was also confined to local consumption. Pelipita was adopted because it adapted well to wet conditions and also because it resembled a local variety called "Bokoboko" mainly used for local brewing. Despite its resemblances to "Bokoboko", Pelipita was instead adopted because of its taste and especially when roasted (Table 13).

The most adopted local varieties included "Mzuzu" and "Mtwike" and this was mainly in Mkuranga and Mvomero districts where they were relatively new to the area and on the reasons that they were easily marketable in urban areas and especially in Dar-es-salaam city. The two varieties were already common and widely grown in Rungwe District before the TARP II-SUA and PANTIL projects and probably that explains the low figures for their adoptability during the projects lifetime in Rungwe District. Instead, it is noticeable that a variety by the name "Jamaica" was highly adopted in Rungwe due to its bunch size and marketability (Table 13).

Table 13: Distribution of respondents by new adopted varieties and by district (n=165)

Varieties	Districts			Total	
	Rungwe	Mkuranga	Mvomero/ Morogoro	Freq	%
FHIA 17	36	13	3	52	31.5
FHIA 23	34	19	11	64	38.8
Yangambi	19	0	9	28	17.0
Pelipita	0	1	9	10	6.1
Matoke	16	2	12	30	18.2
Malindi	12	1	17	30	18.2
Uganda	21	0	0	21	12.7
Ndyali	3	0	0	3	1.8
Kambani	9	0	0	9	5.5
Mzuzu	7	29	33	69	41.8
Moshi	0	12	1	13	7.9
Mtwike	9	24	47	80	48.5
Kisukari	1	7	4	12	7.3
Mshale	3	1	5	9	5.5
Kisanduku	1	1	0	2	1.2
Bokoboko	1	8	0	9	5.5
Jamaica	12	0	6	18	10.9

4.2.2.4 Banana spacing

About 95.8% of the project members and 52.0% of the non-project members acknowledged the introduction of improved spacing for banana (Table 12). Among the project members 90.2% were introduced to improved spacing by the projects, 2.2% by ARI-Uyole 1.1% by extension agents and 5.5 % by their fellow farmers. Among the non-project members who were introduced to improved spacing, about 59.0% of them were introduced by their fellow farmers, 10.3% by extension agents, 2.6% by NGO and only 23.1% by the projects. Most farmers claimed that improved spacing not only increased yield but also assisted in disease and pest control since it was much easier working in the field in terms of weeding and de-suckering

4.2.2.5 De-suckering

In order to realise better yields especially bigger bunches it is normally important to remove excess suckers and leave about 3 to 4 stems per pit which are at different stages of growth to allow them to grow to their full potential. The introduction of this practice was confirmed by about 92.6% of the project members and 61.3% of the non-project members (Table 12). Among the project members 90.0% were introduced to de-suckering by the projects, 2.2% by ARI-Uyole 1.1% by extension agents and 6.3 % by their fellow farmers. Among the non-project members who were introduced to de-suckering about 60.9% of them were introduced by their fellow farmers, 13.0% by extension agents, 2.2% by NGOs and 21.7% by the projects. Most farmers responded that de-suckering increased yield but also helped in disease and pest control.

4.2.2.6 Mulching

In order to conserve moisture especially where rainfall is scarce mulching becomes one of the more reliable options. However, you can simultaneously achieve three goals out of mulching, not only of moisture conservation and weed control but also boosting soil fertility after decomposition. Mulching becomes important in drier places like Mkuranga especially in conserving moisture but also in wet places like Rungwe and Mvomero for weed control.

The introduction of this practice was echoed by about 93.7% of the project members and 56.0% of the non-project members (Table 12). Among the project members 90.0% were introduced to mulching by the projects, 2.2% by ARI-Uyole 1.1% by extension agents and 6.7 % by their fellow farmers. Among the non-project members who were introduced to mulching about 54.2% of them were introduced by their fellow farmers, 19.0% by extension agents, 2.4% by NGO and 19.0% by the projects. In this case extension agents

had played a role though small, even before the commencement of the two projects (TARP II- SUA commenced in July 2001). Some few farmers were already familiar with this practice dating back in 1980 (Table 14). However, most farmers thought mulching not only increased yield through moisture conservation and weed control but also in terms of controlling pests in the soil.

Table 14: Distribution of farmers based on the year of their introduction to banana technologies

Technology introduced	Number of "yes" to period of introduction				Total
	1970-1980	1981-1990	1991-2000	2001-2010	
Pit size	0	2	4	128	134
Planting material	0	0	2	122	124
New varieties	0	0	1	125	126
Spacing	0	0	1	129	130
De-suckering	0	0	2	132	134
Mulching	3	0	2	126	131
Fertilising	2	1	2	126	131
Pest control	1	0	2	109	112

4.2.2.7 Fertilizer application

In order to realise better yields regular fertilizer application in banana production especially manure or compost becomes important. Manure and compost not only add nutrients in the soil but also improve soil texture and soil water retention capacity. Inorganic fertilizers could also be used especially if certain nutrients in the soil are known to be missing (Maerere *et al.*, 2007a). Therefore sometimes a mixture of organic and inorganic fertilizers may be necessary. Mowo *et al.* (1993) described the Eastern Zone soils at 0-800 metres above sea level as relatively low fertility soils except in the flat alluvial plains of the area which have fertile clays and alluvial soils. Medium altitude and tropical lowlands have low fertility soils and coastal lowlands have sand low fertility

soils. At the same time the Southern highlands were described as having high altitude (averaging 1200 metres above sea level) with volcanic ash and heavy textured soils. The mountains are typical tropical mountains with clay soils of moderate fertility and others are volcanic highlands like Rungwe usually with reliable rainfall.

The use of fertiliser was therefore equally important in both areas since most sites in Mkuranga are sandy and highly depleted by other crops such as cashew nuts on the other hand in wetter areas such as Rungwe and Mvomero the soils are highly leached through water infiltration. The introduction of fertilizer application was therefore reported by about 91.6% of the project members and 51.7% of the non-project members (Table 12). However, Maerere *et al.* (2007b) also point out that decline in soil fertility is also caused by growing banana in the same fields, year after year without improving the soil fertility by application of animal manure, farm yard manure, compost or inorganic fertilizers. Similarly, mixed cropping with other crops such as maize, vegetable and fruit trees in one farm decreases various nutrients to banana due to different crop growth habits.

4.2.2.8 Pest control

One of the challenges facing banana production is the question of pests and especially banana weevils. Thus, despite using improved varieties, observing the right spacing, de-suckering, fertilising and mulching, if efforts are not made to control the pests then the negative consequences in terms of yield will take place. Some pests not only inflict physical damage to the plant but also become vehicles for spreading diseases. It is therefore important that pests are controlled in order to realise better yields.

According to Maerere *et al.* (2007b), some of the most important problems affecting banana production in all agro-ecological zones include banana weevils (***Cosmopolities***

sordidus), nematodes (*Meloidagyne spp*), black sigatoka (*Mycosphaerella fijiensis*) and in Kagera and Mara regions, the banana wilt (*Xanthomonas musearum*). In the project sites farmers were introduced to the control of banana weevils which was found to be a major problem.

The introduction of pest control was noted by about 90.5% of the project members and fewer (34.7%) of the non-project members (Table 12). Among the introduced technologies probably this was the poorly disseminated outside the project members as indicated by a low percentage of non-project members who acknowledged its introduction. The existence of this technology happened to be confined within the projects. Among the project members 93.1% were introduced to pest control by the projects, 2.3% by ARI-Uyole and only 4.6 % by their fellow farmers. Among the non-project members who were introduced to pest control about 51.9% of them were introduced by their fellow farmers, 14.8% by extension agents, 3.7% by NGO and 25.9% by the projects.

4.2.3 Participation in needs and problem assessment

Most project members agreed to have participated in needs and problem assessments before the beginning of the project. Their responses indicated to have participated in all the technologies that they mentioned to have been introduced by the projects. Their participation in these assessment exercises was quite high as expected since most of them were directly involved in such exercises as they were the project target group. Their participation ranged from lowest at about 86.4% on the issue of pest control to highest at about 91.6% on issues of pit size, spacing, de-suckering and fertiliser application (Tables 15; 23).

The non-project members' participation in needs and problem assessments was low compared to project members ranging from lowest 16.0% in pest control aspect to highest of just 35.5% in pit size issue (Tables 15; 23). Although the non-project members' participation was low, yet it somehow indicates the projects wider engagement in the communities beyond the project members. In other words it testifies to wider consultation at the beginning of the projects before narrowing to project members. It is positive to note that though few, community members beyond project members were consulted on which issues were to be addressed by the projects in order to improve banana production.

Table 15: Percentage distribution of respondents on the basis of their participation in needs assessment of the introduced technologies (n= 182)

Technology introduced	Percentages of respondents acknowledging participation		
	Whole sample (n= 182)	Project members (n= 95)	Non-project members (n= 87)
Pit size	66.7	91.6	35.5
Type of planting materials	64.1	88.4	33.3
New varieties	61.2	88.4	26.7
Spacing	65.3	91.6	32.0
De-suckering	65.9	91.6	33.3
Mulching	65.3	90.5	33.3
Fertilising	66.5	91.6	34.7
Pest control	55.3	86.3	16.0

4.2.4 Participation in training for banana production

When comparisons were made between districts, there were few differences between districts as far as farmer training in banana production was concerned. Similar distributions or similar patterns were observed across Districts in terms of numbers of those who were trained in banana production technologies and those who were not trained (Table 16).

Table 16: Percentage distribution of respondents on the basis of their training in banana production by District (n= 182)

District	Description	Training in banana production		Total
		No	Yes	
Mvomero	Count	24.0	35.0	59.0
	% within District	40.7	59.3	100.0
	% of Total	13.2	19.2	32.4
Mkuranga	Count	24.0	33.0	57.0
	% within District	42.1	57.9	100.0
	% of Total	13.2	18.1	31.3
Rungwe	Count	23.0	43.0	66.0
	% within District	34.8	65.2	100.0
	% of Total	12.6	23.6	36.3
Total	**Count**	**71.0**	**111.0**	**182.0**
	% of Total	**39.0**	**61.0**	**100.0**

However, when comparisons were made between project member and non-project, there was a significant difference between the two groups of farmers ($p<0.05$). There were more project members trained than non-project members (Tables 17 and 23).

Table 17: Percentage distribution of respondents on the basis of their training in banana production by farmer type (n= 182)

Farmer type	Description	Training in banana production		Total
		No	Yes	
Project member	Count	6.0	89.0	95.0
	% within farmer type	6.3	93.7	100.0
	% within received training	8.5	80.2	52.2
	% of Total	3.3	48.9	52.2
Non-project me.	Count	65.0	22.0	87.0
	% within farmer type	74.7	25.3	100.0
	% within received training	91.5	19.8	47.8
	% of Total	35.7	12.1	47.8
Total	**Count**	71.0	111.0	182.0
	% of Total	39.0	61.0	100.0

This pattern of having more training among project members than in non-project members was similar across all districts. The reason being the projects training concentrated more among project members than on non-project members. This became obvious when farmers were asked to identify the institutions that conducted training. Most of the trained project members mentioned the two projects of PANTIL and TARP II-SUA, whereas, for most non-project members such training was received from their fellow farmers (Table 18).

Table 18: Percentage distributions of respondents by training institution in banana production and by farmer type (n= 111)

Training institution	Description	Farmer type		Total
		Project member	Non project member	
PANTIL	Count	43.0	3.0	46.0
	% within received training	93.5	6.5	100.0
	% of Total	93.5	6.5	100.0
PANTIL &	Count	26.0	1.0	27.0
TARP II	% within received training	96.3	3.7	100.0
SUA	% of Total	92.9	3.6	96.4
Fellow farmer	Count	16.0	14.0	30.0
	% within received training	53.3	46.7	100.0
	% of Total	53.3	46.7	100.0
Extension	Count	3.0	2.0	5.0
agent	% within received training	60.0	40.0	100.0
	% of Total	60.0	40.0	100.0
District	Count	-	1.0	1.0
Council	% within received training	-	100.0	100.0
	% of Total	-	100.0	100.0
NGO	Count	-	1.0	1.0
	% within received training	-	100.0	100.0
	% of Total	-	100.0	100.0
MATI Uyole	Count	1.0	-	1.0
	% within received training	100.0	-	100.0
	% of Total	100.0	-	100.0

4.2.5 Perceptions on weather conditions, soils and agricultural services in relation to banana production

The adoption of various technologies depended on the farmers' perceptions and evaluation of the situation and conditions prevailing in their areas. If the conditions are perceived to be harsh, coupled with lack of the necessary services, then the expectation is poor adoption of the technology. The opposite is true when conditions are favourable the adoption rate is expected to be better because it is less taxing on the part of the receiver.

Based on their experiences in their areas farmers were asked to assess various aspects in relation to banana production. Their opinions were sought in relation to climate and weather, availability of water for irrigation and rainfall, soils characteristics, agricultural services and infrastructure conditions. In relation to climate and weather there were variations in the ratings between districts. For example, in Rungwe District most farmers rated their climate and weather from average to good, whereas in Mkuranga District they rated them from average to bad, while in Mvomero District it was good to average (Table 19).

With regard to soils in all districts farmers rated their soils to vary from average to good. In other words in all districts they thought their soils were sufficiently good for banana production. However, according to scientific studies it is only the Eastern zone clay and alluvial soils at low altitude under flat alluvial plain that are relatively fertile. The Southern highlands were described to have moderate fertility and the coastal area to have low fertility sandy soils (Mowo *et al.* 1993; Maerere *et al.*, 2007b). Thus, this is contrary to the assessment of some of the respondents about their soils especially those of Mkuranga which are mainly sandy soils with low fertility.

When it came to sources of inputs there was a difference between Mvomero District and the other districts. While Mvomero District rated the sources to vary from bad to average the other districts rated them from average to bad. Thus, in totality percentage-wise sources of inputs for banana production were generally bad (Table 19).

Table 19: Percentage distributions of respondents by rating climate, weather, water for irrigation, rainfall, soil fertility and sources of inputs in relation to banana production by district (n= 182)

District	Description	Rating climate in relation to banana production in their area			Total	Rating weather conditions in relation to banana production in their area			Total
		Good	Average	Bad		Good	Average	Bad	
Mvomero	% within District	25.4	69.5	5.1	100	15.3	64.4	20.3	100
Mkuranga	% within District	10.5	43.9	45.6	100	5.3	47.4	47.4	100
Rungwe	% within District	56.1	42.4	1.5	100	54.5	43.9	1.5	100
Total	**% entire sample**	**31.9**	**51.6**	**16.5**	**100**	**26.4**	**51.6**	**22.0**	**100**
		Rating water for irrigation in relation to banana production in their area				**Rating rainfall in relation to banana production in their area**			
		Good	Average	Bad		Good	Average	Bad	
Mvomero	% within District	15.3	33.9	50.8	100	5.1	78.0	16.9	100
Mkuranga	% within District	3.5	10.5	86.0	100	.0	50.9	49.1	100
Rungwe	% within District	59.1	15.2	25.8	100	68.2	30.3	1.5	100
Total	% entire sample	27.5	19.8	52.7	100	26.4	52.2	21.4	100
		Rating soil fertility in relation to banana production in their area				**Rating sources of inputs in relation to banana production in their area**			
		Good	Average	Bad		Good	Average	Bad	
Mvomero	% within District	54.2	42.4	3.4	100	15.3	55.9	28.8	100
Mkuranga	% within District	68.4	29.8	1.8	100	7.0	24.6	68.4	100
Rungwe	% within District	68.2	31.8	0	100	19.7	37.9	42.4	100
Total	% entire sample	63.7	34.6	1.6	100	14.3	39.6	46.2	100

Meanwhile water for irrigation in relation to banana production was generally considered to be good in Rungwe, since there are many perennial streams and rivers. The situation was considered to be generally bad in Mkuranga while in Mvomero they considered it to be average to bad. This definitely has a bearing to the nature of rainfall in the area, of course coupled with other environmental factors such as the nature of forestation. For example, perennial streams mainly exist in such enabling conditions. Thus, the ratings on rainfall had a similar pattern as those of water for irrigation with Rungwe being good. Mkuranga bad, and Mvomero bad to average (Table 19).

Extension advice in relation to banana production were generally rated to vary from average to good in all districts, whereas, sources of information on banana production were generally rated from good to average, although, Rungwe farmers slightly thought it was from average to good (Table 20). However, it is important to note that although the projects were mainly meant for research activities they also provided extension services especially to their project farmers. This made farmers perceive a significant extension contact as far as banana production was concerned. What emerged in the FGDs was also the fact that despite the projects efforts to collaborate with the government extension personnel yet most extension agents never made their own personal visits or initiatives. Instead, they continued to wait for the project research teams to accompany them into the villages.

Table 20: Percentage distributions of respondents by rating extension advice, sources of information, markets, prices, research and agricultural policies in relation to banana production by district (n= 182)

District	Description	Rating extension advice in relation to banana production in their area			Total	Rating sources of information in relation to banana production in their area			Total
		Good	Average	Bad		Good	Average	Bad	
Mvomero	% within District	47.5	33.9	18.6	100	30.5	54.2	15.3	100
Mkuranga	% within District	50.9	40.4	8.8	100	38.6	45.6	15.8	100
Rungwe	% within District	63.6	28.8	7.6	100	43.9	42.4	13.6	100
Total	**% entire sample**	**54.4**	**34.1**	**11.5**	**100**	**37.9**	**47.3**	**14.8**	**100**
		Rating markets in relation to banana production in their area				**Rating prices in relation to banana production in their area**			
		Good	Average	Bad		Good	Average	Bad	
Mvomero	% within District	40.7	39.0	20.3	100	25.4	59.3	15.3	100
Mkuranga	% within District	56.1	35.1	8.8	100	61.4	31.6	7.0	100
Rungwe	% within District	22.7	50.0	27.3	100	19.7	48.5	31.8	100
Total	**% entire sample**	**39.0**	**41.8**	**19.2**	**100**	**34.6**	**46.7**	**18.7**	**100**
		Rating research in relation to banana production in their area				**Rating agricultural policies in relation to banana production in their area**			
		Good	Average	Bad		Good	Average	Bad	
Mvomero	% within District	39.0	47.5	13.6	100	44.1	42.4	13.6	100
Mkuranga	% within District	49.1	38.6	12.3	100	71.9	26.3	1.8	100
Rungwe	% within District	60.6	28.8	10.6	100	68.2	30.3	1.5	100
Total	% entire sample	50.0	37.9	12.1	100	61.5	33.0	5.5	100

Markets for banana were considered to be average to good in the two districts of Mkuranga and Mvomero and this had to do with their proximity to Dar-es- Salaam city (About 250 kilometres from Mvomero and about 70 kilometres from Mkuranga) a major consumer of banana products. Unfortunately, Rungwe is a long distance from Dar-es-Salaam (close to 1 000 kilometres) and as a result banana markets become a problem since the nearby markets of Mbeya and Iringa are normally easily saturated. Similarly, that rating was also reflected in the prices for banana. Mkuranga enjoyed better prices and farmers rated them as being mainly good. Farmers in Mvomero on the other hand mainly considered banana prices to be average to good while their counterparts in Rungwe considered them to be average to bad (Table 20). More proximity and good roads to Dar-es-Salaam according to FGD has made Mkuranga to easily access that market.

With respect to research activities in banana production, Mkuranga and Rungwe farmers generally considered them to be good while those in Mvomero generally regarded them to be average. Similarly, with agricultural policies, Mkuranga and Rungwe farmers generally considered them to be good while those in Mvomero generally regarded them to be good to average (Table 20).

The ratings on roads by farmers were as reflected in the banana markets and prices. In Mkuranga for example, most farmers considered the roads to be good since a tarmac road goes through all the study villages while in Rungwe and Mvomero they considered them to be average to good. Similarly for transport, most Mkuranga farmers considered transport to be good since a tarmac road makes available and to even access vehicles which come from as far as Mtwara in the south, heading to Dar-es-Salaam. Based on observations as well as to what emerged in the FGD, there are quite a number of commuter vehicles popularly known as "Daladala" and medium-sized cargo trucks that ply the route all the time.

According to the farmers it is possible to make several trips to Dar-es-Salaam in a day, even at late in the evening. On the other hand Rungwe and Mvomero they considered transport to be good to average and average to good respectively (Table 21).

Sources of capital with regard to banana production were a major problem to all these areas. Farmers in all these districts rated the situation to be generally bad (Table 21). With regard to lack of sources of capital, a similar situation was found by Mpagalile *et al.* (2009) among the sunflower farmers and even in the entire sunflower value chain. What emerged out of FGDs especially in Mkuranga and Mvomero was based on a perceived contradiction among various authorities for not recognising banana as a food crop neither as a cash crop and as a result banana is not given its due weight when it comes to credit. There are no credit institutions that are available targeting banana because of its' projected low status by the authorities. In Mkuranga for example, they consider without having irrigation facilities like water pumps it is impossible to make a breakthrough and expand in banana production.

Table 21: Percentage distributions of respondents by rating roads, transport, and sources of capital in relation to banana production by district (n= 182)

District	Description	Rating roads in relation to banana production in their area			Total	Rating transport in relation to banana production in their area			Total
		Good	Average	Bad		Good	Average	Bad	
Mvomero	% within District	27.1	59.3	13.6	100	23.7	61.0	15.3	100
Mkuranga	% within District	78.9	8.8	12.3	100	75.4	12.3	12.3	100
Rungwe	% within District	37.9	50.0	12.1	100	42.4	34.8	22.7	100
Total	**% entire sample**	**47.3**	**40.1**	**12.6**	**100**	**46.7**	**36.3**	**17.0**	**100**
		Rating sources of capital in relation to banana production in their area							
		Good	**Average**	**Bad**					
Mvomero	% within District	6.8	27.1	66.1	100				
Mkuranga	% within District	1.8	15.8	82.5	100				
Rungwe	% within District	6.1	18.2	75.8	100				
Total	**% entire sample**	**4.9**	**20.3**	**74.7**	**100**				

As mentioned earlier, farmers' perceptions and assessment of weather conditions, soils, and various agricultural services has a bearing on their response behaviour to a certain technology or agricultural practice and also their motive to engage a stakeholder that would address what they consider to be limiting. However, with regard to these factors the three study districts were endowed differently and this influenced the way they responded in seeking various services and adopting the technologies and practices as it will be exemplified in the next sections. For example, Mkuranga area because of their proximity to Dar-es-Salaam and good road infrastructure and transportation to the market they never considered to engage a reliable buyer or form an association that could have improved their farm gate prices. On the other hand, at Kiroka Ward in Morogoro District because of the terrain and lack of feeder roads and means of transportation from the production sites they were reluctant to adopt varieties such as FHIA 23 and FHIA 17 because of their huge bunches.

4.2.5.1 Current support of banana production

In this section results are presented in relation to the farmers' views after examining the current situation in relation to supporting banana production. Generally, respondents thought the current government incentives for improved banana production was average to bad and only about 24.7% thought it was good (Table 22). This could be clarified from the FGDs where farmers expressed the fact that banana is not given due weight by the government like other crops. Banana is never considered as an important food crop neither as a cash crop. For example in Mkuranga there is more emphasis on cashewnut than on banana. Similarly in Mvomero especially Hembeti area there is more emphasis and even support in terms of training in rice than it is for banana. Even in Rungwe where it is known to be a staple food, according to the farmers there were no specific

government incentives that were targeting banana. Instead, tea was more prominent to an extent of maintaining feeder roads for transportation of tea.

Table 22: Percentage distribution of respondents by rating various current situations in relation to banana production (n= 182)

Description of issues	Rating			Total %
	% Bad	% Average	% Good	
Government incentives for improved banana production	31.9	43.4	24.7	100
Availability of trained & experienced extension workers in banana production	23.1	53.3	23.6	100
Local universities, research institutions and agricultural training institutions responsiveness to farmers banana production needs	13.7	39.0	47.3	100
Availability of financing /venture capital	71.4	22.5	6.0	100
Training in banana production	23.1	46.7	30.2	100
State of water supply for banana production	50.5	24.2	25.3	100
Roads for transporting banana	16.5	44.0	39.6	100
Marketing infrastructure	36.8	43.4	19.8	100

On the availability of trained and experienced extension workers in banana production the majority of the respondents thought it was just average. However, as expressed earlier on, in the FGDs farmers expressed some dissatisfaction on the part of extension workers by paying more attention to the so called cash crops and main staple foods especially grains. Probably that is why only about 23.6% thought their availability and experiences were

good (Table 22). Similarly, there were extension workers who admitted to have less knowledge, experience and skills on improved banana production as compared to some farmers they were supposed to assist.

With regard to local universities, research institutions and agricultural training institutions responsiveness to farmers banana production needs, the majority of respondents rated them from average to good, with 47.3% of them actually rating good (Table 22). Indeed this is not a bad rating and could have risen out of the good work that these institutions were doing. However, not forgetting the fact that these were the key players in both TARP II-SUA and PANTIL banana projects and therefore if they did their work well that expression will be expected especially considering that the study covered the project villages. Thus, this rating could be confirming the job that was done by the two projects and in particular SUA. Even in the FGDs they expressed to have relied on the projects which were basically research projects for extension advice because of the close linkage they had established.

With regard to availability of finances or capital for banana production the majority of respondents expressed it to be bad (71.4%), meaning the situation was still bad even towards the end of the project. As expressed in the FGDs there were very few credit institutions around that could cater for banana production ventures. Training in banana production was mainly rated average (46.7%) while state of water supply for banana production was rated mainly bad (50.5%). The bad rating for state of water mainly rose from Mkuranga and Mvomero districts since in Rungwe it was expressed as satisfactory. Roads for transporting banana were generally rated from average (44.0%) to good (39.6%) since most of these villages are either close to a tarmac road or there is a well

maintained gravel feeder road passing through (Table 22). Thus, roads were generally not considered to be a problem.

On the other hand, marketing infrastructure was rated by majority of the respondents to be average (43.3%) to bad (36.8%) situation (Table 22). This is actually one of the aspects that farmers in the FGDs thought that if once resolved could be a solution to other problems. Their argument was that even if you produce a lot if there are no markets then you are doomed. On the other hand, if the markets are available the income accrued out of that can assist in improving production through financing farm operations like fertilisers, water irrigation facilities and others. They observed that with markets around and good prices banana production can finance itself.

4.2.6 Adoption of the improved banana production technologies.

Generally, most of the technologies were well received and ultimately adopted by farmers depending on the evaluation of their conditions and the various prevailing situations. Such conditions included terrain, weather, sources of water and rainfall, labour sources or markets and prices. Overall the adoption rate ranged from highest at 88.0% in type of planting materials to lowest at 53.5% in pest control. However, when examined by type of farmers it was generally high among project members compared to non-project members. It was high among project farmers because of the constant training that they received from the projects. With project members it ranged from highest at 93.5% in planting pit size and spacing to lowest at 77.9% in pest control (Table 23).

Non-project members never did very badly either especially considering that they were not part of the project. However, by making observations, receiving training and learning from their colleagues they were able to put up an impressive performance. They had the highest

adoption at 77.3% in types of planting materials to lowest at 22.7% in pest control (Table 23). They did badly in the pest control practice since this technology was neither well covered even among the project farmers who happened to be the source of information and skills to non-project farmers.

These adoption rates were higher as compared to national banana sector study. In the banana sector study the use of new and improved banana varieties was reported to be at 66.5% of the respondents, while adoption of new banana cultural practices was at 57.3%, and the use of new banana pest management at 39.9% (Maerere *et al.*, 2007b). In this study the adoption rate of new varieties was quite high compared to those established by the national banana sector study. Overall 82.9% of the respondents adopted new varieties, among project members 87.8% and among non-project members 71.8% despite depending on their fellow farmers for information and training (Table 23). Similarly, in this study the adoption of cultural practices was higher overall as compared to the above study except among non-project members in mulching (49.3%), de-suckering (48.0%) and in pest control (22.7%) where their adoption rates were lower (Table 23).

Table 23: Percentage distributions of respondents by participating in needs assessment, training and decisions to adopt the technologies by farmer type

Technology	Farmer type	No.	% being part of assessing needs	No.	% Trained in technology	No.	% Adopted the technology	No.	% Own Decision
Pit size	Entire Sample	171	66.7	141	92.9	141	86.5	135	88.9
	Project	95	91.6	93	100.0	93	93.5	90	96.7
	Non- project	76	35.5	48	79.2	48	72.9	45	73.3
Type of planting materials	Entire Sample	170	64.1	134	91.0	133	88.0	129	87.6
	Project	95	88.4	90	97.8	89	93.3	85	95.3
	Non -project	75	33.3	44	77.3	44	77.3	44	72.7
New varieties	Entire Sample	170	61.2	129	92.2	129	82.9	121	86.8
	Project	95	88.4	90	98.9	90	87.8	84	94.0
	Non- project	75	26.7	39	76.9	39	71.8	37	70.3
Spacing	Entire Sample	170	65.3	139	91.4	139	87.1	135	88.1
	Project	95	91.6	93	100	93	93.5	89	97.8
	Non- project	75	32.0	46	73.9	46	73.9	46	69.6
De-suckering	Entire Sample	170	65.9	170	76.5	170	71.8	135	88.9
	Project	95	91.6	95	96.8	95	90.5	90	95.6
	Non- project	75	33.3	75	50.7	75	48.0	45	75.6
Mulching	Entire Sample	170	65.3	170	72.4	170	67.6	135	85.2
	Project	95	90.5	95	93.7	95	82.1	87	92.0
	Non- project	75	33.3	75	45.3	75	49.3	48	72.9
Fertilising	Entire Sample	170	66.5	170	78.2	170	72.4	140	85.0
	Project	95	91.6	95	96.8	95	87.4	90	91.1
	Non- project	75	34.7	75	54.7	75	53.3	50	74.0
Pest control	Entire Sample	170	55.3	170	61.2	170	53.5	92	100
	Project	95	86.3	95	90.5	95	77.9	75	100
	Non- project	75	16.0	75	24.0	75	22.7	17	100

4.2.6.1 Adoption of planting pit size

As mentioned earlier, project members did well in adopting almost all the technologies. However, they did very well in adopting the pit size, types of planting materials and spacing (Table 23). Pit size was highly adopted by project farmers to a rate of 93.5% and 72.9% among the non project members with reasons that it increased yield through moisture conservation and soil fertility since it makes easy to fertilise the stem without losing the fertility through runoffs. However, there were no differences in patterns between districts, instead, there was a significant difference ($p<0.05$) between the two categories of farmers. Suggesting that, more project members were already using banana pit management that non-project members. According to the majority (88.9%) of these farmers the decisions to adopt were made by themselves rather than certain coercion from outside (Table 23).

4.2.6.2 Adoption of planting materials

Similarly, with type of planting materials the adoption rate was relatively high to both farmers in the project (93.3%) and non-project farmers (77.3%). The main reasons for their adoption were the need to control pests and diseases in order to increase yield. Accordingly, the decision to adopt the new type of planting materials by the majority (87.6%) was mainly theirs and not compulsion from other people (Table 23).

4.2.6.3 Adoption of new varieties

Since most of the cultural practices are meant to assist a certain variety to express it's genetic potential, one would have expected that probably the new varieties should have emerged among the topmost adopted aspects since some varieties such as FHIA 23 and FHIA 17 had depicted some incredible features or qualities (from the scientific point of view). Such qualities included high yielding in terms of bigger bunches and number of

bananas, the "stem" is bigger and strong to withstand winds. However, from the producer's point of view the very same "good quality" could be judged differently depending on the prevailing circumstances. For example, if the market is not available or it is not ready for such a product then the producer will ignore it. Sometimes the market could be somewhere but if the infrastructure is not supportive, may be in terms of transportation then the producer might end up ignoring it as well.

This is exactly what happened with some of the very promising varieties from the researchers' point of view like FHIA 23 and FHIA 17. Some farmers in mountainous areas of Morogoro/ Mvomero like in some parts of Hembeti and generally in Kiroka could not adopt these varieties because of the transportation problems. At Kiroka for example, most of the farms are up in the mountains, there are no roads to the farms and therefore produce has to be transported on the head to the markets in the lowlands. According to FGDs the bigger the bunch from the ordinary size the more difficult it becomes in transporting it. They further explained that they normally use hired labour to transport banana bunches down to the road, but with bigger bunches even hired people wouldn't accept. In some cases as it was explained in Rungwe, it is not easy for two people to lift one bunch of FHIA 23. Unfortunately, you cannot cut them into pieces since in most cases green banana business goes by bunches.

In the same lines in Rungwe FGDs, they made another observation on the size of the bunch and in their case it had to do with the price. They claimed that sometimes you are disadvantaged with bigger sizes since the traders are used to certain common local varieties prices per bunch thus, even if your bunches are bigger, the extra money that you are going to earn after negotiations will not match the efforts and value for money.

Fortunately for Kiroka farmers, their proximity to Dar-es-Salaam had made them start value addition through tunnel smoke ripening process on banana and sell it ripe through their local association by the name Kiroka Agricultural Produce Marketing Co-operative Society (KAPMACOS). Unlike in the natural process where banana on the same bunch ripen at different rates, the smoking process helps in ripening the entire consignment of banana at the same time and therefore be able to sell the whole lot at once. This to some extent has also resolved the problem of transportation of banana from the fields. Since ripe banana business is through banana fingers rather than bunches, it is now possible to detach the fingers from the bunch in the farm and transport the manageable loads to the ripening processing sites down the hill. Similarly, it is also possible to transport ripe banana by trucks in baskets called "tenga" to the huge market in Dar-es-Salaam and some to Morogoro Municipality. For Rungwe such a move will be futile since as mentioned earlier, their main market is Dar-es-Salaam and transporting ripe banana for over 10 hours in hot and humid conditions it is almost impossible since even green bananas sometimes get spoiled, unless special packaging is made and the right temperature maintained.

For Mkuranga, the story is different since the new varieties like FHIA 23 and FHIA 17 were a blessing. According to FGDs these varieties have been positively received in the market of Dar-es-Salaam both as green banana and as ripe banana and they are fetching a good price. Since transportation is not a problem they claimed to be in business and they are making money. They pointed out that some of them have actually bought motorcycle out of FHIA 23 and FHIA 17 banana sales.

Similarly, Pelipita was another example of a new variety that was less adopted despite its good qualities of resistance to diseases as well as withstanding water logged conditions. This was almost immediately rejected because of its' external features which resemble

local varieties that they disliked. However, it later became acceptable to farmers at Hembeti- Mvomero after reaching maturity in their Farmer Field School (FFS) plot and testing it (see Table 13). They found its' taste to be pleasant especially when roasted.

On the other hand, another new variety by the name of Yangambi was adopted especially with farmers in Rungwe and Mvomero not necessarily because of its' good qualities that it had, but mainly because it resembled a local variety that they knew and liked by the name of "Kisukari". From a scientific point of view Yangambi is actually highly resistant to many banana diseases. It actually bears the name of a place it was originally found, growing wildly without succumbing to diseases. However, according to farmers these are facts that they came to find out later after choosing it. They also said its' banana has a very distinctive pleasant aroma.

Generally, there was good adoption of these varieties with 87.8% of the project farmers and 71.8% of non project farmers and a move made by the majority (86.8%) on their own discretion (Table 23). Among farmers who had already introduced new varieties in their farms in the past five years, 72.9% of those had introduced about one to four varieties while 25.2% had introduced between five and nine varieties and only 1.9% had introduced above ten varieties. There was more or less similar patterns across districts but there was a significant difference ($p<0.05$) between project members and non- project members, implying that project members had adopted more new varieties in their farms than it was with non-project members. A number of reasons were given as to why new varieties were adopted and these included the need to control diseases through disease resistant varieties, to increase yield through high yielding varieties in areas where transportation was favourable and control pests.

4.2.6.4 Adoption of spacing

Spacing was another well adopted technology by both (87.1%) categories of farmers with 93.5% of the project farmers and 73.9% of the non-project farmers. This is a decision that most preferred, but with about 30.0% of the non-project members who adopted the technology probably they adopted it out of peer pressure (Table 23). Recommended banana spacing depended on the mix of crops that were grown in the same plot and the measurements were quite spread. Among those who innovated on spacing 19.8% used 3 by 3 metres space and mainly under monoculture. Under mixed or intercropping there were 14.3% with 3 by 4 metres, 28.6% with 4 by 4 metres, 20.6% with 4 by 5metres and 16.7% using 5 by 5 metres.

Although the trend indicated better performance in Rungwe followed by Mkuranga but again as it was with the varieties, there were no differences between districts. Instead, there was a significant difference ($p<0.05$) between the two categories of farmers, meaning more project members employed new spacing regimes than non-project members. Reasons for adopting these new spacing regimes were to increase yield through having sufficient number of banana stems in a given area as well as allow sufficient light through.

4.2.6.5 Adoption of de-suckering

De-suckering, mulching, fertilising and pest control were among the technologies that were not very well adopted especially among the non-project members. Although with de-suckering there was a high rate of adoption among the project members to the rate of about 90.5%, there was only 48.0% of the non-project members adopting it (Table 23). Among those who were thinning their banana 72.8% left 3 stems per pit, whereas 25.8% left 4 stems per pit. Although the trend indicated an inclination towards Rungwe doing

better than other districts, however, there were no significant differences among them in this practice. Instead, there was a significant difference ($p<0.05$) in thinning between categories of farmers where project members did better than non-project members.

It however, emerged in the FGDs even among the project members that it is normally quite a painful experience to remove the suckers which sometimes are looking good and healthy and just throw them away. That is why some will just let them continue. They however, confessed that through their observations over time they have realised that you get a better bunch with fewer stems around. Similarly, they said it is much easier to fertilise and weed the farm and thus increase yield.

4.2.6.6 Adoption of mulching

Mulching was another technology that was not well received among non-project members. While 82.1% among the project members adopted mulching it was only 49.3% among the non-project members (Table 23). The reason for low adoption among non-project members being it is labour demanding. Again most of those who adopted the practice (85.2%), they did on their own discretion (Table 23). However, those who adopted acknowledged the practice to help in moisture conservation and improve soil fertility.

4.2.6.7 Adoption of fertilizer application

Fertilizer application on the other hand was adopted by 87.4% among project members and 53.3% by non-project members with the major reasons that it improves soil fertility and hence increases yield (Table 23). Among those who fertilised their farms, 91.5% used manure while 8.5% made a combination of manure and commercial or inorganic fertilisers. There were significant differences ($p<0.05$) between districts suggesting

Rungwe to have done better in fertilising their farms followed by Mkuranga and then Mvomero. It is important to remember that in Rungwe almost everybody kept livestock and thus, easy access to manure whereas for Mkuranga these had to be drawn from not less than 25 kilometres away.

Similarly, a significant difference ($p<0.05$) was observed between the two categories of farmers implying more project members fertilised their farms than it was with non-project members. All of those that adopted fertilizer application (100%) made that decision on their own rather than compulsion from other people or institutions (Table 23). The reason given being it hastens growth and also increases yield which translates into more income.

4.2.6.8 Adoption of pest control

Pest control was the most poorly adopted technology especially among non-project members. About 77.9% of project members adopted the technology but only 22.7% of the non-members did (Table 23). This can be explained especially on part of the non-project members since many of them were not trained in the technology with only 24.0% being trained (Table 23). Since they were more dependent on other farmers for training this left them in an awkward position. For example, even among project members, out of 90.5% that received training, it was only 77.9% that ultimately adopted the practice (Table 23).

In pest management, all districts and both categories of farmers performed poorly. Looking at the figures, one realises that even among project members this activity was never adequately attended to by the projects as a result similar effects manifested among non-project members whom their skills depended more on their fellow trained project farmers. With fewer adopters among project members it translates to fewer trainers to

non-project farmers. Those who adopted indicated the fact that with fewer pests around a good yield is guaranteed.

4.2.6.9 Search of new markets

In the process of production ultimately one has to consume the product if it is food and when in excess it has to be disposed to the market. About 36.8% of the respondents had already found new markets for their banana. Among those who found new markets 88.2% had found one market source and 8.8% had found two market sources. Significant differences ($p<0.05$) were observed among districts with Mkuranga to have done well followed by Rungwe and then Mvomero. Mkuranga was again favoured by it proximity to major urban centres like Dar-es-Salaam.

There was also a significant difference ($p<0.05$) between project members to have done well than non-project members in soliciting new markets. This could have been a result of FFS sessions, since such issues were discussed as part of making progress in banana production. Similarly, their groupings might have played a role since project farmers had formed and operated in groups, met regularly, and thus shared information including marketing information, something that was not available to the non-project farmers.

4.2.7 General observations on adoption of technologies

Adoption of technologies was relatively high among project members than it was with non-project members. Even among those who adopted yet they could not implement all the expected practices that go with the technology because they either needed certain inputs or capital. Similarly, it was difficult for some to actually access the markets and prices that would guarantee profitable returns for their investments. One of the major reasons for this state of affairs was the fact that other stakeholders that would have

extended such technologies to the rest of the community members as well as provide services on credit and marketing did not participate. For example, training conducted by banana experts was mainly confined to project members while non-project members had to rely on the goodwill of their fellow project members to acquire those skills.

Similarly, some of the technologies were not extensively adopted among the project members because of non-participation of other stakeholders. For example, the absence of inputs suppliers for fertilisers made the application of fertilisers to be minimal and those who applied it was mainly through the application of manure. Pest control training was also less extensively covered by the project members and therefore its effects could not be significantly expressed among the non-project members because there were no other committed stakeholders apart from the project staff to further extend the technology in the communities. This was also true for practices like de-suckering and mulching that were found to be marginally adopted among non-project members (Table 23).

Absence of other key stakeholders also hampered the process of value addition which some farmers (like in Kiroka) had to be creative and initiate the process by themselves. The presence of stakeholders such as banana chips processors and reliable traders could have assisted in value addition probably by even training the farmers on how to handle banana in order to maintain its quality until it reaches the market and ultimately get a better price. Such stakeholders would have probably created a similar scenario of what happened with the cassava farmers under the Power Foods Company in Dar-es-Salaam who were trained to improve quality of their products by the company (Mpagalile *et al.*, 2009). Similarly, such stakeholders could have hopefully resolved the issue of ripe banana and the question of storage and transportation to the market by initiating the processing of banana.

Tissue culture planting materials according to the project plans were expected to be easily available to the farmers through private sector (Macrere *et al.*, 2004). The anticipation was for a private company to be buying young seedlings from the project laboratories nurturing them until they are ready to enter the farmers' fields through business transactions. The evolvement of such an arrangement was expected to guarantee sustainability in planting material supply even in the absence of the project. Since no private company was engaged right from the beginning that business venture never materialised and thus farmers had to mainly rely on the project something that hampered the tissue culture planting materials wider distribution and utilisation.

Similarly, the presence of transportation stakeholders would have assisted to address transportation problems and address the farmers concerns. Assurance of transport would have become a motivation for expansion of farms in order to increase production but more importantly would have encouraged farmers to adopt technologies that enhance productivity. Therefore with value additions or processing combined with transportation would have resolved the issue of bulkiness of the FHIA varieties. That is why Mytelka and Goertzen (2004) noted that the flow of knowledge and information that link economic actors and institutions provides stimulus to innovations and are core to all innovation systems to succeed.

There were many significant differences between project farmers and non-project farmers in most of the adoptions made by farmers. However, this should not come as a surprise since project members were constantly being supported and reinforced by the projects through training and advice or even with some other services such as supply of planting materials. From that point of view therefore many of such differences were more or less expected.

4.3 Actors, Functions and Their Roles in Banana Technologies Development

According to Technology Specific Innovation System (TSIS) one's expectation would be the participation of the various actors of the different elements of the TSIS (CTA, 2005; Hekkert *et al.*, 2006) and in the case of this study the different stakeholders of banana industry. Thus, from the innovation systems perspective, expectations would be to find evidence of involvement by various actors concerned in banana production. Involvement is expected from stakeholders such as those involved in banana research and training, extension, marketing, credit, input supplies, policy making and others. Such involvement is anticipated to commence right from the initiation of the technology development. Unfortunately, in the case of this banana technological innovation, fewer institutions were identified by farmers and in most cases had to do with those that dealt with research and extension such as SUA, ARI-Uyole and government extension agents.

4.3.1 Institutions/individuals participated in banana technologies development

Farmers were able to identify just a few institutions or stakeholders that participated in the banana technologies development and these were mainly TARP II-SUA and PANTIL projects which were basically efforts by Sokoine University of Agriculture (SUA), ARI-Uyole, local government extension agents and their district councils and NGOs. Most of these were either doing research or extension and therefore other elements of the Banana Innovation System were not represented (Tables 24; 25, 26 and 27).

Sokoine University of Agriculture (SUA) and ARI-Uyole were basically doing research although they had to add in some elements of extension. This was important since the extension system could not quickly respond to address farmers' needs and concerns. For example, some of the extension agents admitted to know little about banana improved practices as they compared themselves with some of the farmers who were initially

trained by TARP II-SUA and PANTIL projects and especially those who were trained during the TARP II-SUA project. Some of these extension agents sometimes felt incompetent to handle some of the banana farmers concerns and thus, they had to wait for SUA researchers' visits to the project villages. A similar observation was made during the FGDs in Mkuranga and Mvomero, where farmers indicated that they relied more on SUA researchers for extension advice on banana than it is for extension agents since their extension agents are mainly seen when visitors are around.

It is however, surprising for such extension agents to have felt incompetent since according to project research members and reports and even the extension agents themselves, extension agents used to participate in farmers trainings. This was later confirmed by farmers during the FGDs in Rungwe, Mkuranga and Mvomero. During farmers' training, an extension officer from the district headquarters, ward extension agent and village extension agents would be involved. May be a major disturbing factor on the part of extension agents could be the official transfers or somebody leaving for further studies as it happened in Rungwe and therefore somebody else has to fill in the gap. Under such circumstances then the new extension agent coming into the project village might find some of the project activities to be new. However, that is not a good excuse since as an agricultural trained person some of those implemented activities were supposed to be part of his/her training in the college. If not, then as an extension agent is expected to be creative enough to find sources where he/she could get the necessary information and skills.

On the other hand, district councils and extension agents were representing the dissemination component just doing their mandated extension work. Even with that mandate still according to this survey and FGDs their role in banana production was

marginally recognised for the reasons explained above. According to FGDs in all districts of the study, for most extension workers it was business as usual and they rarely paid attention to banana, instead, they concentrated to the so called "nationally recognised" cash crops such as cashewnut in Mkuranga, rice in Mvomero and tea in Rungwe. Farmers in the FGDs observed that banana has not yet been given its' due weight and priority as both a food and cash crop instead, it is still considered as a marginal crop. Under those circumstances, they were concerned that it would be difficult for them to tap foreign markets in the future.

When it came to other elements of the banana innovation system, farmers were unable to identify any representation from marketing, credit, policy or input supply institutions. Although a countywide banana sector study was able to identify three institutions that were processing banana, including one that was processing banana into wine and flour (Nyire-Farmi), Kyimo Investment that was making chips and farmer groups under MVIWATA that were undertaking small scale solar drying of ripe banana (Maerere *et al.*, 2007b). Such activities and institutions were not found in the study areas. A clear indication that the collaboration was skewed and confined among fewer players who were doing banana research and extension together with farmers who were responsible for production.

The presence of credit institution would have probably benefited farmers. For example Muffui (2007), reported that in the Uluguru Mountains Agricultural Development Project about 76.7% of the farmers used credit from rural banks to buy fertilisers, seeds, pesticides, and animal manure. Out of those 50% indicated production to have increased after receiving credit and the increase in yields was significantly different ($p< 0.001$). Unfortunately, in the study areas there were no rural banks. Similarly, Maerere *et al.*

(2007b) also observed a general trend in the banana sector in rural areas that generally financing agents are largely missing.

In this study, apart from asking respondents to identify and rank the various institutions and other actors who participated in the banana technologies development, they were also requested to indicate the strength of their collaboration. Among the 121 who were able to do that the first identification in rank was PANTIL (69.4%) followed by TARP II-SUA (15.7%) and these had to do with research activities. Extension agents came next (9.1%) and it had to do with dissemination activities (Table 24).

The collaboration with PANTIL and TARP II-SUA were considered by the majority to be quite strong at 73.8% and 89.5% respectively. With extension agents they thought it was average to strong relationships. However, this is contrary to what Maerere *et al.* (2007b) found out since most farmers regarded extension services provided by the government as not being good and also they thought extension agents were not their major source of information. Other institutions that were mentioned in the first set though to a lesser extent included ARI-Uyole and extension agents on research issues, district councils on extension and NGOs on both research and extension (Table 24).

Table 24: Percentage distribution of respondents by identification of first ranked institutions, their roles and intensity of the collaborations (n= 121)

Actor/ Institution	Function	No.	%	Linkage intensity			Total
				Weak	Average	Strong	
PANTIL	Research	84	69	0	22	62	84
				(0)	(26.2)	(73.8)	(100)
TARP II-SUA	Research	19	15.70	0	2	12	19
				(0)	(10.5)	(89.5)	(100)
Extension Agents	Extension	11	09.10	0	7	4	11
				(0)	(63.6)	(36.4)	(100)
ARI- Uyole	Research	3	02.48	0	1	2	3
				(0)	(33.3)	(66.7)	(100)
Extension Agents	Research	1	00.83	0	0	1	1
				(0)	(0)	(100)	(100)
District Council	Extension	1	00.83	0	1	0	1
				(0)	(100)	0	(100)
NGO	Research	1	00.83	0	0	1	1
				(0)	(0)	(100)	(100)
NGO	Extension	1	00.83	0	0	1	1
				(0)	(0)	(100)	(100)
Total	**NA**	**121**	**100**	**NA**	**NA**	**NA**	**NA**

Under the second rank more less the same institutions emerged. Among the 62 respondents who were able to identify the second institution TARP II-SUA and PANTIL emerged highest with about 41.94% and 35.50% respectively, on research issues. The other institutions were extension agents 12.90% on dissemination and ARI-Uyole 8.10% on research activities and 1.61% on extension issues (Table 25). The collaborations with TARP II-SUA and PANTIL were generally considered to be strong while those of ARI-Uyole and extension agents were considered to be average (Table 25).

Table 25: Percentage distribution of respondents by identification of second ranked institutions, their roles and intensity of the collaboration (n= 62)

Actor/ Institution	Function	No.	%	Linkage intensity			Total
				Weak	Average	Strong	
TARP II-SUA	Research	26	41.94	0	9	17	26
				(0)	(34.6)	(65.4)	(100)
PANTIL	Research	22	35.50	0	3	19	22
				(0)	(31.6)	(86.4)	(100)
Extension Agents	Extension	8	12.90	0	5	3	8
				(0)	(62.5)	(37.5)	(100)
ARI- Uyole	Research	5	08.10	0	3	2	5
				(0)	(60.0)	(40.0)	(100)
ARI- Uyole	Extension	1	01.61	0	1	0	1
				(0)	(100)	(0)	(100)
Total	**NA**	62	100	NA	NA	NA	NA

Even fewer people were able to make the third ranking of institutions. Among 27 respondents who were able to make three identifications it emerged that it was almost the same institutions that had been identified by others in the first and second identifications. This was a clear indication that it was only those few institutions that had participated in the technologies development. In the third batch ARI-Uyole emerged top followed by extension agents and then PANTIL and TARP II-SUA with the district councils coming last. Generally their collaborations were considered to be from average to strong linkages (Table 26).

Table 26: Percentage distribution of respondents by identification of third ranked institutions, their roles and intensity of the collaboration (n= 27)

Actor/ Institution	Function	No.	%	Linkage Intensity			Total
				Weak	Average	Strong	
ARI- Uyole	Research	12	44.44	0	4	8	12
				(0)	(33.3)	(66.7)	(100)
Extension Agents	Extension	7	25.93	0	3	4	7
				(0)	(42.9)	(57.1)	(100)
PANTIL	Research	3	11.11	0	1	2	3
				(0)	(33.3)	(66.7)	(100)
TARP II-SUA	Research	2	07.41	0	1	1	2
				(0)	(50.0)	(50.0)	(100)
ARI- Uyole	Extension	2	07.41	0	2	0	2
				(0)	(100)	(0)	(100)
District Council	Extension	1	03.70	0	1	0	1
				(0)	(100)	(0)	(100)
Total	**NA**	27	100	NA	NA	NA	NA

Only seven people were able to make the fourth rank of institutions that they identified to have participated in the technology development. These institutions were extension agents and district councils mainly on issues of extension. Generally their collaborations were considered by this group to have been strong (Table 27).

Table 27: Percentage distribution of respondents by identification of fourth ranked institutions, their roles and intensity of the collaboration (n= 7)

Actor/ Institution	Function	No.	%	Linkage intensity			Total
				Weak	Average	Strong	
Extension Agents	Extension	4	57.14	0	0	4	4
				(0)	(0)	(100)	(100)
District Council	Research	2	28.57	0	0	2	2
				(0)	(0)	(100)	(100)
District Council	Extension	1	14.29	0	0	1	1
				(0)	(0)	(100)	(100)
Total	**NA**	7	100.0	NA	NA	NA	NA

Examining these identifications, ranking lists and figures it was clear that few institutions participated in the development of these technologies and most of them had to do with either research or extension. Similarly, there was no indication of the coordination among the various stakeholders as they attended to the farming communities. Researchers and extension agents assumed most of the responsibilities that went with the technology development and dissemination. Other institutions that constitute other components of the innovation system according to these lists were not involved. For example, institutions to cater for inputs supply, credit or marketing did not emerge among the identified institutions. Therefore there were no sufficient collaborations among stakeholders to make the system function properly. Apart from farmers, researchers and extension agents, representative institutions from marketing input supply and credit were supposed to participate in the process right from the beginning in order to foster adoption of the technologies.

The scenario described above later explains the kind of problems that farmers were facing in the process of adopting such technologies. As pointed out at the beginning of this section, according to TSIS the expectation was for other institutions involved in banana marketing, credit, input supplies or policy making to have been identified by farmers. None among those other components of the system participated in the technology development. Thus, when farmers complain about markets and prices for example, it can be understood because there were no institutions that could have addressed those challenges. Similarly, when they complained of not observing certain practices like digging the right planting pit size due to shortages of labour it can also be understood because there were no financial institutions that could lend them money in order to hire labour. Thus, adoption of the technologies to some extent was negatively affected because of the non-participation of such institutions.

4.3.1.1 Banana development partners and their collaborations

It was also the interest of this study to find out if there were any banana development partners involved in exchange of information and experiences with farmers, probably also holding together either formal or informal meeting or helping farmers in training or capacity development. Thus, farmers were asked to identify such institutions, organisations or even individuals who they were collaborating with and at the same time indicate the intensity of collaboration.

It was more less the same institutions that they identified to have collaborated in the development, training and dissemination of the banana technologies. Another confirmation that it was the very same few institutions inclined towards research and extension together with farmers formed the core of the actors in the banana technology and production development systems. Going through the list (Table 28) it is just the same PANTIL, TARP II-SUA, ARI-Uyole, SUA and local government extension agents.

Table 28: Percentage distribution of respondents by banana development partners and the intensity of collaboration

Area of collaboration	Organisations/ institutions/Persons	Intensity of collaboration			Total
		Weak	Average	Strong	
Exchange of information and experiences	PANTIL	0	0	2	2
		(0)	0	(100)	(100)
	PANTIL & TARP II-SUA	0	0	5	5
		(0)	0	(100)	(100)
	SUA	0	1	1	2
		(0)	50.0	(50.0)	(100)
	ARI-Uyole	0	2	2	4
		(0)	50.0	(50.0)	(100)
	Local extension agent	1	7	3	11
		(9.1)	(63.6)	(27.3)	(100)
	Fellow farmers	2	20	25	47
		(4.3)	(42.6)	(53.2)	(100)
Formal and informal meetings	PANTIL	0	0	3	3
		(0)	(0)	(100)	(100)
	TARP II-SUA	0	1	0	1
		(0)	(100)	(0)	(100)
	PANTIL & TARP II-SUA	0	1	2	3
		(0)	(33.3)	(66.7)	(100)
	ARI-Uyole	0	0	5	5
		(0)	(0)	(100)	(100)
	Local extension agent	1	7	3	11
		(9.1)	(63.6)	(27.3)	(100)
	Fellow farmers	0	6	12	18
		(0)	(33.3)	(66.7)	(100)
	NGO	0	0	1	1
		(0)	(0)	(100)	(100)
Training/ capacity development	PANTIL	0	5	8	13
		(0)	(38.5)	(61.5)	(100)
	TARP II-SUA	0	0	2	2
		(0)	(0)	(100)	(100)
	PANTIL & TARP II-SUA	0	3	18	21
		(0)	(14.3)	(85.7)	(100)
	SUA	0	1	8	9
		(0)	(11.1)	(88.9)	(100)
	Local extension agent	1	1	0	2
		(50.0)	(50.0)	(0)	(100)
	NGO	0	0	1	1
		.(0)	(0)	(100)	(100)

Although there were a number of institutions involved in exchange of information and experiences with farmers, the exchange of information and experiences however, was mainly shared among farmers themselves. Fellow farmers were the people whom most often exchanged information, to some extent, with village extension agents. These exchanges were generally considered to be strong among farmers and average with extension agents (Table 28). The same pattern repeated was when it came to holding formal and informal meetings. There were more meetings among farmers themselves than it was with other partners. Local extension agents came second probably because they are also based in the same locality and actually in their area of jurisdiction (Table 28). This one probably should not be surprising since in actual fact extension agents are the people who are supposed to frequently hold meetings with farmers who are their clients. Again these collaborations were considered to be strong among farmers themselves and average between farmers and extension agents.

There were no formal meetings between other partners say for example between researchers and extension agents. Similarly, there were no formal mechanisms of exchanging information and experiences about their common clientele who are the farmers. The only collaboration of significant nature was during the farmers training where extension agents would also attend. However, collaborations in terms of planning together how to handle various issues pertaining to the technologies and improved practices dissemination never took place.

If farmers dominated in the exchange of information and experiences as well in formal and informal meetings, it is another testimony that if farmers are capacitated then it is possible for them to effect quick change for their own development. That kind of development is easily sustained because the architectures, engineers and drivers of

development will be originating within the people themselves rather than waiting for outsiders like extension agents and universities. It is thus important in such projects that efforts are made to build capacity among farmers so that they drive their own development. They need to build capacity for example, in how best to organise meetings, how to keep records of the meetings and those of production as well as how to retrieve information from different sources.

With regard to training and capacity development PANTIL and TARP II-SUA, which were basically originating from SUA and SUA itself dominated the collaboration of capacity development and trainings with farmers. The collaboration was generally considered by the farmers to be strong (Table 28). SUA was basically a research institution and thus, the training they were credited for, should have originated from extension since they were also partners in the process. Unfortunately, extension did not feature out very much probably because of lack of resources to conduct such training or probably because of preoccupation with other government priorities as it was speculated by farmers in the FGDs.

4.3.2 Other institutions providing services

As the projects progressed it was the expectation that other players will join on board in different ways. For example, as farms get established they would require certain inputs and therefore an input supply institution is expected to provide the requisite service. Similarly, once there is produce a marketing institution is expected to emerge and provide marketing services. Thus, farmers were requested to identify such institutions that emerged and the kind of services that they provided. Only 8.8% could respond to this question a clear indication that there were few institutions if any that emerged to provide service.

The few (8.8%) respondents that managed to identify such institutions also had a very short list and most of the identified institutions had to do with sensitization or training. Such institutions included district councils in sensitizing other farmers to join in, training workshops and supply of inputs. The input supply referred to were mainly banana planting materials especially in Rungwe District. Similarly, they mentioned the extension agents for providing extension services. One of the respondents in Rungwe attended training at Farmers Training Institute at Inyala Mbeya, this was also later confirmed by others in the FGD held at Rungwe. Others pointed out nearby villages by sensitizing them and providing training in improved banana production. This was clarified in FGDs where in Rungwe for example, villages that had participated in TARP II-SUA project played a role in reinforcement training to new villages that joined the PANTIL project, even providing them with planting materials. A similar situation also happened in Mkuranga where some farmers from Mwarusembe village trained new farmers at Mkenge and Kimanzichana villages.

Generally, similar accounts emerged in the FGDs as farmers pointed out that besides very few individuals that were attending workshops organised by district councils, basically there were no other formal institutions that provided services. Even with marketing they said they continued with the same banana traders as they used to do in the past or take it to the local market. These traders are not even regular and thus, you keep meeting new faces all the time. The exception was however, at Kiroka where a local co-operative called Kiroka Agricultural Produce Marketing Co-operative Society (KAPMACOS) was established in order to organise transport for marketing of banana to Dar-es-Salaam. Thus, they pooled efforts in hiring transport but the actual marketing more or less remained the individual's responsibility.

The arrangements by KAPMACOS were for the individual member to organise his/her own broker in Dar-es-Salaam to whom the consignment will be delivered and then the person who went with the truck will collect the money on their behalf. On return the money will be deposited at the KAPMACOS's office where respective sellers will collect their money and pay a small fee.

4.3.3 Important institutions that did not participate

When respondents were requested to pinpoint which institutions in their opinion should have participated in this innovation but did not participate and to indicate which role they should have played, they came up with varied views. There was a long list but most of it with less than one percent of people mentioning it. Some of them based on the suggested roles seemed not to be in relation with banana production. The list ran from agricultural training colleges for providing training, research centres conducting research, community based organisations for sensitization, extension organisations for provision of advice, financial institutions for provision of loans, businessmen for trade and government on policy matters.

However, out of the survey the most prominent in the four lists identifications among many were banks (34.1%) for provision of loans, district councils (30.2%) for training and input supplies, input supply institutions (11.5%) to supply inputs and credit institutions like Savings and Credit Co-operative Societies (SACCOS) (17.0%) to provide loans (Table 29). This was somehow contrary to what emerged in the FGDs since during the discussions the most crucial institutions were marketing rather than financial ones as portrayed in the survey. They pointed out that if markets were available it is possible for the banana industry to finance itself. They observed that, you just need about one year to start harvesting and it is possible to plough the income accrued back into production and

hence possibility for expansion. Thus, institutions like banana wholesalers, banana agro-processing industries were suggested.

Like in the survey, in FGDs institutions like banks and SACCOS for loans, input supply institutions for fertilisers and pesticides were suggested. They even went further to suggest that the district councils should be involved in input supply something that is contrary to current government policy. The current policy encourages this responsibility to be mainly undertaken by the private sector. Training institutions especially in banana processing and those with expertise in irrigation were thought to have been important. They also suggested more recruitment of extension agents and also train more farmers who will become trainers. They also thought there was a need for direct involvement of national and local governments to give priority to banana in government policy.

Table 29: Percentage distribution of respondents by identification and ranking of important institutions that should have participated (n= 182)

Institutions identified	Ranking								Total	
	rank one		rank two		rank three		rank four			
	No.	%	No.	%	No.	%	No.	%	No.	%
Banks	33	18.1	18	09.9	8	04.4	2	01.1	61	33.5
District councils	34	18.7	18	09.9	1	00.5	2	01.1	55	30.2
SACCOS	13	07.1	13	07.1	4	03.0	1	00.5	31	17.7
Input suppliers	9	04.9	11	06.4	1	00.5	0	00.0	21	11.8

Based on their concerns and suggestions, it is very clear that farmers already articulated the importance of other elements of the improved banana production system that should have been in place for the system to function properly. Most of the institutions they

suggested represented the system elements that did not participate from the beginning. It was as if they had the system structure in their mind before suggesting those institutions. This also exemplifies the fact that if farmers are taken as equal partners and facilitated right from the planning phase of the project, they can provide quite valuable information that will help in the smooth running and success of the project.

4.3.4 Linkages between technology utilisation and actors

The banana research projects that respondents had participated in were quite few and these were TARP II-SUA and PANTIL banana projects. Almost all respondents could not mention any other research work apart from TARP II-SUA and PANTIL banana projects. In other words it was only the project members that have participated in banana research projects. According to farmers basically they have been collaborating with SUA (91.6%) and to a lesser extent with ARI-Uyole (7.4%) for those in Rungwe and the district councils (Table 30).

Table 30: Percentage distribution of respondents by research institutions collaborating in banana research (n= 95)

Research institution	Frequency	Percent
SUA	87	91.6
ARI-Uyole	1	1.1
SUA &ARI-Uyole	6	6.3
District Council	1	1.1
Total	95	100

According to those who participated in research, TARP II-SUA and PANTIL were addressing issues of spacing, pests and disease and increased yield. Most of them (97.9%)

participated almost in all stages from problem identification, choice of varieties, testing and production itself (Table 31).

Table 31: Percentage distribution of respondents by participation stages in banana research (n= 95)

Participation stages	Frequency	Percent
Problem identification	1	1.1
Production activities	1	1.1
Problem identification through to production	93	97.9
Total	95	100

In the process of collaborating in these research activities farmers were able to receive some materials from the projects. However, these materials were mainly confined to planting materials. Among those who participated, 28.6% received tissue culture seedlings, 54.8% received banana suckers and 16.7% received both tissue culture seedlings and banana suckers. There was no financial assistance that was advanced to the participating farmers. Similarly, even when they were asked to identify institutions that financially supported their banana production only one respondent was able to borrow. This individual borrowed money from SACCOS to the tune of Tshs 200 000 for the purpose of farm expansion.

This basically explains why credit institutions were among the actors that farmers thought should have been part of the key players, right from the beginning of the projects. There are few credit institutions available to the farmers since even banks that provide agricultural loans their priorities are geared towards export cash crops like tea and cashew-nut and not crops like banana. Similarly, according to farmers the banks

conditions are too stringent and complicated for ordinary small farmers to be able to borrow. The only hope is for the SACCOS movement to sufficiently grow so that farmers can have access to loans since these are normally based in their areas, run by members and according to the conditions they have set for themselves.

The absence of other key institutions in the banana production system especially those that are concerned with marketing and credit denied farmers opportunity to expand and improve productivity of their farms. Farmers expressed their concerns that they could not expand their farms, could not use inputs like fertilizers and could not irrigate during dry spells because they did not have capital and there were no credit institutions around for them to borrow. The key issue that farmers were actually expressing is the fact that when innovations are implemented, all key elements of innovation development system must be in place for the endeavour to succeed.

In the course of undertaking banana production farmers utilised a number of inputs supplied by other institutions or obtained from their own sources. They were thus requested to indicate the kind of inputs supplied the source of the inputs and the system under which it was acquired. The majority of the farmers (83.8%) used banana seedling supplied by PANTIL (31.3%), fellow farmers (54.0%) or from their own farms (14.0%). Again fellow farmers played a crucial role in the dissemination of banana seedlings. Among these 27.9% said they bought the seedlings while 72.1% received them as grants from the project and fellow farmers. Thus, there were strong linkages and solidarity among farmers themselves to have supplied their colleagues with seedlings and to great extent as grants.

The cost for seedlings among those who bought and those who incurred on labour to uproot the seedlings even though from own farm ranged from as low as 200 Tshs to 1 500 000 Tshs at most. These however were the two extreme ends. The general picture was that about 12.7% spent less that 1 000 Tshs, 42.9% between 1,000 and 9,000 Tshs, 39.6% between 10 000 and 90 000 Tshs and 4.0% between 100 000 and 300 000 Tshs. There was only one person who spent about 1 500 000 Tshs.

Fertilisers were another input that they used and which included both inorganic and chemical/industrial fertiliser and organic fertilisers like manure. Only 51.1% of the respondents indicated to have used any kind of fertilisers. Among these, 54.8% obtained manure from their own livestock or compost from their farms, 29.0% from their fellow farmers and about 11.8% bought inorganic fertilisers from input shops. About 50.6% obtained fertilisers by cash, 48.2% as grant, and 1.2% as loan. About 13.8% spent less than 1 000 Tshs on fertilisers, 22.5% spent between 1 000 and 9 000 Tshs, 53.7% spent between 10 000 and 90 000 Tshs and only 10.0% spent between 100 000 and 500 000 Tshs.

In Mkuranga the cost of manure is extremely high because they are not livestock keepers and they have to incur transportation costs to purchase them from distant pastoral communities (about 25 kilometres). According to FGD though expensive however, based on Dar-es-Salaam prices one can still make profit if correct amounts are applied, although it will have partially eroded the expected profit.

Pesticides were another input that was used though by very few (5.5%) farmers. The major sources for pesticides were input shops and PANTIL project. Among those few 70.0% bought by cash and 30.0% received as grants. Those who bought spent between 1

600 to 50 000 Tshs. Based on statistics there was very low utilisation of pesticides. Similarly, these three were the only inputs that farmers managed to identify as being used in their farms.

4.4 Institutions Involvement in Dissemination of Improved Banana Technologies

Various institutions were expected to disseminate the developed improved banana technologies either during the development of the technologies, during implementation or even after some farmers had adopted them so that the technologies can spread to other members of the communities. As a result of this understanding farmers were asked to identify such institutions, estimate the number of contacts per month and whether during their visits were actually addressing banana issues. Similarly, they were requested to pinpoint the kind methods or strategies that they were employing during dissemination exercises.

4.4.1 Availability of village extension agents

The government policy on extension is to a have at least a village extension agent in each village so that farmers can be informed or trained in various aspects of agricultural production. Similarly, it was the same extension agent who was expected to be responsible for dissemination of the improved banana technologies. When respondents were requested to identify whether they had a village extension agent, 68.7% agreed to have had a village extension agent, while the remaining 31.3% reported to have none.

However, when this was checked through cross-tabulations against the districts there were significant differences ($p<0.05$) between districts. More Mvomero respondents had indicated to have a village extension agent than it was for Mkuranga and Rungwe (Table 32).

Table 32: Percentage distribution of respondents by presence of extension agent by district (n= 182)

Presence of extension agent	Description	District of the respondent			Total
		Rungwe	Mkuranga	Mvomero	
No	Count	32.0	20.0	5.0	57.0
	% within having	56.1	35.1	8.8	100.0
	% within District	48.5	35.1	8.5	31.3
	% of Total	17.6	11.0	2.7	31.3
Yes	Count	34.0	37.0	54.0	125.0
	% within having	27.2	29.6	43.2	100.0
	% within District	51.5	64.9	91.5	68.7
	% of Total	18.7	20.3	29.7	68.7
Total	**Count**	**66**	**57**	**59**	**182**
	% of Total	**36.3**	**31.3**	**32.4**	**100.0**

When the same aspect was checked through cross-tabulations against farmer type there were no significant differences in their distributions. In other words a similar pattern was observed between project members' responses and those of non-project members (Table 33).

Table 33: Percentage distribution of respondents by presence of extension agent by farmer type (n= 182)

Presence of ext. agent	Description	Farmer type		Total
		Project member	Non-project member	
NO	Count	31.0	26.0	57.0
	% within having	54.4	45.6	100.0
	% within Farmer type	32.6	29.9	31.3
	% of Total	17.0	14.3	31.3
YES	Count	64.0	61.0	125.0
	% within having	51.2	48.8	100.0
	% within Farmer type	67.4	70.1	68.7
	% of Total	35.2	33.5	68.7
Total	**Count**	**95.0**	**87.0**	**182.0**
	% of Total	**52.2**	**47.8**	**100.0**

4.4.2 Extension services by various institutions

With regard to institutions that were involved in the dissemination of improved banana production technologies, farmers managed to identify a few and these included Government village level extension agents (48.4%), Government Ward level extension agents (30.8%), NGOs like Caritas Tanzania (2.2%), CBOs like KAPMACOS (1.1%) and the University (SUA) by 48.4%. Thus, the major players according to these findings were the Government village and ward level extension agents and SUA (Table 34). All these institutions were reported to have addressed banana issues wherever they made a visit to the farmers or villages. Village level extension agents had made on average two visits per month, while the rest were reported to have made on average one visit per month (Table 34).

Both village and ward level extension agents used heavily the farm visit method of extension to the tune of about 87.5% and 83.9% respectively. Thus, there was little variation in the methods that both village and ward level extension agents employed in their dissemination work. To a lesser extent they also used demonstrations and workshops (Table 34). NGOs used demonstrations (50.0%), farm visits (25.0%), and a combination of workshops, demonstrations and farm visit to about 25.0% of the respondents that they reached. On the other hand CBOs inclined towards farm visits (50.0%) and a combination of workshops or seminars and demonstrations (50.0%).

Table 34: Percentage distributions of respondents by identification of agencies assisting them in matters of improved banana production

(n= 182)

Type of organisation	Total sample	Yes to contact	% yes Have contact	Average visits/ month	% yes Addresses banana	Extension methods used				
						% Workshop/ Seminars	% Demonst-ration	% Leaflets & booklets	% Farm visits	% Worksh, semin., demos & farm visits
Govt. Village Ext. Agent	182	88	48.4	2	87.5	2.5	10.2	0.0	87.5	0.0
Govt. Ward Ext. Agent	182	56	30.8	1	91.1	7.1	8.9	0.0	83.9	0.0
NGO	182	4	2.2	1	100	0.0	50.0	0.0	25.0	25.0
CBO	182	2	1.1	1	100	0.0	0.0	0.0	50.0	50.0
University	182	88	48.4	1	100	12.5	13.6	1.1	22.7	50.0

The University (SUA) however, diversified its methods of engagement using a combination of farm visits, workshops and demonstrations closer to a tune of 76.1%. Similarly, this is the only institution that was able to distribute leaflets and booklets to farmers though to a lesser extent (Table 34). Booklets and leaflets could be very useful especially to farmers that train their colleagues to serve as reference materials. This was a positive move by the University even though it also failed to distribute sufficient leaflets and booklets to as many people as possible. Such materials would not only be useful to project members but also to people who did not have the opportunity to participate in the project to articulate what was going on. According to SUA researchers, they also organised farmer exchange and study tours which encouraged some farmers to quickly adopt the technologies.

4.4.3 Training as a dissemination strategy by various institutions

Various institutions organised training though at different intensities as a strategy to spread the various improved banana technologies. These institutions included the two projects of PANTIL and TARP II-SUA, ARI-Uyole, extension agents, fellow farmers, and NGOs like Caritas Tanzania. However, the most prominent ones were PANTIL, TARP II-SUA and fellow farmers. These three institutions trained many farmers in almost all the improved banana production associated technologies except in banana processing and packaging where only about 6 people benefited. The technologies that they were heavily involved in included the banana pit size, the type of banana planting materials, new banana varieties, banana spacing, de-suckering, mulching, fertilizer applications and banana pests control (Table 35).

Table 35: Percentage distributions of respondents by organisations that provided trainings in improved banana production technologies

Technology	Description	Organisation providing training								Total
		PANTIL	TARP II	SUA	ARI-Uyole	Extension agent	Fellow farmers	PANTIL & TARP II SUA	NGO	
Pit size	Count	43	4	5	1	4	31	41	1	130
	% within trained	33.1	3.1	3.8	.8	3.1	23.8	31.5	.8	100
Planting materials	Count	49	1	5	1	2	27	39	0	124
	% within trained	39.5	.8	4.0	.8	1.6	21.8	31.5	0	100
New varieties	Count	41	-	5	10	4	28	39	1	128
	% within trained	32.0	-	3.9	7.8	3.1	21.9	30.5	.8	100
Spacing	Count	44	1	5	6	4	33	37	1	131
	% within trained	33.6	.8	3.8	4.6	3.1	25.2	28.2	.8	100
De-suckering	Count	44	4	5	3	4	33	37	1	131
	% within trained	33.6	3.1	3.8	2.3	3.1	25.2	28.2	.8	100
Mulching	Count	40	1	5	7	9	26	38	1	127
	% within trained	31.5	.8	3.9	5.5	7.1	20.5	29.9	.8	100
Fertilising	Count	45	-	5	5	5	34	37	1	132
	% within trained	34.1	-	3.8	3.8	3.8	25.8	28.0	.8	100
Pest control	Count	41	-	5	4	8	19	39	1	117
	% within trained	35.0	-	4.3	3.4	6.8	16.2	33.3	.9	100
Banana processing	Count	1	-	-	-	-	1	-	-	2
	% within trained	50.0	-	-	-	-	50.0	-	-	100
Packaging	Count	2	-	-	-	-	2	-	-	4
	% within trained	50.0	-	-	-	-	50.0	-	-	100

PANTIL, TARP II-SUA and another category under the banner SUA in Table 35, all those could be regarded as SUA since the projects were basically originating from SUA. If their figures are combined then is obvious that, with the exception of banana processing and packaging, they trained over 60% of the trainees in each of the other technologies and for that matter fellow farmers becomes second among trainers. This is an important aspect to note since it has proved the fact that farmers exchange information, help each other in skills development and also visit each other to check whether what they learnt are being implemented (this is basically extension).

It is important to illustrate this with few examples. For example, after the FGD in Rungwe District at a village called Bujela one of the participants took the researcher around to visit his so called "students" who were also amazingly proud to be under the supervision of their fellow farmer. These were entirely his personal initiatives and not the directives of the project. Similarly, another one in Mkuranga District at Mwarusembe village has trained many other farmers and he has also been used by the project to train other farmers in different forums as well as in the agricultural shows. These two farmers were initially intensively trained by the University under the TARP II-SUA project. Their efforts never diminished even after the end of the project. This further stresses the need to target certain farmers to be trainers of their colleagues since that will guarantee continuity or sustainability even after the end of the project.

The contributions by other institutions cannot be ignored though small since they added value to other efforts and also we should remember that they were doing this on top of their other responsibilities. For example, ARI-Uyole apart from contributing almost in every technology their recognition by farmers was mainly in training for new banana

varieties, spacing and mulching. Similarly, for extension agents their contributions were mainly recognised in mulching and pest control (Table 35).

4.5 Description of the Improved Banana Innovation System in the Eastern and Southern Highlands Zones

Banana as the main crop under study was associated with other crops in different ways. Some of those crops became a source of capital for various banana production operations like digging of the planting pits. Similarly, others became a source of soils fertility, others suppressed weeds, while others assisted in erosion controls (see Table 6). However, the ultimate goals were to finally describe the agricultural technology innovation system for banana that was developed as well as the expected one. Thus, the actors that participated in this process of improved banana production system as identified by farmers and their corresponding components are presented in a matrix table (Table 36).

Table 36: Matrix table of actors in the improved banana production system under PANTIL and TARP II-SUA projects by system components

Component	Participated Actors
Banana Market/Demand	Irregular Small middlemen banana traders - Not formal they keep on changing all the time. They buy for distant markets in the urban centres. Village markets – individuals – For example, in Rungwe it is once a week called "Gulio" KAPMACOS
Banana Enterprise	Project farmers Non-project farmers Village shops input suppliers, especially for pesticides
Diffusion of Improved Banana Production	Public extension services, Village and Ward extension agents and District extension officers PANTIL Banana Project TARP II-SUA Banana project Sokoine University of Agriculture (SUA) Fellow farmers ARI-Uyole CBOs
Research and Training	PANTIL Banana Project TARP II-SUA Banana project Sokoine University of Agriculture (SUA) ARI-Uyole Fellow farmers Farmers Training College -Inyala MATI -Uyole NGOs
Infrastructure	SACCOS

With regard to marketing component of the system, only small traders played some role in terms of buying banana fruits for distant markets. Such traders were not regular and there was no common meeting place, in the sense that sometimes they show up at the farm gate and sometimes at the local market. For example, in Rungwe area there is a local market every Thursdays and farmers normally take their produce to that market.

The problem with such a market according to Rungwe FGD is the fact that small traders keep on changing every week and therefore there is no room to negotiate a more stable price and also difficult to build business relationships.

On the other hand, in Mvomero they relied on farm gate sales and their major concerned was the fact that one cannot be in a better position or advantage to negotiate for a better price because the trader controls both the market and transportation. Similarly, these traders according to Mvomero FGD they just show up without prior notification and in most cases are different people and therefore it is not possible to create relations and negotiate for better prices or even other services like supply of inputs. When bananas are ripe and a small trader does not show up it becomes another downfall in the sense that one has to dispose that to the local market where the demand is low and hence very low prices. Even when small traders finally appear a farmer is on a weaker negotiating position because of desperation to dispose banana which if not sold, he/she is not in a position to process it into storable products.

That also applied on transport in the sense that there were no specialised companies or even specialised trucks for transporting banana. Small traders had to negotiate with any truck that is available and especially those which are heading back to urban centres after offloading their cargo to carry their banana consignments. Such traders in Rungwe area included both men and women. Most of those women traders were mainly from Dar-es-Salaam but of local roots to the area. On the other hand for Mkuranga and Mvomero those who were found in the area and also according to FGD constituted only men. The only exception was at Kiroka where farmers had organised themselves to handle the marketing aspect of banana. This association (KAPMACOS) proved to be effective and even efficient through pooling together the resources that are available to them.

Certainly it was cost effective for them to hire a truck and carry everybody's small load and one or two persons to escort the loads to the market destination with a small chargeable fee.

In the marketing component of the system there were few stakeholders that participated in the process and who just came in on their own initiative and who were trying to make their ends meet similar to the farmers. Similarly, there were no formal efforts to integrate them into the process. Due to lack of consolidated private companies' participation in the process it was difficult to create business relationships and forge collaborations that would benefit both sides. For example, there were no companies that would process excess banana into more valuable products like chips or juice. Such participation would have not only improved prices but also created reliable markets and job creations.

Within the banana enterprise component of the system only small farmers both project and non-project farmers were the prominent key players. There were no big commercial banana farms which could have probably helped in transmitting production skills to small farmers. There was virtually no participation of the input suppliers except for small shops that sold pesticides. Therefore fertilisation of banana farms with commercial or inorganic fertilisers never happened. The anticipation was that if other stakeholders would have participated they could have taught farmers how create compost manure especially in areas where animal manure was scarce rather than relying on distant sources which proved to be costly.

With regard to infrastructure component of the system which includes policies, legislations and financial resources, there was minimal participation of the various stakeholders who were supposed to play a role in this process. The only institution that

researchers and extension agents in terms of disseminating the technologies and practices.

Generally, the improved banana innovation system was not an ideal one because some of the expected stakeholders who were supposed to play certain roles never participated in the process. Such institutions included for example, banana wholesalers, banana processing industries, irrigation experts, fertiliser suppliers, pesticide suppliers, banks for provision of loans, SACCOSs and reliable banana transporters (Table 37). Therefore new relationships and collaborations in terms of providing certain services never took place. Similarly, the sharing and exchange of knowledge and experiences among various stakeholders except between researchers and farmers and somehow extension agents never took place. Participation of the private sector both in terms of marketing and financial services never materialised as anticipated because these institutions never participated from the beginning.

For the system to have functioned to the expectations, the extra actors that should have participated were suggested by farmers and are presented in a matrix table according to their corresponding components (Table 37). With regard to marketing component farmers thought the participation of banana wholesalers and agro-processing industries for juice or banana chips was important to guarantee a better price and reliable market. Similarly, in the enterprise component they suggested the participation of input suppliers for fertilisers and pesticides in order to boost production. In the diffusion component they suggested to have more extension agents who are well trained in banana production aspects.

With regard to research and training component their suggestions inclined towards training farmer experts who will assist their colleagues. Farmer experts were suggested on the understanding that they will be resident to the area and cannot transfer to another location but also on the fact that they are easily approachable and can articulate the concerns of their colleagues. In the research component they also suggested the need to have had included irrigation experts in the team in order to assess the irrigation potentials of the areas and also suggest possible cost effective irrigation methods to be used (Table 37). This was especially important in Mkuranga area which experiences severe seasonal rainfall droughts.

In the infrastructure component, banks for provision of loans, SACCOS and other credit institutions were suggested as being important as a source of capital for making investment and implementing the improved banana technologies. They also suggested more affordable and regular transporters in order to access distant markets and hence better prices. However, they thought that some of these aspects to be realised there is need for both local government and central government to give banana crop the priority and the attention it deserves (Table 37).

Table 37: Matrix table of the suggested actors that should have also participated in the improved banana production system by components

Component	Suggested Actors
Banana Market/Demand	Market institutions Banana wholesalers Banana processing industries such as juice
Banana Enterprise	Input suppliers Fertiliser input suppliers Pesticides input suppliers District Councils to supply inputs
Diffusion of Improved Banana Production	Extension agents
Research and Training	Trained farmers Irrigation experts
Infrastructure	Reliable affordable regular transporters. Banks for provision of loans SACCOS and other credit institutions Central Government for policy priority. Local Government

Since innovation is technical, social, organisational or institutional change which is stimulated and influenced by many actors and factors, accompanied by their diffusion, absorption and use, then, the concept of "innovation systems" is an attempt of analysing societal subsystems, actors and institutions contributing in one way or the other, directly or indirectly, intentionally or not, to the emergence or production of innovations (Hekkert *et al.*, 2006). Thus, the banana technology innovation system was supposed to have been adequately constituted by the five components and their elements which are: (i) Banana enterprise such as farmers and input suppliers (ii) Banana research and training - meaning knowledge generation. (iii) Diffusion of improved banana system i.e. information and knowledge transmitters (iv) Banana market/demand - implying prices, volumes and

quality and (v) Banana infrastructure in terms of policies and legislations that would prioritise banana as both a food and a potential export cash crop and direct investments in terms of finances and resources into the sector.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Few institutions participated in this banana technology innovation system and had to do with elements in research and training, diffusion and enterprise components. From research and training it was TARP II-SUA, PANTIL, SUA and ARI-Uyole, in diffusion component extension agents and NGOs and farmers from the enterprise component. Elements in other components of banana marketing, banana enterprise such as input suppliers and those in policy formulation and financial institutions like banks did not participate. Thus, the agricultural technology innovation system for banana that was developed during the implementation of the two projects of TARP II-SUA and PANTIL was not that robust due to non-participation of key stakeholders in marketing, processing, inputs supplies, transportation and credit supply which farmers thought their participation could have improved their income.

TARP II-SUA and PANTIL projects in collaboration with farmers and other few stakeholders advanced a number of improved banana technologies and practices that were thought to be critical in order to improve banana production. Such technologies and practices included banana pit size, new type of planting materials like tissue culture, new high yielding and disease resistant varieties, spacing, de-suckering, mulching, fertiliser application and pests' control.

There were significant rates of adoptions of improved banana technologies among project members than it was for non-project members in improved varieties, spacing, pit management, thinning and in finding new markets. Rungwe farmers did significantly

better in fertilising farms as a result of livestock keeping while Mkuranga farmers significantly better in finding new markets because of their proximity to huge urban markets.

Participation in the improved banana technologies development was dominated by PANTIL and TARP II-SUA and their collaborations with farmers were considered to have been quite strong. District councils and extension agents' roles were marginally recognised because they paid more attention on cash crops such as cashewnut in Mkuranga, rice in Mvomero and tea in Rungwe.

There was more training for project members in improved banana technologies than it were for non-project members and this pattern was similar across all research districts. The prominent trainers among most project members were the two projects of PANTIL and TARP II-SUA, whereas for most non-project members their fellow farmers.

The major players in diffusion of improved banana technologies were the government village extension agents, SUA and government ward extension agents. Village and Ward extension agents relied heavily on farm visits and demonstrations as their methods of dissemination. SUA on the other hand managed to diversify its' methods to also include workshops, distribution of booklets and leaflets as well as farmer exchange and study tours. Farmer exchange and study tours managed to speed up adoption among farmers especially those of Hembeti village. Similarly, to promote learning and discovery, SUA researchers especially under PANTIL used the FFS approach.

Despite considering information from agricultural show not to be that useful, the majority of the non-project farmers (51.7%) used agricultural shows as one of their major source for agricultural innovation information.

Lack of markets, poor prices, lack of capital and non-participation of their relevant institutions were identified by farmers as key challenges to realisation of improved banana production system.

Due to non-representation or non-participation of some elements of the innovation system, some farmers became innovative to address the missing institutional functions and roles through creating farmers associations. Marketing associations such as KAPMACOS was created to address the missing marketing component elements. Similarly, to meet learning and skills development needs or gaps, they had to rely on fellow farmers and some of these farmers managed to sustain innovation activities and training to other farmers even after the project had ended.

5.2 Recommendations

In light of the above results and conclusions the following recommendations are made:

1. Based on an innovation systems perspective it is necessary that all key elements of the components that constitute the system to be represented right from the beginning. Involving all key elements of the system will address two key issues: First is for the relevant elements to resolve or address the challenges or problems related to their functions as they emerge. Secondly, the relationships that would have been created will ensure the sustainability of the technologies and production after the project ends. Thus, in future implementations of similar

research or even developmental activities need to adopt the technology innovation systems approach.

2. It was apparent out of this study that on matters of advice, training or even supply of planting materials, beside the projects, non-project farmers relied on their fellow farmers more than even with extension agents. This was also true among some project members. It was also evident that farmers continued to assist their colleagues even in the absence of the projects' personnel or end of the project. The few trained farmers managed to disseminate the technologies and sustain the activities. With such evidence, it is recommended that in order to sustain such future innovations and activities, it is important to intensively train few farmers not only in the technologies but also in few relevant techniques of extension to better assist their colleagues.

3. Farmer exchange and study tours that were provided to some farmers such as those at Hembeti made them quickly adopt the technologies. Similarly, the FFS provided the opportunity for farmers to make their own choices especially on the banana varieties. With those observations it is thus recommended to vary approaches of engagement and methods of dissemination when innovating in order to address different farmers learning needs and styles.

4. After realising the absence of the marketing elements in the system, some farmers themselves out of their own initiative resolved the challenge by forming a marketing association. It is thus, recommended that in future similar endeavours it might be wise to encourage and facilitate farmers to be innovative. The formation of such associations could be encouraged alongside other

institutions right from the beginning rather than waiting until the problem surfaces. Such associations could be in form of marketing service, financing (e.g. SACCOS) and input supply or even in training.

REFERENCES

Andersson, B. A. and Jacobsson, S. (2000). Monitoring and Assessing Technology Choice: The case of Solar cells. *Energy Policy* 28(14):1037-1049.

Agwu, A. E. Dimelu, M.U. and Madukwe, M. C. (2008) Innovation System Approach to Agricultural Development: Policy implications for Agricultural Extension Delivery in Nigeria. *African journal of Biotechnology* 7(11):1604-1611.

Chambers, R. and Ghildyal, B. P. (1985). Agricultural research for resource-poor farmers: the farmer-first-and-last model. *Agricultural Administration* 20:1-30.

CONCERN Worldwide (2008). Responding to the Needs of Marginal Farmers: A review of Selected DADPs in Tanzania, August, 2008. 58pp.

CTA, (2005). Methodological Framework for Analysing the Agricultural Science Technology and Innovation (ASTI) Systems in ACP countries. CTA/UNU-INTECH/KIT Oct. 2005. 17pp.

Doloreux, D. and Parto, S. (2004). Regional Innovation System: A critical synthesis. *Discussion Paper Series* 2004-17 UN University INTECH Institute for New Technology, The Netherlands. 194pp.

Edmeades, S., Smale, M. and Karamura, D. (2006). The demand for Cultivar Attributes and the Biodiversity of Bananas on farms in Uganda. In: *Valuing Crop Diversity: On farm Genetic Resources and Economic Change.* Smale, M.[Ed]. CABI Publishing. pp. 97-116.

Edquist, C. (ed.) (1997). *Systems of Innovation: Technologies, Institutions and Organizations*. London. Pinter. 427pp.

European Union (2007). Diagnostic Study on capacity building for the implementation of the ASDP in Tanzania, Final draft, June, 2007. 28pp.

FAO, (1995). Production Year Book. 239pp.

Fowler, F. J. (1993). *Survey Research Methods*. (2nd Ed) SAGE Publications, London. 192pp.

Geels, F. (2002). Technological Transitions as Evolutionary Reconfiguration Processes: A Multi-level perspective and A Case Study. *Research Policy* 31: 1257-1274.

Godin, B. (2006). The Linear Model of Innovation: The Historical Construction of an Analytical Framework. *Science, Technology and Human Values*, 31(6):639-667, SAGE Publications.

Goel, V. K., Koryukin, E. Bhatia, M. and Agarwal, P. (2004). *Innovation Systems: World Bank Support of Science and Technology Development*. World Bank Working Paper No. 32. World Bank, Washington D.C. USA. 24 pp.

Gu, S. (1996). Toward an Analytical Framework for National Innovation Systems, UNU/INTECH *Discussion Paper* No. 9605, 1996.

Hall, A., Rasheed, V. S., Clark, N. and Yoganand, B. (2003). From Measuring Impact to Learning Institutional Lessons: An Innovation Systems Perspective on Improving

the Management of International Agricultural Research. *Science Direct Agricultural Systems* 78: 213-241.

Hekkert, M. P., Suurs, R., Negro, S., Kuhlmann, S. and Smits, R. E. H. M. (2006). Functions of innovation Systems: A new Approach for Analysing technological Change. *Technological Forecasting and Social Change* 74(2007): 413-432.

Iturriagagoitia, J. M. Z. (2005). Analysis and Measurement of Interactions in Innovation Systems: A Corporative and Sectoral Approach. DRIUD Academy Winter Conference, 2005. 33pp.

Kalamata, S. L. (2006). Performance Assessment of Extension Services Under Contract Farming Arrangement: A Case Study of Flue Cured Tobacco Growers in Urambo District. A Dissertation submitted in Partial Fulfilment of the Requirements for The Degree of Master of Science in Agricultural Education and Extension of Sokoine University of agriculture. 150pp.

Kibwika, P., Kyazze, F. B. and Musoke, M. N. (2009). Uganda: Fish, Banana and Vegetables. *Agribusiness and Innovation Systems in Africa*. The World Bank, Washington D.C. Larsen, K., Kim, R. and Theus, F. (Eds) Chapter V, pp. 163-189.

Lahey B. B. (2001) Psychology an Introduction. Seventh Edition, Mc Graw Hill. USA. 676pp.

Leeuwis C. and van den Ban, A. (2004). *Communication for Rural Innovation: Rethinking Agricultural Extension.* Third Edition, Blackwell Publishing. UK, USA and Australia. 405pp.

Lefrancois G. R. (2011) Theories of Human Learning: What the Professor Said. Sixth Edition, Cangage Learning. USA. 442pp

Lundvall, B.-Å. (ed.) (1992). *National Innovation Systems: Towards a Theory of Innovation and Interactive Learning.* London, Pinter Publishers. 24pp.

Lundvall, B.-Å. (2002). *Innovation, Growth and Social Cohesion,* Elgar Publishers. 62pp.

Lundvall, B.-Å. (2007). *National Innovation Systems: Analytical Focusing Device and Policy Learning Tool,* ITPS Sweden Working Paper R2007:004. 59pp.

Lusty, C. (2003). Impact of Improved Banana Varieties on Livelihoods in East Africa. In *Info Musa International Journal on Banana and Plantain* 12(2): 31-35.

Maerere, A. P., Mgembe, E. R., Mwaitulo, S., Mwatawala, M. W., Nsemwa, L. T., Ndunguru, A., Spetz, C. J. J., May-Guri S., Senkondo, E. M., Rwambali E. and Mwajombe K. K. (2007a). Status of Banana Production in the Eastern and Southern Zones of Tanzania. In the *Proceedings of the first Annual PANTIL Research Workshop: Transforming Livelihoods of Small-scale Farmers: Contributions of Agricultural and Natural resources* Research, September 2006. Kinabo,L.D.B. and Abeli W.S. (Eds) pp. 197-204.

Maerere, A. P., Msogoya, T. J., Kusolwa, P. M., Mgembe, E. R., Mneney, E. and Nsemwa, L.T. (2004). In Vitro Micro-propagation for Mass Production of Clean Planting Materials of Desirable Banana Cultivars. Research Project Terminal Report TARP II SUA Project. 13pp.

Maerere, A. P., Rweyemamu, C. L., Sibuga, K. P., Mgembe, E. R., Rwambali, E. and Nchimbi-Msolla S. (2007b). Analysis of the Agricultural Science Technology and Innovation System: Banana Case Study in Tanzania. SUA and CTA, October 2007. 59pp.

Mattee, A. Z., Ngetti, M. S. and Rwambali, E. G. (2008a). An Assessment of the Performance of agricultural Extension Services Delivery Under ASDP: A Case Study of Kilosa and Kilombero Districts. A Report submitted to Embassy of Ireland, July, 2008. 39pp.

Mattee, A. .Z., Ngetti, M. S. and Rwambali, E. G. (2008b). Progress Towards the Achievement of the ASDP Outputs and Outcomes. Report Submitted to Director of Policy and Planning, Ministry of Agriculture, Food Security & Cooperatives, October, 2008. 68pp.

Maunder, A. H. (1973). *Agricultural Extension: A Reference Manual*, Rome, FAO. 270pp.

Mowo, J. G., Flooor, J., Kaihura, F. B. S. and Magogo, J. P. (1993). Review of Fertilizer Recommendations in Tanzania: Soil Fertility Report No. F6. National Soil Service, ARI Mlingano, Tanga, Tanzania. 71pp.

Mpagalile, J., Ishengoma, R., and Gillah, P. (2009). Tanzania: Sunflower, Cassava and dairy. *Agribusiness and Innovation Systems in Africa.* The World Bank, Washington D.C. Larsen, K., Kim, R. and Theus, F. (Eds) Chapter IV, pp. 135-162.

Muffui E. N. (2007). The Role of Credit in the Sustainability of Agricultural Extension Services: The Case of Uluguru Mountains Agricultural Development Project. Dissertation submitted in Partial Fulfilment of the Requirements for The Degree of Master of Science in Agricultural Education and Extension of Sokoine University of Agriculture. 80pp.

Mwajombe, K. K. (2011). Urban Agriculture Indices in Selected Towns in Tanzania and Some Issues on Technical Efficiency: Implications for Urban Agricultural Extension Services. A Thesis submitted in Fulfilment of the Requirements for The Degree of Doctor of Philosophy of Sokoine University of Agriculture. 184pp.

Mwaseba, D. L. (2006). *Impact of Agricultural Research: A study of On-Farm Development Effects of Agricultural Research in Southern Highlands and Eastern Zones of Tanzania.* Published Doctoral Thesis, Dept of International Environment and Development Studies, Noragric. 114pp.

Mytelka, L. K. and Goertzen, H. (2004). Vision, Innovation and Identity: The Emergence of a Wine Cluster in the Niagara Peninsula, UN University INTECH Institute for New Technology, The Netherlands. 31pp.

Ngeze, P. B. (1994). Bananas and Their Management. Kagera Writers and Publishers Cooperative Society Limited. 111pp.

Niosi, J., Saviotti, P., Bellon, B. and Crown, M. (1993). National Systems of Innovations: In search of a Workable Concept. *Technology in Society* 15:207-227.

Nkuba. J. M., Ndege, L. J. and Nkulila, S. (2002). On-farm Testing and Acceptability of Improved Banana Varieties in Bukoba District, Kagera Region (1997-2001). Field Note No.144. Agricultural Research Development Institute, Lake Agro-ecological Zone, Maruku District, Bukoba Tanzania.

Nkuba, J., Edmeades, S. and Smale, M. (2006). Promising Crop Biotechnologies for Smallholder Farmers in East Africa: Banana and Maize: Gauging Potential Based on Current Adoption of Banana Hybrids in Tanzania. Genetic Resources Policies-Brief NO.21: 1-4. International Plant genetic Resources Institute, Rome Italy.

PANTIL (2007). Annual Review Workshop Document, Dodoma, August 2007. 140pp

Rajalahti, R., Janssen, W. and Pehu, E. (2008). "Agricultural Innovation System: From Diagnostics Towards Operational Practices" Agriculture and Rural Development Discussion Paper 38, World Bank, Washington, DC. 84pp.

RAS/DADS Mbeya (2008). The Assessment of the Provision of Agricultural Extension Services by District Councils: a Case of Roll-out of DADP in Mbozi District, June, 2008. 89pp.

Reece, J. D. and Sumberg, J. (2003). More Clients, Less Resources: Toward a new conceptual Framework for Agricultural Research in Marginal Areas. *Technovation* 23:409-421.

Rogers, E. M. (1983). *Diffusion of Innovations.* New York: Free Press. 440pp.

Rogers, E. M. (2003). *Diffusion of Innovations.* 5th edition. New York: Free Press. 543pp.

Roling, N. and Pretty, J. N. (1997). Extension's role in sustainable agricultural development. In *Improving Agricultural Extension: A Reference Manual*, Swanson, B., Bentz R.P. and A. Sofranko (Eds) FAO, Rome. pp.181-191.

Rweyemamu, C. L., Mugasha, A. G., Ndyetabura, I. L. and Kavia F. (2007). On-Farm Vanilla Production Experiments in Selected Villages of Bukoba District, Kagera Region In the *Proceedings of the first Annual PANTIL Research Workshop: Transforming Livelihoods of Small-scale Farmers: Contributions of Agricultural and Natural Resources Research*, Kinabo,L.D.B. and Abeli W.S. (Eds), 166-173pp.

Sagar, A. D. and Holdren, J. P. (2002). Assessing the Global Energy Innovation System: Some Key Issues. *Energy Policy* 30(6): 465-469.

Scarborough, V., Killouch, S., Johnson, D. and Farrington, J. (Eds) (1997). *Farmer-Led Extension: Concepts and Practices*, ODI, Intermediate Technology Publications. 214pp.

Schaefer R. T. (2005) Sociology. Ninth Edition. McGraw-Hill. New York. 630pp.

Shetto, M. C. (2008) Strategies for Scaling up Outputs of Research on Natural Resources Management: The Case of Rainwater Harvesting Research in Tanzania. A Thesis

submitted in Fulfilment of the Requirements for The Degree of Doctor of Philosophy of Sokoine University of agriculture. 266pp.

Spielman, D. J. (2005). *Innovation Systems perspective on Developing-Country Agriculture: A critical Review*, IFPRI Discussion Paper 2. Washington DC. 64pp

Sulaiman, V. R. and Hall, A. (2002). Beyond Technology Dissemination: Reinventing Agricultural Extension. *Outlook on Agriculture* 31(4): 225-233.

Sumberg, J. and Reece, J. D. (2004). Agricultural Research Through a 'New Product Development' Lens. *Expl Agric* 40: 295-314.

TARP II – SUA Project (2005). In Vitro Micro-propagation of Banana. In: *Adoption of Technologies for Sustainable Livelihoods*. August 2005. pp 254-259.

Thakur, D. (1993). *Research Methodology in Social Sciences*. Deep & Deep Publications, Delhi. 234pp.

Tidd, J. (2001). Innovation Management in Context: Environment, organization and Performance. *International Journal of Management Reviews* 3:169-183.

United Republic of Tanzania, (1997). *Agriculture and livestock Policy.* Dar-es-Salaam, Tanzania: Ministry of Agriculture and Co-operatives. 152pp.

United Republic of Tanzania, (2001). *Agricultural Sector Development Programme: framework and process Document.* Dar-es-Salaam, Tanzania: Ministry of Agriculture and Co-operatives. 68pp.

United Republic of Tanzania, (2002). *Small and Medium Enterprise Development Policy.* Dar-es-Salaam, Tanzania: Ministry of Industries and Trade. 35pp.

United Republic of Tanzania, (2003): *Agricultural Sector Development Programme: framework and process Document.* Dar-es-Salaam, Tanzania: Ministry of Agriculture and Food Security. 96pp.

United Republic of Tanzania, (2005a). *National Strategy for Growth and Reduction of Poverty.* Dar-es-Salaam, Tanzania. June 2005: Vice President's Office. 117pp.

United Republic of Tanzania, (2005b). *National Microfinance Policy.* Dar-es-Salaam, Tanzania: Ministry of Finance. 30pp.

United Nations, (2010). Technology and Innovation Report 2010. 124pp.

Velho, L. (2002). North-South Collaboration and Systems of Innovation. *The International Journal of Technology Management and Sustainable Development.* 1(3): 195-272.

Wixted, B. (2006). Cluster Complexes: A Framework for Understanding the Internationalisation of Innovation System. Unpublished Report 06-04 Simon Fraser University, Vancouver, B.C. 31 pp.

APPENDICES

Appendix 1Farmers Questionnaire

SECTION1: FARMER IDENTIFICATION

1. District_____

2. Village_____

3. Farmer Type
   i) Project member TARP II SUA and PANTIL____
   ii) Non Project member____

4. Name of Respondent_____

SECTION 2: SOCIO-ECONOMIC CHARACTERISTICS OF THE RESPONDENTS

5. Sex of respondent: i) Male_____ ii) Female_____

6. What is your education level?

No formal education		Primary education		Secondary education		Tertiary education	

7. Marital status

Single		Married		Divorced		Widowed	

8. What is your age? _____ Years

9. Family size
   i) Number of adults (above 18 yrs)_____
   ii) Number of able bodied people among adults _____
   iii) Number of young children (below 18yrs)_____
   iv) Number of older people (above 60 yrs)_____

10. Farm size
   i) Total farm size _____ acres
   ii) Banana farm size_____ acres
   iii) Banana farm size under old practice_____ acres
   iv) Banana farm size under improved practices_____ acres

11. Other income generating activities
    i) Shop_____
    ii) Carpentry_____
    iii) Masonry_____
    iv) Trading agricultural goods____
    v) Other (Specify)_____

12. Does some of the generated income go into banana production?
    i) Yes_____ ii) No_____

SECTION 3: INFORMATION ON BANANA PRODUCTION

13. What is the cropping system for banana in your farm?

Monoculture		Intercropping		Mixed farming		Mixed cropping	

14. Have you ever received any training in banana production? Yes □ No □

    If yes (specify from which institution/person)_____

15. Which new banana varieties are you growing?

SN	Banana variety (eg FHIA 17 & 23, Yangambi, Pelipita, mzuzu)	Number of Acreage/Stems

16 Which other crops do you grow and how are they related to banana production?

SN	Crop	Area in Acres	Relation to banana 1= Intercropped 2= ground cover 3= Other (specify)	Benefits to banana production 1= Source of capital 2= Source of fertility 3= Weed control 4= Erosion control 5= Other (specify)
1.	Coffee			
2.	Cocoa			
3.	Cashew			
4.	Pineapple			
5.	Vegetables			
6.	Tea			
7.	Groundnuts			
8.	Beans			
9.	Bambara nuts			
10.	Coco yam			
11.	Other (specify)			

17. Which type of livestock do you keep and how are they related to banana production?

SN	Animal	Number of animals	Benefits to banana production 1= source of power 2= source of capital 3= source of manure 4= feed on banana remains 5= Other (specify)
1.	Cattle		
2.	Goats/ Sheep		
3.	Poultry		
4.	Pigs		

18. Rate the following aspects in relation to banana production in your area

SN	Aspect	Good	Average	Bad
1.	Climate			
2.	Weather conditions			
3.	Water for irrigation			
4.	Rainfall			
5.	Soil fertility			
6.	Agricultural policies			
7.	Extension advice			
8.	Sources of information			
9.	Research			
10.	Markets			
11.	Prices			
12.	Roads			
13.	Transport			
14.	Sources of inputs			
15.	Sources of capital			

19. Where do you source information on new banana-improved varieties, technologies, improved practices and markets?

SN	Source	Type of information	Tick	Indicate quality of information using the scale of 1 to 3 (1=not useful; 2= average; 3 = useful ;) (circle a number)
1.	Radio	Improved varieties		1 2 3
		Technologies		1 2 3
		Improved practices		1 2 3
		Markets		1 2 3
2.	Television	Improved varieties		1 2 3
		Technologies		1 2 3
		Improved practices		1 2 3
		Markets		1 2 3
3.	Other farmers	Improved varieties		1 2 3
		Technologies		1 2 3
		Improved practices		1 2 3
		Markets		1 2 3
4.	Extension agents	Improved varieties		1 2 3
		Technologies		1 2 3
		Improved practices		1 2 3
		Markets		1 2 3
5.	SUA, ARI, MATI	Improved varieties		1 2 3
		Technologies		1 2 3
		Improved practices		1 2 3
		Markets		1 2 3
6.	Input suppliers	Improved varieties		1 2 3
		Technologies		1 2 3
		Improved practices		1 2 3
		Markets		1 2 3
7.	Agricultural shows	Improved varieties		1 2 3
		Technologies		1 2 3
		Improved practices		1 2 3
		Markets		1 2 3
8.	Newspapers/ magazines	Improved varieties		1 2 3
		Technologies		1 2 3
		Improved practices		1 2 3
		Markets		1 2 3
9.	Government Researchers	Improved varieties		1 2 3
		Technologies		1 2 3
		Improved practices		1 2 3
		Markets		1 2 3
10.	Other (Specify)			

SECTION 4: EXAMINATION OF BANANA TECHNOLOGIES AND IMPROVED PRACTICES INTRODUCED

20. Which banana technologies were introduced by TARP II SUA and PANTIL and for which purpose? Which person or institution introduced the technologies?

SN	Type of technology introduced	Y= yes N= no	Purpose *1= increase yield 2= control diseases 3= control pests 4= Others (specify)*	Source of technology (Institutions/person)	When introduced (year)
1.	Pit size				
2.	Type of planting materials (e.g. tissue culture)				
3.	New varieties				
4.	Spacing				
5.	De-suckering				
6.	Mulching				
7.	Fertilising				
8.	Pest control				

21. Did you participate in the needs assessment/problem identification?
Did you finally choose the technology yourself?

SN	Type of technology	Participated in Needs assessment /problem identification Y= yes N= no	Trained in the technology Y= yes N= no	Adopted the technology Y= yes N= no	Why did you adopt or did not adopt the technology?	If adopted, did you decide on your own? Y= yes N= no
1.	Pit size					
2.	Type of planting materials					
3.	New varieties					
4.	Spacing					
5.	Desuckering					
6.	Mulching					
7.	Fertilising					
8.	Pest control					

SECTION 5: IDENTIFICATION OF ACTORS IN BANANA PRODUCTION, THEIR FUNCTIONS AND ROLES

22 Which institutions or individuals participated in the technologies development and what were their roles and the intensity of the collaborations with them?

SN	Actor (Institution/persons) (Examples; PANTIL, TARP II etc)	Function/role 1= consumer 2= buyer/retailer 3= wholesaler 4= middlemen 5= banana market 6= research 7= extension 8= other (specify)	Location	Linkage - indicate intensity of collaboration using the scale of 1 to 5 *(1= weak; 2= average; 3 = strong;* (circle a number)
1.				1 2 3
2.				1 2 3
3.				1 2 3
4.				1 2 3
5.				1 2 3
6.				1 2 3
7.				1 2 3
8.				1 2 3

23. Which services did the other institutions provide in the development and promotion of the technologies?

SN	Institution	Type of services it provided *1 = extension 2 = research* *3 = credit 4 = sensitisation* *5 = training 6 = suppliers of inputs 7 = buyers 8= brokers* *9= other (specify)*	Whether a beneficiary of the service *Y = yes* *N = no*
1.			
2.			
3.			
4.			
5.			

24. Which institutions didn't participate but you think their services would have been crucial in the development and promotion of the technologies?

SN	Institution	Type of services it should have provided *1 = extension 2 = research* *3 = credit 4 = sensitisation* *5 = training 6 = suppliers of inputs 7 = buyers 8= brokers 9= other (specify)*
1.		
2.		
3.		
4.		
5.		

SECTION 6: LINKAGE BETWEEN TECHNOLOGY UTILISATION AND ACTORS

25. Which banana research activities/ projects have you participated in and at which stage? (Key to participation stage: *1= identification of the problem 2= choice of the varieties 3= testing of the varieties 4= production stage* **(Record all stages participated in).**

SN	Research project and Institution	Issues addressed (Key: 1=Plant spacing; 2= Pests; 3= Diseases 4= Yield	Participation stages	Materials/ products received (1=Seedlings; 2= Planting suckers
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

26. Which institution financially supports your banana production and in which areas?

SN	Institution	Type of financial support 1= Credit 2= Grant	For which activity	Value in Tshs. in the past 5 years
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

27. Indicate type of inputs used in banana production, their sources, the system of access and their value.

SN	Type of input supplied *1= seedlings* *2= fertilizers* *3= pesticides* *4= other (specify)*	Source of inputs *(Institution/ company/ organisation)*	System of access *1= cash* *2= loan* *3= grant*	Value in Tshs. in the last season
1.				
2.				
3.				
4.				
5.				
6.				
7.				

28. Indicate the status on the following practices related to banana production in your farm within the past five years (***See table below***)

Innovation in inputs, practices or services	No	Yes	Situation in the past five years
a) Introduced a new or improved banana variety	☐	☐	→ Number of varieties in the past 5 yrs (i) 1-4 (ii) 5-9 (iii) Over 10
b) Using New recommended banana spacing	☐	☐	→In the past 5 years (i) 3 x 3 metres (ii) 3 x 4 metres (iii) 4 x 4 metres (iv) 4 x 5 metres (v) 5 x 5 metres
c) Using New banana pit management practices	☐	☐	→In the past 5 years
d) Using New banana fertilising practices	☐	☐	→ In the past 5 years (i) Commercial Fertilisers (ii) Manure (iii) Commercial Fertilisers + manure
e) New banana thinning practice to 3 or 4 stems	☐	☐	→In the past 5 years (i) 3 stems (ii) 4 stems
f) New recommended banana pest management practices	☐	☐	→ In the past 5 years (i) One (ii) Two (iii) Three
g) New markets for banana products	☐	☐	→ Number in the past 5 yrs (i) One (ii) Two (iii) Three (iv) More than 3 (specify)

29. Please rate the following present situations in support of banana production **(1=Bad; 2= Average; 3= Good)**

	Statement	Rating (circle a number)		
1	Government incentives for improved banana production	1	2	3
2	Availability of trained & experienced extension workers in banana production	1	2	3
3	Local universities, research institutions and agricultural training institutions responsiveness to your banana production needs	1	2	3
4	Availability of financing /venture capital	1	2	3
5	Training in banana production	1	2	3
6	State of water supply for banana production	1	2	3
7	Roads for transporting banana	1	2	3
8	Marketing infrastructure	1	2	3

SECTION 7: INSTITUTIONS INVOLVED IN BANANA IMPROVED TECHNOLOGIES DISSEMINATION AND STRATEGIES EMPLOYED

30. Do you have a village extension worker? Yes _____ No _____

31. What type of Extension Organisations/Agencies assist you in matters of improved banana production?

SN	Type of Organisation	Approximate Number of visits by extension agent per month	During visit does the agent address banana issues 1= Yes; 2= No	Methods used 1= workshop/seminars 2= demonstrations 3= supply of leaflets/booklets 4= farm visits 5= Other (specify)
1.	Govt. Village Ext. Agent			
2.	Govt. Ward Ext. Agent			
3.	NGO (Specify)			
4.	CBO (Specify)			
5.	University			
6.	Other (specify)			

32. What type of training on banana production have you received and by which organisations?

SN	Area of banana training	Training Institution (e.g PANTIL, TARP II; SUA, Uyole)
1.	Pit size	
2.	Type of planting materials	
3.	New varieties	
4.	Spacing	
5.	De-suckering	
6.	Mulching	
7.	Fertilising	
8.	Pest control	
9.	Banana processing	
10.	Packaging	
11.	Other (specify)	

33. (i) Do you have banana development partners?

(a)Yes_____ (b) No_____

(ii) If yes, indicate areas of collaboration and its intensity.

SN	Areas of collaboration	Organisations/ Institutions/Persons	Indicate intensity of collaboration using the scale of 1 to 3 (1= weak; 2= average; 3 =strong;) (circle a number)
1.	Exchange of Information and Experiences		1 2 3
			1 2 3
			1 2 3
			1 2 3
2.	Formal and Informal Meetings		1 2 3
			1 2 3
			1 2 3
			1 2 3
3.	Training / capacity development		1 2 3
			1 2 3
			1 2 3
			1 2 3
4.	Other (Specify)		1 2 3
			1 2 3
			1 2 3
			1 2 3

THANK YOU VERY MUCH FOR YOUR COOPERATION

Appendix 2: Focus Group Discussions Checklist

Agricultural Technology Innovation System: A Case of TARP II SUA and PANTIL Banana Projects in Tanzania

FOCUS GROUP DISCUSSIONS CHECKLIST

1. What were the needs and problems to be addressed by the technologies developed under TARP II-SUA and PANTIL banana projects?

2. What were the technologies and improved practices developed for banana under TARP II-SUA and PANTIL banana projects?

3. Which actors participated in the technology development and how were they involved?

4. In your opinion which other actors/institutions that didn't participate but should have participated?

5. What kind of financial and input supply services are available to you and from which institutions? Under which arrangements?

6. What kinds of policies/laws enhance or impinge adoption of the new banana technologies?

7. What do you consider to be your important cultural aspects especially in relation to banana production?

8. Can you describe your farming systems in your communities in terms of crops and livestock as well as the mix and intercropping patterns that exists?

9. How do you describe your soils and what is your consideration in terms of their fertility?

10. What do you consider to be the weather conditions in your areas?

11. What are the available local resources that you consider to be supportive of adopting banana technologies?

12. What types of extension organisations are available in your area and what has been their participation in the technology development and dissemination?

THANK YOU FOR YOUR PARTICIPATION