Factors Affecting Cassava Adoption in Southern Province of Zambia: A Case Study of Mazabuka District

Tionenji Phiri

2011

Factors Affecting Cassava Adoption in Southern Province of Zambia: A Case Study of Mazabuka District

A thesis prepared in partial fulfilment of the requirements for the degree of Master of Applied Science in Agri-Commerce at Massey University, New Zealand

MASSEY UNIVERSITY

Tionenji Phiri

2011

Abstract

Southern Province of Zambia is a drought prone area and the main crop that is grown is maize which requires a high amount of rainfall. As a result maize does not do well in the area and there are frequent food shortages. The Government and Non-Governmental Organisations (NGOs) have been promoting cassava technology which is drought tolerant to improve the food security in the area. However, the adoption of cassava technologies has been low. The findings of this study will inform the development of more effective strategies to improve food security in southern province of Zambia and it has done this by exploring the cassava promotion programme.

A single case study was used to investigate the factors that affect cassava adoption in Mazabuka district. Purposive and snowball sampling methods were used to select participants for interviews and observations. 40 farmers who included opinion leaders and 6 key informants were interviewed. The data was analysed using qualitative data methods.

The results of the study indicated that although a small number of farmers continue to grow cassava, the cassava promotion programme was a flawed programme because cassava did not meet the needs of the majority of the farmers. There was a mix of complex and interrelated factors that affected the adoption of cassava. These included internal and external factors to the farm and farm household and those related specifically to the characteristics of cassava relative to the farmers' existing crop of maize. Cassava is a substitute crop to maize.

The result of the study indicated that the farmers' adoption decision was based on the fact that they wanted a crop that would not only meet their food needs but also income. Cassava is a substitute crop and the farmers compared it with maize, an existing crop, which provided them with both food and income. Processing facilities and a market supported by government policy existed for maize and not for cassava. Land tenure was the internal factor, but not as a result of the length of time the lease

was held, but because of the conditions imposed on the leasers in terms of crops they were able to grow.

The most important factors were external factors and these included government policy and an aspect of extension service delivery. A competitive government policy that supported processing and marketing facilities for maize, undermined cassava, for which there was no processing facilities and only a small local market. Lack of training and knowledge amongst the local government agricultural extension personnel as to how to grow and process cassava impacted also on farmers' knowledge and hence adoption of cassava. Although the inputs for growing cassava were provided for free, they were supplied at the wrong time and this impacted also on farmers' willingness to grow the crop.

The research highlights the importance of using bottom-up and not top down approaches in food security programmes. The results suggest that it is important for food security policy and development interventions to understand the needs of farmers in terms of food, income and livelihoods.

Acknowledgements

Firstly, I would like to thank God who guided and protected me during my study and stay in New Zealand. Even when things were hard and difficult, he was with me.

I would like to thank the New Zealand Government for offering me the scholarship to further my studies at Massey University. Many thanks also go to the International Student Support office, especially Sylvia and Olive for their support during my study.

I would like to thank my major supervisor Ms Janet Reid for her valuable advice, insight and guidance throughout the research work. I am again thankful to my second supervisor, Dr. David Gray for his valuable guidance, constructive comments and support throughout my research work. Both have worked hard to keep me on the right track and complete my study.

I am also grateful to the lecturers and staff of the Institute of Natural Resources and the Institute of Animal Food and Nutrition for their support. I would also like to thank my friends and course mates for their support during my study and stay in New Zealand. Special thanks go to Mr Bornwell Mupeyo who informed me about the scholarship and encouraged me to apply for it.

My deepest thanks also go to all my family particularly my father Mr Lazarus Phiri my brothers, Kabvinira, Raphael, Shadreck, Justin and my sister Falesi for being the pillar for my academic progress. Sincere thanks go to the farmers who volunteered to be interviewed. Without sacrificing their valuable time to answer the questions, this study would not have been possible. I am grateful to the Ministry of Agricultural and Cooperatives in Mazabuka district, Plan Zambia and PAM for their assistance and guidance during my data collection.

Lastly, I would like to express my deepest gratitude to my husband, Ishmael, for his love, care and patience. Ishmael, you were my pillar of strength and your support and encouragement gave me a reason to look towards my goals. For these, I cannot thank you enough.

Dedication

This thesis is dedicated to Ishmael and the boys; Luundu and Nduba for the support and patience during the time I was studying and working on the thesis. I dedicate the thesis to my Dad, brothers and sister for their continued support and encouragement the time I was far away from home, without forgetting my late mother who made me realise the value of education at an early age.

Table of Contents

List of Tables

List of Figures

List of Acronyms and Abbreviations

ACF	Agriculture Consultative Forum
CSO	Central Statistics Office
DFID	Department for International Development
DMEWU	Database Management and Early Warning Unit
FAO	Food and Agriculture Organisation
FRA	Food Reserve Agency
FoDis	Food Crop Diversification Support Project
GDP	Gross Domestic Product
JAICAF	Japan Association for International Collaboration of Agriculture and Forestry
MACO	Ministry of Agriculture and Cooperatives
MAFF	Ministry of Agriculture, Food and Fisheries
MCB	Maize Control Board
MOFED	Ministry of Finance and Economic Development
NGO	Non-Governmental Organisation
RTIP	Root and Tuber Improvement Program
PAM	Program Against Malnutrition
SAP	Structural Adjustment Program
WTO	World Trade Organisation

List of Appendices

Chapter 1: INTRODUCTION

1.1 Background

Zambia is a landlocked country occupying a near central position on the southern African subcontinent and it covers an area of 752,620 square kilometres, which is approximately 2.5% of the continent's total area. It shares borders with eight countries: Angola, Botswana, the Democratic Republic of Congo, Malawi, Mozambique, Namibia, Tanzania and Zimbabwe. It is administratively divided into nine provinces: Central, Copperbelt, Eastern, Lusaka, Western, Luapula, Northern, North Western and Southern provinces (Figure 1.1). This research project was undertaken in the southern province of Zambia.

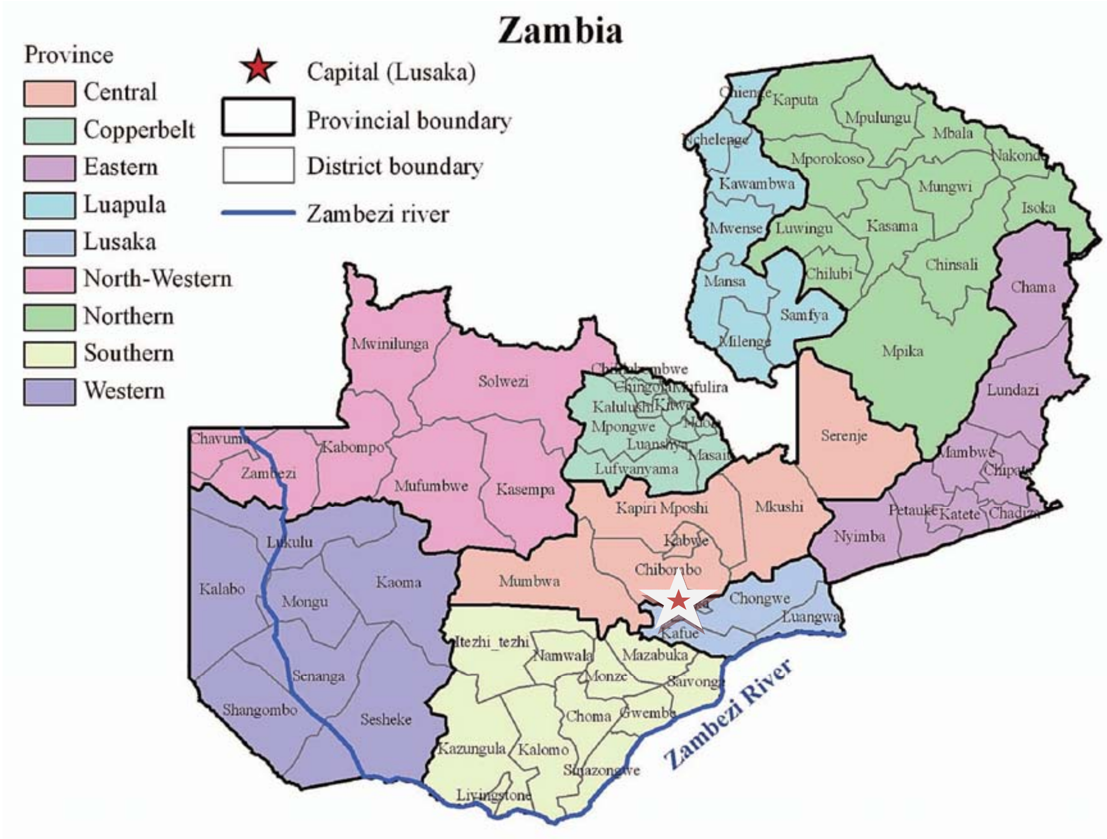

Figure 1.1 Map of Zambia showing the provinces, the capital and the study area

Source: Maps of Zambia

Zambia has a tropical climate and it is situated at a relatively high altitude across most parts of the country (between 900 and 1,500 m above sea level). This permits the production of temperate crops and exotic breeds of livestock. The 7.5 million hectares which comprises the country of Zambia, 4.2 million (58%) are classified as medium to high potential for agricultural production and 12% is suitable for arable production although only an estimated 14% of this is currently cultivated (MAFF, 2000a). Zambia’s agriculture potential remains largely unexploited (Kambikambi, 2004).

Zambia also has abundant groundwater resources in the Congo/Zaire and Zambezi river basins. The combined irrigation potential for these areas is 523,000ha, of which only 46,400ha (9%) is currently being used, mostly by commercial farmers cultivating sugar, wheat and plantation crops (Kambikambi, 2004). The majority of agricultural production remains rain-fed and therefore production varies according to variations in rainfall. Agricultural is one of the main contributors to the country’s Gross Domestic Product (GDP) and in 2007 it was estimated that it contributed 13 per-cent of GDP (from the primary sector) and 9 per cent of GDP from (the secondary sector) (CSO, 2008). Although Zambia has a relatively large urban population, approximately 45% of the total population (4.6 million people) are poor people living in rural areas who are dependent on agriculture (CSO, 2000).

Zambian agriculture, as defined by the Ministry of Agriculture Food and Fisheries, has three broad categories of farmers, small-scale (or subsistence) farmers, medium (or emergent) farmers, and large-scale or commercial farmers. Small-scale farmers are generally subsistence producers of staple foods, with an occasional marketable surplus. These farmers will be the focus of this research. Medium-scale farmers produce maize and a few other cash crops for the market. Large-scale farmers produce various crops for local and export markets. According to the Ministry of Agriculture Food and Fisheries (2000a), from the estimated 600, 000 farmers in Zambia, 76% are small-scale farmers. Their farm holdings are less than five hectares. Medium-scale farmers account for 20% of these farmers and they focus on food and cash crop farming. Their holdings range from 5 to 20 hectares. Commercial farmers make up the remaining 4% of the farming population and their focus is on cash crops. Commercial farmers operate farms that are larger than 20 hectares. It has been observed that the number of households in the small-scale category has been increasing in recent years, whilst the numbers of medium and large-scale farmers have remained more or less the same (Hantuba, 2002). Increased unemployment in Zambia, which is at 50% (The World Fact Book, 2000 est.), has led people into agriculture as small-scale farmers.

The farming systems in Zambia are generally influenced by the physical and climatic characteristics of the three Agro Ecological Regions or Zones which divide the country (Figure 1.2). Region I, where this research is located, covers the southern and eastern river valleys and it receives an average annual rainfall of less than 700 mm per annum (FAO, 1978–81). It is the driest region and the one most prone to drought with limitations in terms of crop production. Regions IIa and IIb, the central and western plateaux, receive between 800 – 1000 mm of rain per annum. Region III, the north and north western plateaux receives between 1000 – 1500 mm of rain per annum.

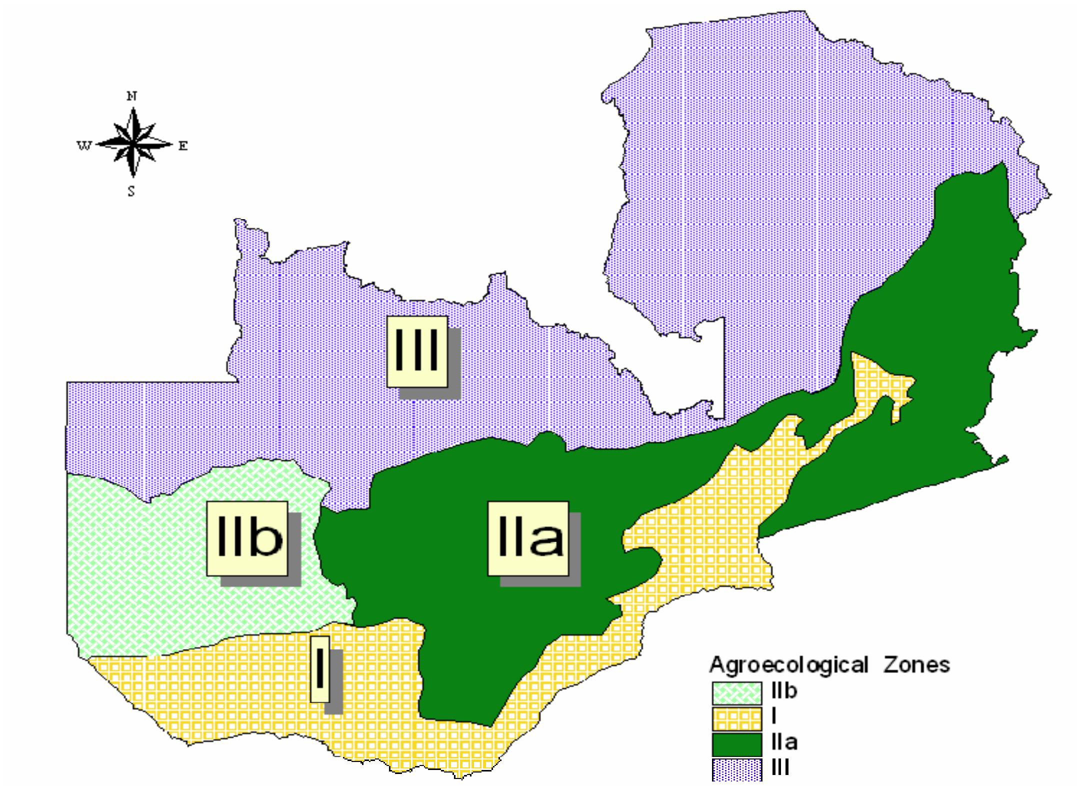

Figure 1.2 Zambia's Agro Ecological Zones
Data source: FEWS NET Dept. of Meteorology

There are two main staple food crops grown in these regions. These are maize and cassava, which both arrived from the Americas with Portuguese traders, during the 17th century (Jones, 1959; Miracle, 1966). Since their arrival, these two crops have revolutionised Zambian agriculture. Whilst maize has become the principal staple food in regions I and II, cassava is now the mainstay of diets in region III.

For the country as a whole, maize is the most important staple. It is also the main staple food in urban areas which comprise nearly half of the population. The Zambian Government (between 1964 and 1991), in its effort to ensure food security, started promoting increased crop production of maize, by supporting high producer prices (Howard & Mungoma, 1996). They introduced uniform prices for inputs such as fertiliser, seed and agriculture chemicals and uniform producer prices. At their peak, in the late 1980s, maize subsidies amounted to 17% of total government spending (Howard & Mungoma, 1996). The production of maize was encouraged, even in areas that were not suitable for maize production.

After 1991, there was a change in agriculture policy and agricultural production and marketing was liberalised (Seshamani, 1998). Subsidies on maize were removed, in addition to controls on the prices of inputs and other crops. Farmers were encouraged to grow crops that were ecologically adapted to their respective regions (high rainfall, medium rainfall and low rainfall regions) (Chizuni, 1994). Following the withdrawal of these substantial support programmes, maize production has gradually declined, whilst the production of cassava, groundnuts, cotton, tobacco and horticultural products has expanded significantly (Jayne, Govereh, Mwanaumo, Nyoro, & Chapoto, 2002). Amongst staple foods, cassava output has grown most rapidly (Govereh, 2007). At the present time, maize supplies about 60% of the national calorie consumption, with supplying a further 15% (FAO, 2002).

The increase in cassava output has occurred because of the interest that the government has been showing in it as a food security crop. In 1979, it established the first root crop research and support programme, the ‘Root and Tuber Improvement Program’ (RTIP). This resulted in the release of a great many new, highly productive, early maturing cassava varieties. NGOs, concerned with household food security, have also contributed to supporting the increase in cassava production amongst vulnerable households, after realising the potential of the new varieties to improve food security, in drought prone areas. In the late 1990s, they began to distribute cassava cuttings in food security packs, as part of drought mitigation in the central and southern province (Chitundu, Droppelmann & Haggblade, 2006).

Around the same time, the private sector began to develop commercial cassava-based products, on a small scale (Chitundu, Droppelmann, & Haggblade, 2006). Several local livestock farmers and feed companies began experimenting with cassava-based feed rations. A few local bakeries and catering services began developing cassava-based biscuits, nshima and composite-flour fritters, whilst several West African immigrants have worked to develop local gari production (Chitundu, Droppelmann & Haggblade, 2006). Zambia's largest brewery, together with a newly established food processor, has been exploring the prospects for cassava-based malt beer, in addition to cassava-based sweeteners for soft drinks, juices and prepared foods. However, the development of cassava-based products was not implemented in the southern province, where this study is located, since there was little production of cassava.

In the continued effort to promote cassava, a cassava task force was formed in 2005 (Simwambana, 2005) which was comprised of the 'Agriculture Consultative Forum' (ACF), an association promoting information exchange and policy dialogue amongst farm groups, agribusinesses and the government. The other members are stakeholders from private and public sectors. The main objective of ACF is to realise the commercial potential of cassava and to consolidate its contribution to household food security.

Cassava varieties have been spreading rapidly in northern Zambia (region III), through farmer to farmer distribution of planting material (MAFF, 2000b). Outside the north, cassava production has grown most rapidly in the eastern province. In the southern province (region I), apart from small pockets of growth, cassava remains a minor crop (Barratt et al., 2006). Maize is the primary source of food in addition to being a source of income for most rural households in the southern province (Murray & Mwengwe, 2005). As a crop, maize is particularly vulnerable to drought and since the southern province has erratic and low rainfall, it has had a severe impact on maize production in that area (Murray & Mwengwe, 2005). In addition to the unfavourable climate, the country underwent a structural adjustment programme in 1992, which resulted in the withdrawal of government support to producers of maize (Seshamani, 1998). The state marketing boards and cooperatives were replaced with private traders and a free market. As a result, farmers had to struggle to secure inputs for maize and this led to a reduction in yields.

During the late 1990s, people protested against the withdrawal of government support for maize production and marketing. In response, the government went back to pan-territorial pricing. To date, the support for maize, in terms of price and fertiliser subsidies is still there throughout the country, including the southern province: although the amount of support has been reduced.

There have also been economic changes in the southern province that have had an impact on households key assets, such as livestock (Lungu, 2003). In addition there have been high cattle mortalities, due to tick-borne diseases and corridor disease and this has left many families in the southern province without draft animals and therefore, they are unable to cultivate adequate areas of land. As a consequence of these environmental and economic shocks, the southern province, which was historically the source of a great deal of the country's agricultural produce, has become characterised by chronic food insecurity (Murray & Mwengwe, 2005). The province now depends on food aid during some parts of the year.

Cassava is being promoted in the southern province because, it could potentially play a major role in food security (Prudencio & Al-Hassan, 1994). It can bridge the food gap during the 'hungry season'. In Zambia this period is usually in December, January and February, before the maize harvest. During this time, maize prices are at their peak, incomes are low, and hunger is most acute (M. Chitundu et al., 2006). Cassava can also be used as a food reserve on which to fall back on, in the case of adverse weather conditions or pest infestations (Prudencio & Al-Hassan, 1994) since it is less sensitive than most crops to environmental changes (IITA, 1990b). Even in sufficient rainfall years, when maize yields are highest, cassava production, per hectare, exceeds that of smallholder maize by about 20% for fertilised maize hybrids and by 100% compared to unfertilised local maize varieties (Barratt et al., 2006).

Cassava also produces more calories per unit of land and per unit of labour, than does maize (Chitundu et al., 2006). Whilst cultivation of other crops, such as hybrid maize, requires the purchase of new seeds and inorganic fertiliser each season, cassava farmers require neither. They simply replant cuttings from their existing fields. Therefore cassava production, it is argued, is accessible to even the very poorest families (Chitundu et al., 2006).

Despite the benefits associated with cassava, the majority of farmers in the southern province have not adopted it. According to CSO (2003), 95.5% of the farmers still grow maize and only 9% have incorporated cassava into their farming systems. There is little information known about why farmers have not adopted cassava.

1.2 Problem statement

Maize is the predominant crop for small-scale farmers in the southern province of Zambia. However, maize needs adequate rainfall and a high level of inputs (fertiliser, seeds, and insecticides). The southern province has a low rainfall and it is subject to regular droughts. As a result, maize does not grow well in this area and this has created food security problems in the southern province.

In order to overcome this food security problem, the government together with several NGOs have put in place various policies to promote cassava, as an alternative crop. Cassava is being promoted as a food security crop, because it is a famine crop: or last resort crop. It is high yielding and it has an ability to tolerate highly unfavourable environmental conditions. The aim of this research, therefore, is to inform the development of more effective strategies for improving cassava technology adoption and food security, in the southern province of Zambia.

1.3 Research Question

How can the adoption of cassava technology be improved in order to assist farmers improve their food security in the southern province of Zambia.

1.4 Objectives

1. To identify and describe factors that influence the adoption and non-adoption of cassava technology, by farmers in the southern province of Zambia and the reasons why these factors are influential.

1.5 Thesis structure

This research identifies and describes the factors that affect cassava adoption in Mazabuka district. The thesis is organized into seven chapters. It begins with the introduction, which includes a statement of the problem, the research question and the objectives. The second chapter reviews the literature that deals with past studies and information which are pertinent to the study. The third chapter explains the research methodology, including sampling techniques, methods of data collection and tools for data analysis. The fourth chapter provides a description of the study area and in the fifth chapter the main findings of the study are outlined. In the sixth chapter, the research results are compared and contrasted with the reviewed literature and the key findings relevant to the research question, are discussed. Finally, the conclusions and discussion on possibilities for further research are provided in Chapter Seven.

Chapter 2: LITERATURE REVIEW

2.0 Introduction

The purpose of this research is to inform the development of more effective strategies for improving cassava technology adoption and food security, in the southern province of Zambia. The literature relevant to this study will be reviewed in this chapter. Firstly, food security strategies, the role of extension agents in food security and the different types of technologies associated with food security will be reviewed. This is followed by a review on the importance of technology adoption, in relation to food security. Subsequent sections will define the term ‘technology’ and examine how technologies are classified in addition to an examination of the adoption decision process. Finally, this chapter reviews the factors that affect adoption; the characteristics of the technology; internal factors, such as farm and farmer characteristics and external factors, such as social and institutional factors, infrastructure, government policy and extension systems.

2.1 Food security strategies

Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2000). Food is one of the fundamental necessities for life. A reduction in food intake not only increases the chances of early death, but it also reduces the physical, mental and social development of a human being, which has consequential impacts on the productivity potential and respect for people (Latham, 1997). Due to the importance of food, there are strategies being used by stakeholders to improve food security.

The strategies to increase food security identified in the literature can be placed in two groups: 1) those that focus solely on on-farm food production (Sahn, 1989) and 2) those that, in addition to on-farm production, also focus on income diversification (Gladwin et al., 2001). The food production strategies focus on how farmers can increase their production, in addition to post-harvest handling of their produce. Increasing food production involves the use of new varieties, new crops, agricultural extensification and agricultural intensification (Pretty, 1995; Sahn, 1989; Stout). New varieties and new crops increase yields and reduce food insecurity directly. Farmers can sell their surplus food from increased crop yields and use the income to buy food when it is scarce. The promotion of cassava as a new crop in the southern province of Zambia is one such strategy now being used to increase food production.

Agricultural extensification entails an increase in food production by households expanding their farm size (Stout 1990). The farmers are able to increase their total yield by growing produce on larger tracts of land. Agricultural intensification is associated with increasing yields per hectare through the use of external inputs (especially fertiliser), high yielding crop varieties and improved livestock breeds (Pretty 1995). The use of external inputs increases yield and reduces the risk of crop failure. This leads to an increase in food supply and farmers can then sell off this surplus for income and buy food, in times of scarcity.

Post-harvest handling of produce is important in achieving food security, since it prevents loss of farmers produce (Sahn 1989). This includes storage and processing of the produce. Improved storage leads to a reduction in wastage and consequently, more food is available during times of scarcity (Sahn 1989). Developing countries, including Zambia, have a sub-standard quality of storage for some crops and this contributes to high levels of food losses (Eade & Williams, 1995). Clarke and Friedrich (2000) estimated that 30% of harvested food can be lost due to sub-standard storage in developing countries, whilst (in Zambia) local estimates have shown that this can be as high as 50% (Luswishi Small Scale Farmers, 1997). Processing enhances storage and it also adds value and farmers can receive a more desirable income for their produce (Saka et al., 1998).

Strategies that focus on on-farm food production and income diversification focus on the use of multiple approaches to generate income, such as agriculture, non-farm micro-enterprises and agricultural labour (Orr & Orr, 2002). Multiple approaches to generate income have been used because food insecurity is primarily a problem of low household incomes and poverty and not just inadequate food production (Gladwin, Thomson, Peterson, & Anderson, 2001). For instance, Peters (1992) found that, particularly where drought or pest attacks had a major effect on food security, the households whose members had multiple sources of income were better off in

Malawi. Similarly, Devereux (1993, 1999) and Maxwell and Frankenburger, (1992) found that African women who combined farm and non-farm income-earning had a lower risk of starvation for themselves and their families, during periods of chronic or transitory food insecurity.

2.2 Role of agriculture extension in food security

Agriculture extension is being used to enhance the improvement of food security in rural development programmes, in many developing countries (Ison & Russell, 2000; Kennedy & Bouis, 1993; Rivera & Qamar, 2003) as observed in Zambia. Extension organisations help to devise strategies that will help the achievement of such development programmes (Peterson, 1997). Agriculture extension is extremely important in helping to confront the problems of availability, access and the utilisation of food (Rivera & Qamar, 2003). Extension, it is argued, improves farmers access to information and knowledge relating to improved agricultural practices, in both developed and developing countries (Anderson & Feder, 2004; Marsh, Pannell, & Lindner, 2000). Extension can help to enhance the productivity and hence the production of food (Rivera & Qamar, 2003). Extension can assist in providing opportunities for income generation and it generally provides improvement in nutritional advice, through home economics programmes. It also enhances the quality of rural life, by way of community development. For instance, in Pakistan, extension professionals worked with farmers to better manage soil and water; to diversify their animal production; to intensify their agriculture and to organise themselves around their special agricultural interests, such as the building of greenhouses and processing facilities (Rivera & Qamar, 2003). This led to improved nutritional intake and enhanced income generation for the farmers.

2.3 Types of technologies associated with food security

The technologies associated with food security can usefully be separated into *production* and *post-harvest technologies* (United Nations, 2010). Production technologies can be placed in three broad categories (United Nations, 2010). Firstly, there is *mechanical technology*, encompassing various degrees of mechanisation within agricultural operations, ranging from simple traditional hand tools to animal and engine-powered equipment, implements and farm machinery and irrigation systems that control the timing and volume of water (United Nations, 2010). Secondly, there is *biological* or *biochemical technology*, comprised of a package of high-yielding varieties of seeds, chemical fertilisers and pesticides. Thirdly, there is *biotechnology*, consisting of commercially acceptable techniques that use living organisms (or their parts) to make or modify a product: this includes improving, modifying or manipulating the characteristics of economically important plants and animals and their derivative products and developing micro-organisms, which act favourably on the environment for agricultural production (United Nations, 2010). Cassava technology is an example of biological technology.

Post-harvest technologies are important in achieving food security (United Nations, 2010). This is because post-harvest losses can offset any significant investment made in raising productivity. Studies have shown that post-harvest losses of cassava, in developing countries, are between 5 and 30 per cent (Wenham, 1995). Crop losses could be reduced and the food supply increased by between 10 and 30 per cent, through the use of post-harvest technologies (Wenham, 1995). Appropriate technologies for processing cereals, legumes and roots and tubers (such as cassava) into flours that serve as convenience foods, in the rural areas of many developing countries, are necessary to upgrade traditional food technologies, thus enabling them to enhance the shelf-life and acceptability to consumers, as well as to develop value-added products (United Nations, 2010). Processing enhances cassavas industrial potential and contributes to households' income and food security (Nweke, 1994 and Saka et al., 1998). Appropriate technologies for storage are also important in order to reduce food loss and increase food availability in times of scarcity (Sahn 1989).

2.4 Technology adoption and food security

Studies have shown that food security can be enhanced through technology adoption (Kristjanson, Place, Franzel, & Thornton, 2002; Mendola, 2007; Minten & Barrett, 2008). Minten and Barrett (2008) found that in Madagascar, communities with higher rates of adoption of improved agricultural technologies had higher crop yields and lower levels of food insecurity. Similarly, the widespread adoption of high-yielding varieties of wheat and rice led to major increases in food-grain production in Asia and an increase in food security (Khush, 1999). Kristjanson et al., (2002) also found that there was an increase in the production of maize, due to the adoption of improved fallows, in Zambia and Kenya. The adoption of cassava has also been found to be important in increasing household food security in Ghana, Nigeria and Malawi (Azilah, 2007; Omonona, Oni, & Uwagboe, 2006; Prudencio & Al-Hassan, 1994; Saka et al., 1998).

2.5 Technology adoption

In this section the term 'technology' will be defined and the various ways technologies are classified will be reviewed. Finally, the technology adoption process will be reviewed. Rogers (1995. p 12) defined technology as "the design for instrumental action that reduces the uncertainty in the cause-effect relationship involved in achieving a desired outcome." Guerin and Guerin (1994) and Rogers (1995) suggested that technology is usually comprised of hardware (the object component) and software (the idea component) but it can also be entirely made up of information, which is the software component. Ison and Rusell (2000) defined technology as the "application of scientific knowledge to practical tasks". Abara and Singh (1993) argued that it is the actual application of that knowledge that would be termed 'technology'. The definitions of Ison & Russell (2000) and Abara and Singh (1993) are, however, directed more towards the meaning of the idea or software component of the technology and not the object component. This definition is more useful for technologies that are comprised of entirely ideas or information.

Some studies use the term technology to describe agricultural practices that are considered new to the areas the agricultural practices have been introduced (Feder, Just, & Zilberman, 1985; Ogunlana, 2004). These new agricultural practice (technology) may take the form of a new piece of machinery, a new method for soil cultivation or advice not to cultivate or the recommendation to sow a new cultivar which has improved agronomic properties over one previously grown (Guerin & Guerin, 1994).

Rogers (1995) used the word technology and innovation synonymously. An innovation is an idea, practice or object that is perceived as new, by an individual or other unit of adoption (Rogers, 1995). Guerin and Guerin (1994) agreed with Rogers' (1995) definition of innovation as being a new idea or practice, which is perceived as new by an individual. Technology can, therefore, be an innovation and thus, a new idea, technique or object. The term technology will be used (from this point onwards) in this study to also mean innovation. Cassava technology, in this study, will be defined as a new agriculture practice that is designed to alleviate food security in the southern province of Zambia. Technology transfer is the process of moving scientific and technical knowledge, ideas, services, inventions and products from the origin of their development, to where they can be put into operation (Rogers 1995).

Technologies have been classified in many ways (Feder et al., 1985; Just, Zilberman, & Rauser, 1980). Firstly, they are classified by resource use, such as labour-saving or labour-intensive, capital-saving or capital-intensive and land-saving or land-using (Feder et al., 1985). Labour-saving technologies are technologies which require less labour input (such as ox cultivation) and the adoption of these technologies might be encouraged by labour shortage (Feder et al., 1985). On the other hand, labour-intensive technologies generally require more labour inputs and an example of this is high yielding crop varieties (Feder et al., 1985). Some of the labour inputs include the requirement for fertiliser and pesticide applications. A labour shortage might discourage the adoption of these types of technologies (Feder et al., 1985). Capital-intensive technology is one for which the initial investment cost is high, for its implementation (Zepeda, 1990). Capital-saving technologies require less capital for investment such as high yielding varieties (Feder et al., 1985). Land-saving technologies are ones which permit substitution of capital and labour for land, such as chemical fertilisers, pesticides and high yielding varieties (De Janvry, 1973). Land-using technologies are technologies that require vast tracts of land, such as shifting cultivation (Ker, 1995).

Secondly, some technologies are classified in reference to their scale of operation and they are scale-dependent or scale-neutral. Technologies are classified as scale-dependent because farm size is an important determinant of their adoption. Farm size is an important determinant because technologies often require capital investment and large farms are better able to provide this type of investment (Just et al., 1980). A technology is said to be scale-neutral, if it involves an inexpensive variable-cost input and the size of the farm has no effect on its adoption. In contrast, scale-dependent technologies require a fixed-cost input, normally in the form of a large capital investment and their adoption is dependent on the size of the farm (Kinnucan, Hatch, Molnar, & Venkateswaran, 1990).

Cassava agricultural production activities are said to be labour intensive (Ebukiba, 2010), as is cassava processing (Nweke, 1994). Therefore, cassava can be classified as being labour intensive. Cassava technology is capital saving (Binswanger & Pingali, 1988). This is because the establishment cost of cassava production, for home consumption, is generally low. Stem cuttings and family labour are the main inputs. The cost for new cuttings is low and this is often only a one-off cost: thereafter farmers can multiply their cuttings locally or obtain them from their friends (Binswanger and Pingali, 1988). Cassava technology is scale neutral, because it requires low cost variable inputs and its adoption is not dependent on farm size (Binswanger and Pingali, 1988).

The adoption process

Rogers (1962 p. 17) defined the adoption process as “the mental process an individual passes through from first hearing about an innovation to the final adoption”. A more precise definition, which will be more useful for this study was offered by Shultz (1975). This definition distinguishes individual (farm level) adoption and aggregate adoption. Final adoption at the level of the individual farmer is defined as the degree of use of a new technology in a long-run equilibrium, when the farmer has full information about the new technology and its potential (Schultz, 1975). In this definition, Schultz (1975) contended that the introduction of new technologies results in a period of disequilibrium behaviour, where resources are not utilised efficiently by the individual farm: and learning and experimentation lead the farmer towards new equilibrium levels. In the context of aggregate adoption behaviour, the diffusion process is defined as the process of a spread of new technology within a region (Schultz, 1975). The study of cassava adoption, in this research, refers to both types of adoption.

Adoption studies may fall into two categories: the rate of adoption and the intensity of adoption (Rogers, 1995). It is usually necessary to distinguish between these two concepts since they frequently have different policy implications (Rogers, 1995). The rate of adoption is the relative speed by which farmers adopt an innovation and it has, as one of its pillars, the element of time (Feder et al., 1985; Rogers, 1995). The rate of adoption is usually measured by the length of time required, for a certain percentage of members of a system, to adopt an innovation (Rogers, 1995). The rate of adoption can vary with the level of education, access to mass media and the influence of other situational factors, since individuals may be selective in their exposure and perceptions about the new idea (Boahene, Snijders, & Folmer, 1999; Rogers, 1995). A study by Henry & Gottre (1995) found that the rate of cassava technology adoption was low in Colombia and Thailand due to technological, biological, institutional, socioeconomic and political constraints. This situation suggests that there is a vast range and a complex mix of different on-farm and off farm factors that affect adoption.

Rogers (1995) classified members of a population, in relation to their rate of adoption over time.

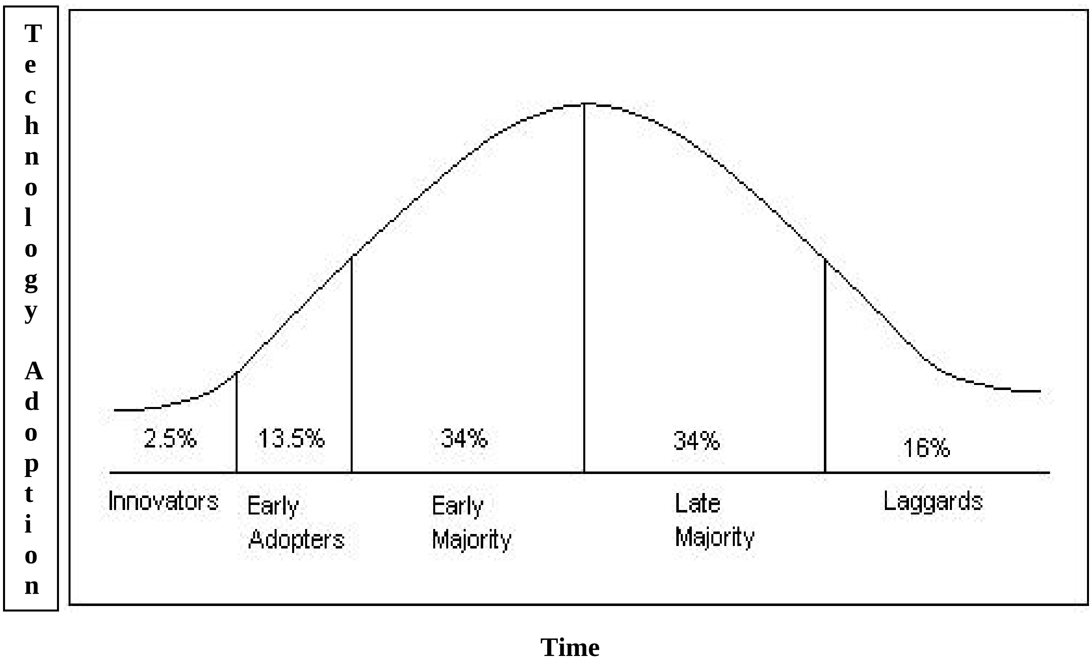

Figure 2.1 Rogers adoption/ innovation curve

Rogers, (1995, 2003) classified individuals, who take a short period of time to adopt innovations, as ‘innovators’ whilst those who are slowest to adopt he referred to as 'laggards' (Figure 2.1). In his model, the majority of individuals fall between the categories of innovators and laggards.

Critics of this model state that it is an overly simplified representation of a complex reality (Steinerb, Scheggc, & Murphy, 2005; Mahajan, Muller, & Wind, 2000). Rogers' (1995, 2003) analysis of adopters is only based on the time of adoption and he assumes that diffusion follows a normal and symmetrical distribution (Mahajan, Muller, & Wind, 2000). It is argued that, in reality, this is not the case. There are external and internal factors influencing adoption, which make it dynamic not symmetrical (Bass, 1969).

The intensity of adoption refers to the level of use of a given technology, during any particular time period (Feder et al., 1985). The intensity of adoption of innovation can be measured at individual farm level or a region level, during a given time period, by the amount or share of farm area utilising the technology, or by the per hectare quantity of input used, where applicable (Feder et al., 1985). In the case of cassava technology, the number of hectares planted in cassava in the southern province of Zambia, can be referred to as the 'intensity' of adoption. In this research the low level of adoption of cassava was identified, based on the rate and intensity of adoption in the province. This study will, therefore, examine the factors, in relation to both the rate and intensity of adoption.

The adoption process, according to Rogers (1983), involves five stages: Firstly, farmers must learn about the innovation (knowledge); secondly, they must be persuaded of the value of the innovation (persuasion); then, they must decide to adopt it or not (decision); the innovation must then be implemented (implementation); and finally, the decision must be reaffirmed or rejected (confirmation). Other authors, such as Spence (1994), have indicated that the stages involved in the adoption process are: awareness, interest, evaluation, trial and adoption. The terms are different, but the steps are similar, with some minor differences.

The knowledge stage, as defined by Rogers (1995), will occur when the farmer is exposed to the innovation's existence and s/he gains an understanding of how it works. Spence (1994) described this first stage as awareness although it differs from Rogers (1995) definition, in that the individual learns of the existence of the innovation but s/he has little knowledge about it. There has been minimal research on the transition from ignorance to awareness, in the literature. Gibbs, Lindner, & Fischer (1987) found that the time taken for different farmers in South Australia to become aware of the existence of new innovations, varied markedly. They found that some farmers took years to become aware of a technology, despite the presence of extension activities designed specifically to raise their awareness.

The persuasion stage is when the individual changes his/her attitude towards the technology that has been introduced (Rogers 1995, 2003). Spence (1994) referred to this stage as the ‘interest’ stage. At this stage, the person develops an interest and has the motivation to search for further information about the technology and examine its application, with regards to his/her circumstances (Spence, 1994). The individual will form a favourable or unfavourable attitude towards the adoption or rejection of the innovation which will be based on how they perceive the innovation (Rogers, 1995) and this might lead to rejection, if perceptions are unfavourable. Kaura (1967) found that farmers’ unfavourable attitude towards artificial insemination was the major cause for its non-adoption, in Haryana villages in India. They had an unfavourable attitude towards artificial insemination because they lacked sufficient information.

At the decision stage, individuals engage in activities that lead to a choice to adopt or reject the innovation (Rogers, 1995). They will try the innovation and if it proves to have at least a certain degree of relative advantage, then they will adopt it (Rogers, 2003). Spence (1994) considered that this stage occurs when the individual has undertaken some mental evaluation of the new idea in order to assess the potential benefits and possible disadvantages, before trying it. Batz, Peters, & Janssen (1999) found that farmers in Kenya adopted technology, if its characteristics promised a higher utility than the traditional technology. Utility was defined as satisfaction with the technology, in terms of profitability, risk, initial cost and management complexity.

The implementation stage occurs when the adopter actually puts the new idea into practice (Rogers, 1995). At this stage, the adopter looks for more information regarding the innovation and finds out if they have made the right decision about adopting the innovation or not (Van den Ban & Hawkins, 1996). They also look for more information on how to use it. According to Rogers (1995), this stage is regarded as full implementation because the decision has already been made to adopt.

However, Spence (1994) regarded this stage as a trial stage and the implementation of the innovation is undertaken on a smaller scale. This implies that Spence (1994) considered the fact that some individuals would like to try the innovation, before finally deciding to adopt or reject it, depending upon the outcome.

The confirmation stage is the stage in which the individual continues to question the wisdom of his/her decision, once the decision to adopt the innovation has been made (Rogers, 1995). Spence (1994) described this stage as adoption. The adopters seek reinforcement of the innovation-decision already made, or they reverse a previous decision to adopt or reject the innovation, if exposed to conflicting messages about the innovation (Rogers, 1995). Some individuals may discontinue the use of a technology, after being dissatisfied with the performance of the new idea or practice (Rogers, 2003). Moser and Barrett (2003) found that farmers in Madagascar had adopted and then discontinued the system of rice intensification, when they discovered that the innovation was labour intensive and required specialist skills to manage it.

Rogers (1995) adoption model has been tested empirically and it is widely used. For example, Gladwin and Murtaugh (1980) and Gladwin (1980) identified stages of farmer decision-making that are largely consistent with Rogers (1962, 1995) stages of the adoption process. Despite its wide use, Rogers' (1995) adoption model has been criticised for being prescriptive, static and deterministic, suggesting an orderly, predictable and linear progression from awareness through to adoption (Öhlmér, Olson, & Brehmer, 1998), whereas, in reality, the process is unpredictable, uncertain and very diverse (Öhlmér et al., 1998).

In spite of the criticisms, Rogers' (1995) model can still provide a useful tool for structuring the analysis of the adoption process of a new technology, including cassava. Moreover, it can also be extended or adapted to cover most other models related to the adoption process. In the following section, the factors that affect the technology adoption process are reviewed.

2.6 Factors affecting adoption

A variety of studies have been undertaken in order to identify the factors that influence the adoption of various technologies. As such, there is an extensive body of literature on technology adoption. Many factors have been found to affect adoption.

These include the age of the potential adopter; education level; experience; gender; farm size; ownership structure; availability of labour; access to credit; membership of organizations; access to extension; infrastructure; government policies; extension service delivery mechanism; and the characteristics of the technology (Anderson & Feder, 2003; Baidu-Forson, 1999; Batz et al., 1999; Eze, Ibekwe, Onoh, & Nwajiuba, 2008; Feder et al., 1985; Jimenez, 1995; Kassie, Zikhali, Manjur, & Edwards, 2009).

Some studies classify the factors into broader categories: farmer characteristics; farm structure; institutional characteristics; and managerial structure (McNamara, Wetzstein, & Douce, 1991), whilst others classify them under social, economic and physical categories (Kebede, Gunjal, & Coffin, 1990). Others group the factors into human capital, production, policy and natural resource characteristics (Wu & Babcock, 1998), or internal and external factors (Chieochan, Lindley, & Dunn, 2000; Gong & Beck, 1992).

The literature reviewed does not define most of the categories but instead it gives examples of what is found in each category. For instance farmers' characteristics include factors such as age, education, gender and income (McNamara et al., 1991). Farm characteristics include factors such as farm size, labour availability and land tenure (McNamara et al., 1991). Institutional characteristics include factors such as access to extension, access to credit and availability of inputs (McNamara et al., 1991). Social factors include education, exposure to information, family size, and experience (Kebede et al., 1990). Economic factors include factors such as income and farm size (Kebede et al., 1990). Human capital includes factors such as education and health (Wu & Babcock, 1998). Internal factors include the characteristics of the adopters and organisation (farm), whilst external factors include policy, economic, institutional and infrastructure factors that are outside the farmers control (Chieochan et al., 2000; Gong & Beck, 1992).

There is no clear distinguishing feature between elements within each category. In fact, some factors can be correctly placed in either category. For instance, education can be placed under farmers' characteristics (Fernandez-Cornejo, Beach, & Huang, 1994) or under human capital (Wu & Babcock, 1998). Farm size can also be placed under farm characteristics (Feder, et al., 1985; Feder and Umali, 1993), or under economic factors (Kebede et al., 1990).

Categorisation of factors is usually undertaken to suit the current technology being investigated, the location and the researcher's preference (Bonabana-Wabbi, 2002). In this study, the factors that affect cassava adoption are classified into characteristics of the technology, internal and external factors. They were classified as such, because the results of the study clearly fitted into these categories. The influence of these factors on technology adoption will be reviewed in the following section.

2.6.1 The Characteristics of a technology

The characteristics of technologies, as perceived by individuals, help to explain their different rates of adoption (Rogers, 1995). Rogers (1995) identified five characteristics of a technology that influenced adoption. These were: relative advantage, compatibility, complexity, trialability and observability. Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers, 1995). The degree of relative advantage may be measured in economic terms, but it can also include (or be based on) social prestige, convenience and satisfaction (Rogers, 1995). For example, Marsh, Pannell and Lindner (2000) and Ghadim, Pannell and Burton (2005) found that the short-term profitability (economic advantage) of new legume crops (e.g. lupins and chick peas) significantly influenced their adoption in Australia. Similarly, Udoh and Kormawa (2009), in their study on cassava adoption in African countries, found that the expected economic benefit to be gained from cassava adoption increased the probability of it being adopted. Kang and Akinnifesi (2000) also found that alley farming was adopted in West Africa, since it was more advantageous (convenient) than the bush fallow system, due to its continuous cropping, thus eradicating a fallow phase and land clearing. Satisfaction with conservation farming technology in Malawi led to its wide spread adoption (Williams, 2008). Farmers were satisfied because conservation technology required less labour, in terms of time and it also led to greater profitability.

The relative advantage is also affected by the innovation's impact on the risks involved in production (Abadi Ghadim, Pannell, & Burton, 2005; Marra, Pannell & Abadi Ghadim, 2003) which include uncertain yield; severe drought which affects yields; crop failure; and crop establishment failure (Juma, Nyangena & Yesuf, 2009). Farmers may also fear the effects of pests and diseases that lead to reduced yields or crop failure. The relative advantage of a technology would be reduced, if it were perceived to be more subject to establishment failure, or to yield losses due to drought, weeds or pests, than the current technology. A study by Batz, Peters and Janssen (1999), found that Kenyan dairy farmers were more likely to adopt technologies that promised a lower production risk (disease), relative to traditional technologies. Juma, Nyangena and Yesuf (2009) found that yield variability and the risk of crop failure affected the adoption of farming inputs, in Kenya. They reported that farmers did not apply manure and fertiliser in sufficient quantities, because yields of these crops were less certain. They would rather have a low output than spend money on applying fertiliser onto a crop they were not sure would give them high yields. A higher probability of crop failure (downside risk) also reduced the farmers' likelihood of adopting fertilizer.

Relative advantage can be affected, positively or negatively, by government policies (Pannell et al., 2006). For example, in the USA, support programmes based on yield, tended to increase the relative advantage of the intensification of farming and thus it increased adoption and use of herbicides (Helms et al.1987; Miranowski et al. 1991). The previously mentioned literature suggests that relative advantage is an important consideration for farmers' production decisions, in both developed and developing countries. The relative advantage is likely to be made up of a mix of considerations upon which farmers place different weight. Studies that identify 'economic' as being important may ignore the fact that other factors have also been considered by the adopters.

Compatibility is the degree to which an innovation is perceived as being consistent with the existing values, past experiences and needs of potential adopters (Rogers, 1995). "An innovation can be compatible or incompatible with 1) sociocultural values and beliefs 2) previously introduced ideas and 3) client needs for the innovation" (Rogers 2003, p 240). Rogers, (1995) definition of compatibility has been expanded by Ogunlana (2004) to include compatibility with the existing farming system. This study, therefore, combines Rogers (2003) and Oglunlanas, (2004) definition of compatibility. An idea that is not compatible with the values and norms of a social system will not be adopted, as rapidly as an innovation that is compatible (Rogers, 1995). Ogunlana (2004) found that alley farming was quickly adopted in Nigeria, due to its similarities with the bush fallow systems that were being practiced. Farmers, whose farmlands had deteriorated, due to the use of foreign technologies, were adopting technologies that were consistent with their indigenous practices, as a means of restoring their farmland (Ogunlana, 2004). Similarly, Brandner & Straus (1959) also found that hybrid sorghum was adopted at a dramatic rate, where hybrid corn was already in general use in America. The reasons for this situation were not offered. Gladwin (1979) also found that farmers in Mexico did not adopt a recommendation to increase the number and change the timing of fertiliser application in their corn fields. This was because the recommendations were not compatible with their past experiences when fertilising corn.

A study by Lubwama (1999) found that some conservation tillage practices were not adopted in Uganda, because they were not compatible with certain communities' cultures and traditions. The author gives an example of the use of draft animals in some communities. The value attached to cattle in some communities could not permit their use for traction and the adoption of donkeys also failed to gain ground in some of these communities, due to a fear of those animals.

Complexity is the degree to which an innovation is perceived as difficult to understand (Rogers, 1995). Some innovations are readily understood by most members of a social system; others are more complicated and they will be adopted more slowly. A study by Batz, Peters and Janssen (1999), in Kenya, found that many farmers in Meru did not adopt complex technologies such as new dairy technologies. These technologies were complex because there were many activities that had to be performed in order to use the technologies. Similarly, Rodriguez, Molnar, Fazio, Sydnor, & Lowe (2008) found that the complexity of many sustainable agriculture practices, in the USA, impeded their adoption. Alley farming was adopted in the Philippines because it was easy to learn and understand (Cramb & Nelson, 1998).

Trialability is the degree to which an innovation may be experimented with, on a limited basis (Roger, 1995). New ideas which can be tried as an instalment plan will generally be adopted more quickly than innovations that are not divisible. Some innovations are more difficult to divide for trial, than are others (Rogers, 1995, 2003). Ryan and Gross (1943) found that all of their Iowa farmer respondents adopted hybrid seed corn by first trying it on a partial basis. Similarly, Öhlmér, Olson, and Brehmer (1998), in their study on understanding farmers' decision making processes and improving managerial assistance in USA, found that farmers adopted technologies which they could try out on a small scale.

Observability is the level to which the outcome or benefits derived from new practices are seen (or can easily be measured) by the prospective users (Rogers, 1995). The earlier the results from using a technology can be seen by the farmer, the better the chances of it being adopted (Rogers, 1995). Geroski (2000) and Shampine (1998) found that observability enhanced the prospects of 'over the fence' learning by farmers and thus, it promoted diffusion of a practice and enhanced the rate of adoption. Rodriguez, Molnar, Fazio, Sydnor, & Lowe (2008) also found that the adoption of sustainable agriculture practices was low because its results could not easily be observed and the results did not occur quickly. Similarly, Pannell (2001) found that the results of salinity management technologies in Australia could not easily be seen and were slow to appear and as a result the adoption rate was low.

Although a vast amount of empirical work confirms Rogers (1995, 2003) categories, as influencing farmers' perception of technology and hence their decisions to adopt or not, they do not capture the diversity and characteristics of technologies that influence farmer adoption decisions. Although the characteristics of the technology are important in influencing the adoption of technologies, internal factors are also important. These are reviewed below.

2.6.2 Internal factors

Internal factors are factors associated with individuals involved in the innovation process and those that directly affect the individuals interaction with the innovation and also the way they view the technology (Chieochan et al., 2000). In this research, the unit of analysis is a household and not an individual, but this is an aspect not highlighted in the literature reviewed. The adoption literature focuses on individual farmers and the focus of food security is the household. The factors that are classified as internal factors are personal characteristics of the adopter and farm (organisation) characteristics (Chieochan et al., 2000; Gong & Beck, 1992). This classification is consistent across a number of authors (Chieochan et al., 2000; Gong & Beck, 1992). Personal characteristics of the adopter include the age of the potential adopter, education level, gender-related aspects and wealth (Chieochan, et al., 2000; Feder, Lau, & Slade, 1987; Fernandez-Cornejo, Beach, & Huang, 1994; Fernandez-Cornejo & McBride, 2002; Franzel, 1999; Lubwama, 1999; Omonona, et al., 2006). Farm characteristics include farm size, labour availability and land ownership (Doss, Mwangi, Verkuijl, & De Groote, 2003, (Feder et al., 1985). These factors are reviewed in the following sections.

2.6.2.1 Personal characteristics of the adopter

The personal characteristics of adopters are characteristics that are inherent to the individual and they cannot be changed (Spence 1994). Personal characteristics include factors such as the age of the potential adopter, education level, gender-related aspects and income levels which influence the farmers' adoption decisions (Chieochan et al., 2000; Feder, Lau, & Slade, 1987; Fernandez-Cornejo, Beach, & Huang, 1994; Fernandez-Cornejo & McBride, 2002; Franzel, 1999; Lubwama, 1999; Omonona et al., 2006). There is consistency amongst the authors in the factors they group as personal characteristics.

Most studies show mixed evidence regarding the effect of personal characteristics in technology adoption. This is because personal characteristics, alone, are not the driving force for someone to adopt a technology (Spence 2004). The factors interact together and influence the adoption decision process (Spence 2004). These factors are discussed in more detail.

Age

The relationship between age and the adoption of technology is not consistent within the literature (Rodgers, 1983). Some studies show age as not being significant, others show it to be positively related to adoption and others show it to be negatively related to adoption. For example, age was found not to be significant in the adoption of rice in Guinea (Adesina & Baidu-Forson, 1995) and Integrated Pest Management (IPM) sweep nets in Texas (Harper, Rister, Mjelde, Drees, & Way, 1990). The reasons why age was not significant were not explained.

Age was found to positively influence the adoption of cassava and soya bean in Nigeria (Omobolanle, 2007) and sorghum in Burkina Faso (Adesina & Baidu-Forson, 1995). The positive relationship between age and adoption could be due to the fact that older farmers have more experience in cultivation and they are better able to assess the characteristics of modern technology, than younger farmers (Teklewold, Dadi, Yami, & Dana, 2006).

Age however, was found to negatively influence the adoption of hybrid cocoa in Ghana (Boahene et al., 1999), natural resource management practises in the USA (Caswell, Fuglie, Ingram, Jans, & Kascak, 2001) and site specific technologies in the USA (Khanna, 2001). Khanna (2001) suggested that older farmers, perhaps due to investing several years in a particular practice, may not want to jeopardise their livelihoods by trying out a completely new method. In addition, older farmers' perception that they will not live long enough to enjoy the benefits of some technologies may also affect their decision not to adopt such practices (Caswell et al., 2001). Younger farmers have been found to be more knowledgeable about new practices and more willing to bear risks, due to their longer planning horizons (Polson & Spencer, 1991). The literature suggests that the relationship between age and adoption is linked to many other factors, such as risk and type of technology.

Education

Studies that have sought to establish the effect of education on adoption, in most cases, relate it to years of formal schooling (Feder & Slade, 1984; Tjornhom, 1995). It is often believed that higher education gives farmers the ability to perceive, interpret and respond to new information more effectively, than their counterparts with lower education (Feder et al., 1985; Rahm & Huffman, 1984). Several studies support this view. For example, in a study of cassava adoption in Nigeria, Eze et al., (2008) found that education positively affected adoption. In other studies by Daku (2002) and Doss and Morris (2001), education positively affected IPM adoption in Albania and Ghana.

Similarly, a study of IPM practices in potatoes identified the level of education as one of the major factors that positively affected the observed level of IPM practices with Ohio potato growers (Waller, Hoy, Henderson, Stinner, & Welty, 1998).

Importantly, other studies in the literature refute the view that education is positively related to adoption. For example, in a study of the adoption of insect sweep nets for IPM in Texas, higher education was negatively related to adoption (Harper et al., 1990). The authors attributed this to the simplicity of the IPM technique that they studied. The insect sweep net was not difficult to understand and did not require specific technical 'know-how', hence its adoption by poorly educated farmers. Bussolo, Godart, Lay & Thiele (2007) also found that less educated farmers were more likely to adopt coffee farming in Uganda. However, the reasons behind these results were not explained. Dadi, Burton, & Ozanne (2004) found that less educated farmers adopted fertiliser and herbicides in Ethiopia. This was because fertiliser and herbicide are relatively simple technologies that do not require a high level of education for their use. Annor & Kusi (2008) found that less educated farmers adopted grass-cutter farming in Ghana. They explained that this could be due to the fact that uneducated farmers copied from the educated farmers in order to effect economic change in their lives. The grass-cutter technology could be copied because it was simple.

The empirical results suggest that education is important for the adoption of technologies that may require specific technical know-how, but for some simple technologies, it may not be important. Education is also linked to other personal characteristics such as gender and wealth.

Gender

Gender issues in agricultural production and technology adoption have been investigated for many years. Most studies show mixed evidence regarding the effect of gender on technology adoption. A study by Doss and Morris (2001), on the factors influencing improved maize technology adoption in Ghana, found that gender had no effect on adoption. This was because males and female had equal access to resources, such as land, extension and education. Similarly, studies by Thapa (2009) and Gilbert, Sakala, & Benson (2002), in Nepal and Malawi, also reveal that given equal access to inputs, adoption rates and production levels were no different between men and women farmers.

Adesina, Mbila, Nkamleu and Endamana (2000) found that men adopted alley farming more than women in the Cameroon. Other studies, which have shown that women farmers are less likely to adopt new technologies, include studies by Tiruneh (2001) on wheat adoption in Ethiopia and Sanginga, Adesina, Manyong, Otite and Dashiell (2007) on improved soyabeans adoption in Nigeria. These studies reported that the lower adoption rates by women was because women farmers are not traditionally targeted by extension agents and research and development activities. Another study by Kassie, Zikhali, Manjur, and Edwards (2009), on the adoption of organic farming in Ethiopia, found that males adopted conservation tillage, whilst females adopted the use of compost. This was because conservation tillage is a labour intensive technology, whilst compost is a labour saving technology. Women did not adopt conservation tillage technologies because they did not have the strength to utilise this technology.

Gender does not influence technology adoption where both males and female have equal access to resources, such as education, land, labour and extension. Gender is an influence on adoption, when there are situational differences between men and women, for example, if there is a difference in access to resources, such as education and extension. The other issue, which may lead to disparities in adoption between men and women, is the differences in physical strength. Women may not have the physical strength to utilise some technologies, such as some labour intensive technologies.

Income level of farmers

The income levels of farmers can influence adoption in several ways. Farmers with high levels of income may be less risk averse (Ogunlana, 2004). They can undertake financial risks since they can afford to offset losses from some of their less successful experiments (Ogunlana, 2004). A study by Feder et al., (1985) found that farmers with off-farm income were more likely to adopt technologies, because the off-farm income provided a buffer if the technology failed. Farmers with high incomes are better educated and they invest more in information acquisition and they will accumulate knowledge that leads to adoption (Feder & Slade, 1984). Farmers with low incomes tend to adopt capital saving technologies and they may not be willing to adopt capital intensive technologies (Peterson, 1997). The literature suggests that the relationship between levels of income and adoption is linked to other factors, such as risk, education and type of technology.

Risk aversion

Risk aversion describes an individual's tendency to take or avoid risks in their decision making (Pannell et al., 2006). Feder and Umali (1990) and Cornejo et al. (2002) reviewed factors that affect technology adoption and they highlighted risk aversion as being one of the key determinants of adoption for the majority of agricultural innovations. More risk-averse farmers may tend to rapidly adopt an innovation that is perceived to reduce risk or to not adopt an innovation which is perceived to increase risk (Pannell et al., 2006).

When an innovation first appears, potential users are generally uncertain of its effectiveness and they tend to view its use as experimental (Mansfield, 1966). Hiebert (1974) and Feder and O'Mara (1981, 1982), in their study showed that uncertainty declines with learning and experience, thus inducing more risk averse farmers to adopt an innovation, provided it is profitable. Innovators and other early adopters are believed to be more inclined to take risks, than the majority of farmers (Fernandez-Cornejo, Dabercow and Mcbride, 2002).

Risk aversion is also linked to farm size and income. In a study by Feder and O'Mara (1981), higher risk aversion was found amongst smaller farmers and this hindered their adoption decisions. Smaller farmers due to less wealth (Oglunlana, 2004), are possibly more risk averse since they cannot afford to offset losses, if their experiments fail.

The other internal factors, apart from the personal characteristics that influence the adoption of technology, are the farm characteristics. In the following section the relevant farm characteristics are reviewed.

2.6.2.2 Farm characteristics

Farm characteristics, in combination with personal characteristics affect the farmers goals and their capacity to adopt specific technologies (Pannell et al., 2006). These factors include farm size, labour availability and land tenure (Feder, et al., 1985 Feder and Umali (1993), Ouédraogo, Mando and Zombré, 2001). This framework of factors is consistent across all authors. These factors are reviewed in detail in the following sections.

Farm Size

Farm size is one of the important factors that affect the adoption of technologies. Farm size is also used as a proxy for wealth, in most adoption studies (Doss, Mwangi, Verkuijl, & De Groote, 2003; Ntege-Nanyeenya, Mugisa-Mutetikka, Mwangi, & Verkuijl, 1997). Depending upon the type of technology, farm size has different effects on the rate of adoption. Some studies on the effect of farm size on adoption have found it to be positive, whilst others have found it to be negative. Studies have shown that farmers with large farms have a greater probability of adopting technologies, than small-scale farmers (Abara & Singh, 1993; Boahene et al., 1999; Ogunlana, 2004). This is because such technologies require capital investment and if the technology requires a substantial amount of initial set up costs, small farmers are not able to afford it (Abara & Singh, 1993; Boahene et al., 1999; Ogunlana, 2004). In contrast, larger farms are better able to provide this investment (Feder et al., 1985). Large farms may have an economic advantage in that they have better access to credit (Feder & O'Mara, 1981) and they also have assets, which they can use as collateral to obtain credit (Godoy et al., 2000).

Large farms can also afford the input costs, such as seeds, fertiliser and labour, which may be associated with a new technology. They also enjoy economies of scale from buying large quantities of certain inputs, which can help reduce their production costs (Boahene et al., 1999; Ogunlana, 2004). A study by Gabre-Madhin and Haggblade (2001), in Kenya, found that large commercial farmers adopted new high-yielding maize varieties more rapidly than smallholders. This was because the large farmers could afford the high yielding varieties, whilst small-holder farmers, after withdrawal of subsidies from the government, were struggling to buy them.

Farm size also has an effect on the adoption of new crops and crop diversification. Brush & Mauricio (1992) found that larger farms are more likely to adopt new crops and diversify because of their ability to partition a single farm into different cropping systems, to grow both the new crop and other crops. For small farms, however, the land available for other crops may be limited, once adoption of the new crop takes place.

Contrasting results have been reported by Yaron, Dinar and Voet, (1992) who undertook a study on family farms in the Nazareth region of Israel(a developed country). They demonstrated that, since land is a limiting resource for small farms, they are more likely to adopt specific technologies, such as input-intensive or land-saving technologies that increase output per hectare. Similarly, a study by Fernandez-Cornejo (1996), found that farm size did not positively influence the adoption of a new fungicide in the USA (a developed country), because the technology was not capital intensive. The farmers could afford to buy the fungicide, regardless of the size of their farms.

The empirical results suggest that the relationship between farm size and the adoption of technology is influenced by factors, such as access to credit and the requirement of the technology for capital and inputs. As noted previously, in developed economies, farm size does not constrain the adoption of technologies because even small farmers have access to credit compared to small farmers in developing countries. In developing countries, small-scale farmers do not have access to credit, since they do not have collateral or assets to borrow against. Farm size is also linked to income levels and types of technology. Large farms, since they have a higher level of income, are more likely to adopt capital intensive, land using and risky technologies. In contrast, small farms are more likely to adopt technologies that are capital saving, land saving and low risk.

Land tenure

The views expressed in the literature on the effects of land tenure and the adoption of technologies are not unanimous and they vary depending on the type of technology, its cost and the time to gain the benefits. Some studies show that land tenure has an influence on the adoption of new technologies. For example, studies by Feder and

Umali (1993) concluded that farmers who leased land are less likely to adopt conservation practices, than farmers who are landowners. This is because the term of the lease limits the leaseholder’s ability to benefit from the conservation technologies, whose benefits are long-term. Similarly Juma, Nyangena and Yesuf (2009) found that secure land tenure increased the probability of the adoption of terracing. Terracing is an expensive technology (in the short term) and its returns are not immediate as such, it would only be undertaken by a farmer who was assured of land ownership. A study by Ouédraogo, Mando and Zombré (2001) also found that farmers who leased land did not adopt compost technology in Burkina Faso. This was because compost technology had long-term soil benefits which the farmers may not obtain, due to the terms of their lease. What is important for the leaseholder’s adoption decision is the period of the lease. Where a farmer has a short term lease, he will not adopt technologies that provide benefits beyond the term of that lease.

Studies of other technologies and their adoption, however, have shown that land tenure has no influence on adoption. For example, Fernandez-Cornejo, Beach, & Huang (1994) found that land ownership did not influence the adoption of integrated pest management. This was because the benefits of integrated pest management occurred quickly. The apparent inconsistencies in the empirical results are due to the nature of the technology and the time frame for receiving benefits. Land ownership is likely to influence adoption, if the innovation requires investments tied to the land that provide benefits over a long time period (Fernandez-Cornejo et al., 1994). Tenants are less likely to adopt these types of innovations, because they perceive that they will not capture the majority of the benefits, relating to the adoption of the technology.

Labour Availability

Labour availability is another often-mentioned variable which affect farmers' decisions relating to the adoption of new agricultural practices or inputs. Some aspects of labour availability and adoption have been referred to in an earlier section. Technologies can be usefully separated into labour saving and labour intensive technologies (Feder et al., 1985). For example, ox cultivation technology is labour saving and its adoption might be encouraged by labour shortages. On the other hand, high yielding variety technology generally requires higher labour input, so therefore, labour availability may prevent its adoption. Moreover, new technologies may increase the seasonal demand for labour, so that adoption is less attractive for those with limited family labour, or those operating in areas with less access to labour markets.

Krishna and Quaim (2007) found that the availability of family labour led to a greater adoption of labour-intensive Bt eggplant hybrids in India. Labour was required for the application of insecticides, the removal of infested fruits and twigs and harvesting. Similarly, Ouédraogo, Mando and Zombré (2001) found that a shortage of family labour explained the non-adoption of labour intensive compost technology in Burkina Faso. This was because the production of compost requires intensive work, which cannot be managed by small households. Moser & Barrett (2003) also found that farmers did not adopt a system of rice intensification (SRI) in Madagascar, because the method required significant additional labour input, at a time of the year when liquidity was low and labour effort was already high.

In addition to internal factors, external factors are also important in influencing adoption of technologies. In the following section, the relevant external factors that could influence the adoption of technologies are reviewed.

2.6.3 External factors

External factors are factors external to the individual farmer, but they are part of the environment within which they carry out their daily activities (Spence, 1994). These include institutional factors, infrastructure, government policy and extension service delivery (Eze et al., 2008; Feder et al., 1985; Fernandez-Cornejo & McBride, 2002; Kassie et al., 2009; Nkonya, Schroeder, & Norman, 1997; Ogunlana, 2004; Zeller, Diagne, & Mataya, 1998). This framework of factors is consistent across all the authors. These factors are reviewed in detail in the following sections.

2.6.3.1 Institutional factors

Farmers make decisions within a broader environment or context (Tesfaye, 2003). Institutional factors are part of such broader environments, which affect farmers' adoption decisions on agricultural technologies. Institutional factors include support provided by various institutions and organisations to enhance the use of new technologies (Negash, 2007). These factors include membership of organisations (social organisation); access to extension; availability of inputs; and access to credit

(Karki and Bauer, (2004), Mazvimavi and Twomlow, (2009), Sodiya, Lawal-Adebowale & Fabusoro, (2007). This framework of factors is consistent across authors. These factors are reviewed in detail below.

Membership of organisations

Membership of organisations such as farmers' cooperatives and other associations, has been found to be very important in changing the attitudes of farmers towards new agricultural practices and thereby enhancing the adoption of such practices (Gottret, Henry, & Duque, 1993; Ogunlana, 2004; Zeller et al., 1998). Such organisations serve as forums for gaining access to information, credit and other productive inputs (Caviglia & Kahn, 2001). Membership of cooperatives was found to positively influence the adoption of new practices in Nigeria (Omobolanle, 2007) and conservation tillage in Ethiopia (Kassie et al., 2009). This was because farmers obtained information about the new technologies from different organisations and this influenced their decisions to adopt. Deji (2005) found that membership of cooperatives increased the likelihood that women farmers would adopt technology, in Nigeria. Membership of cooperative societies provided better and more reliable access to credit facilities, which determined the extent of production capacity and influenced the attitude of the farmers towards new innovations (Deji, 2005).

In some studies, however, membership of organisations has been found not to be a factor in adoption. Kuntashula, Ajayi, Phiri, Mafongoya, & Franzel (2002) found that membership of cooperatives did not affect adoption of improved tree fallow technology, in Zambia. This was because the farmers belonged to cooperative groups, whose objectives were not related to tree fallow farming. In another study of factors that affected the adoption of cassava, in a range of African countries, Udoh and Kormawa, (2009) found that membership of cassava cooperatives did not affect the adoption of cassava in Ghana, Niger and Burkina Faso, but it did have an effect in Nigeria and Chad. The reasons why these differences existed were not explained.

The above empirical studies point to the fact that membership of organisations can provide enhanced access to information relating to the technologies and importantly it can also provide access to credit, which can enhance the adoption decisions of farmers. However, the work of Kuntashula, Ajayi, Phiri, Mafongoya, & Franzel

(2002) suggests that, if farmers belong to cooperatives whose objectives are not related to the new technology, organisation membership will have no impact on adoption.

Access to Extension

The influence of extension on the adoption of new technologies is of major importance. Access to extension is also linked to wealth and education, as earlier stated. Farmers with wealth are better educated: they invest more in information acquisition and they accumulate knowledge that leads to adoption (Feder & Slade, 1984). Contact with extension services can provide farmers with access to information about innovations (Kassie et al., 2009). Consequently, access to extension is often used as an indicator of access to information (Adesina et al., 2000; Honlonkou, 2004).

In their study on the factors that determined cassava adoption in a range of African countries, Udo and Kormawa (2007) found that contact with extension agents (and through them access to adequate information), was one of the major predictors of the decision by farmers to allocate land for the cultivation of cassava. The probability of adopting cassava, in these countries, increased as contact with extension agents increased. These results were similar to those reported by Adesina and Zinnah (1993), who found that farmers were more likely to adopt a technology, if they had been provided with information about the technology from an extension agent. In fact, Yaron, Dinar and Voet (1992), showed that the influence of information, through contact with extension agents, can counter-balance the negative effects of a lack of formal education, in the overall decision to adopt some technologies. This implies that farmers with less schooling may adopt and implement innovative and even sophisticated technologies, if they receive proper guidance from extension agents.

Access to extension is also linked to the distance from main centres and the quality of roads. Households further from main centres have less access to extension support and as a result the adoption of new technologies is a challenge (Stall, Delgado and Nicholson, 1997).

Availability and access to inputs

The availability and access to inputs can also affect the adoption of some technologies. Availability and access to inputs is also linked to roading infrastructure and distance from market centres. Poor road infrastructure and long distance from market centres limit the availability and access to inputs: and this may lead to low adoption of technologies (Nzomoi, Byaruhanga, Maritim and Omboto, 2007). Studies by Omonona, Oni and Uwagboe, (2006) and Sodiya, Lawal-Adebowale, & Fabusoro (2007), in Nigeria, found that access to agro-input support services was a significant factor in influencing farmers' adoption of cassava technologies. This was because farmers were able to gain timely access to the cassava technologies and associated inputs, such as fertiliser, at an affordable price and this enhanced their adoption decisions.

In Zimbabwe, Mazvimavi and Twomlow (2009) found that the provision of free inputs by NGOs increased the rate of conservation farming adoption. The provision of free inputs ensured that farmers could access and use critical inputs and this influenced their adoption decision. Similarly, Kohli and Singh (1997) also found that inputs played an important role in the rapid adoption of high yielding varieties of rice in the Punjab area in India. They claimed that the effort made by the Punjab government, to make the technological innovations and their complementary inputs more easily and cheaply available, allowed the technology to diffuse faster than in the rest of India. In a similar vein, Ehui, Lynam and Okike (2004) stated that, for efficient utilisation of a new technology, the availability of the necessary inputs to small-holders, at the right time and place and in the right quantity and quality, should be ensured.

Access to credit

A substantial amount of the adoption literature has reported on the impact of access to credit in relation to adoption of new technologies and a vast amount of this literature shows that the availability of credit has a positive impact on adoption. This is particularly important in lesser developed countries for small scale subsistence farmers. Feder and Umali (1993) reviewed factors that affect technology adoption in these countries and they highlighted access to credit, as being a key determinant of the adoption of most agricultural innovations. Any fixed investment requires the use of a farmer's own or borrowed capital. The adoption of a technology, which requires a large initial investment, may be hampered by a lack of borrowing capacity (Batz et al., 1999; El-Osta & Morehart, 1999). The adoption of such technologies is limited to larger farmers, who have sufficient wealth that allows them to make the capital investment (Khanna, 2001). A study by Karki and Bauer (2004), on the adoption of improved technologies by peasant farmers in Nepal, found that the availability of credit encouraged farmers to adopt improved technologies which required high capital outlay.

Other studies have also found that a lack of credit played a significant role in the adoption of technologies, which did not involve large fixed costs, such as high yielding varieties. Simtowe and Zeller (2006) and Doss, Mwangi, Verkuijl and De Groote (2003) found that lack of access to credit led to the low adoption of improved maize varieties, amongst farmers in Zambia and East Africa. This credit was required to purchase maize seed and associated inputs. Similarly, Udoh & Omonona (2008) also found lower levels of improved rice adoption amongst households that had no access to credit in Nigeria. These results show that access to credit is linked to wealth, farm size and type of technology. Large farms have more wealth and they are able to borrow and adopt capital intensive technologies, compared to small farmers.

Apart from institutional factors, the quality of the local infrastructure has been found to affect adoption. In the following section the importance of infrastructure is highlighted.

2.6.3.2 Infrastructure

Infrastructure plays a key role in facilitating technology adoption (Jimenez, 1995). Infrastructure affects agricultural production indirectly through prices, diffusion of technology and the use of inputs: it also has a profound impact on the incomes of the poor (Ahmed & Hossain, 1990; Dorward, Kydd, Morrison & Urey, 2004). The state of infrastructure implies improved access to markets and institutions. Infrastructure includes transport, roading and processing infrastructure (Binswanger, 1989; Langyintuo & Mungoma, 2008; Nweke, 1994). This is consistent across all the authors. These factors are now discussed.

Transport Infrastructure

The state of road infrastructure has been found to be important in influencing the adoption of agriculture technology (Binswanger, 1989; Nzomoi, Byaruhanga, Maritim & Omboto, 2007). Sub-standard roads lead to high transport costs for transporting agricultural products to markets as well as high cost of farm inputs, thus reducing farmers' competitiveness (Binswanger, 1989; Nzomoi, Byaruhanga, Maritim, & Omboto, 2007). A study by Binswanger (1989) in India, showed that improvements in infrastructure (rural road density, paved roads) led to a significant increase in fertiliser adoption. A study by Nzomoi, Byaruhanga, Maritim and Omboto (2007), in Kenya, found that sub-standard road networks led to the low adoption of technology, in the production of horticultural export produce. It limited the farmers to where they could source their inputs and where they could sell their produce. Sub-standard road networks also led to the damage of fresh consignments of produce and greatly reduced the life span of the vehicles carrying the produce, due to excessive wear and tear. A sub-standard transportation system also makes it difficult for extension efforts to reach farmers with the improved technology and (as a result) the adoption of improved technology is limited (Leta et al., 2004; Nzomoi et al., 2007; Peterson, 1997).

Access to markets

A farmer's access to markets may influence the net benefits available from a new technology and therefore, its likely adoption (Langyintuo & Mungoma, 2008). Distance to markets is also used as a proxy for market accessibility in adoption studies (Langyintuo & Mungoma, 2008). Distance from major market centres leads to more limited and costly access to inputs. Distance from major markets is also linked to transport infrastructure as previously discussed. Longer distances can reflect increased marketing costs (transport, organisation costs). Zeller et al. (1998) found that households that were far from markets had low levels of hybrid corn adoption in Malawi. This was because of the high costs of inputs, due to high transportation costs. Another study, by Udoh & Kormawa (2007), on the factors that farmers considered relevant, when adopting cassava production in African countries, found that distance to a nearby urban market was important in the adoption of cassava technology. The nearby market reduced transport costs for the farmers to get their produce to the market and it therefore encouraged them to adopt the cassava technologies.

Distance to output markets also affects the adoption of agriculture technology. Langyintuo & Mungoma (2008) found that distance to output markets had a negative and significant relationship, with adoption of improved maize varieties, in Zimbabwe. The reason for this was that farmers who were further away from market centres tended to be less market orientated and this meant that their technology-use decisions would rely less on profitability considerations and more on subsistence production. As a result, they were not interested in investing in improved varieties, so long as the traditional varieties provided a subsistence level of output for their families. Wiggins' (2000) survey of African case studies found a number of agriculture innovations were adopted because of easy access to output markets.

Distance to markets may also negatively affect the adoption of perishable products, especially in less developed countries, where transport is expensive. Staal, Delgado, & Nicholson (1997) found this to be true, particularly in the dairy sector in Kenya, with the high perishability of raw milk. This reduced the time available for marketing and raised the risks of spoilage with the increased distance to market. As a result, farms that were located further from central markets had lower levels of adoption of crossbred cow technology, in Kenya.

Access to Processing equipment

Access to post-harvest processing equipment has a relatively large influence on farmers' decisions to produce crops that need processing, including cassava (Nweke, 1994). Cassava is easily cultivated, but, in its fresh form, it is bulky and perishable and many varieties are 'bitter' with high levels of toxic hydrocyanic acid (HCN), which must be removed before consumption (Hahn, 1989; IITA, 1990a). Processing reduces the bulkiness of cassava, extends shelf-life and therefore it reduces the transportation cost, in addition adding value to the product (Janssen & Wheatley, 1985; Jeon & Halos, 1991, 1992). The processed products can be sold at a higher price and the farmers can obtain a higher income. The Collaborative Study of Cassava in Africa found that, in both Ghana and Nigeria, cassava cash incomes were the highest amongst farms with access to mechanised cassava processing equipment for the preparation of gari (Nweke, 1988). In Tanzania and Uganda, farmers' income from cassava was low, because the majority of farmers in both countries lacked access to improved cassava processing equipment. A study by Johnson and Masters (2004) and Agwu and Anyaeche (2007), in Nigeria, found that new cassava varieties were adopted, because processing equipment was available.

Another external factor which is important in influencing the adoption of technologies is government policy. This is reviewed in the following section.

2.6.3.3 Government Policy

Policy support from Government has been found to affect the adoption of new technologies. Governments can use macro-economic policy, trade regulations, input subsidies, regulations or education and extension, to alter the decision-making environment in which farmers choose one practice over another (Drechsel et al., 2005). Studies have shown government policy to positively and negatively impact on the adoption of new technology. Government policies which have had a positive impact on adoption include direct support, such as price subsidies, input subsidies, credit facilities and indirect support such as marketing facilities and input facilities. A study by Howard and Mungoma (1996), on the impact of policies and organisations on the development and spread of maize technology in Zambia, found that small-holders adopted improved maize technology, because the government provided direct price subsidies on fertiliser; pan-territorial pricing of fertiliser, seeds and in addition they also provided local credit, input and marketing facilities through cooperatives.

Government policies, which have had a negative impact on the adoption of technologies, include indirect support, such as maintaining artificially high exchange rates; maintaining low prices for imported substitutes; and the removal of direct support such as credit and price subsidies (Ahmed, Salih & Sanders, 1992). Government policy may also be antagonistic to technology adoption, because it supports competing technologies. For instance, in Nigeria, an overvalued exchange rate, combined with food subsidies for imported rice, hindered the adoption of improved cassava varieties during the early years of their release, in the late 1970s (Haggblade, 2004). A decade later, after petroleum revenues dried up and the government was forced to devalue the Naira (Nigerian currency) and suspend its subsidies on imported foods, the adoption of improved cassava varieties increased. Similarly, a study by Ahmed, Salih & Sanders (1992) found that the adoption of improved sorghum, in Sudan, suffered a set-back when the government pricing policy changed. Subsidies on land and credit were eliminated and the production of sorghum reduced.

A study by FAO (2001) on the economics of conservation agriculture, in Sub-Saharan Africa, found that many programmes promoting conservation farming have been relatively ineffective. This was because policies designed to promote sustainable agriculture were undermined by other policy measures in support of highly erosive cash crops, or by weak or slow-to-respond research and extension efforts.

The final external factor that can influence the adoption of technology is the extension service delivery system. This is reviewed in the following section.

2.6.3.4 Extension service delivery

Extension service delivery involves the adequate and timely provision of information to farmers, so that they can adopt new technologies if they suit their socio-economic and agro-ecological circumstances (Anderson & Feder, 2003). The extension service can be private or public. In developing countries such as Zambia, the provision of extension is mainly through the government. However, this government service has been reduced, in some developing countries, as government funding has been cut back (Swanson & Samy, 2002). It is being replaced, to some extent, by user-pays services and cost recovery procedures (Kidd, Lamers, Ficarelli, & Hoffmann, 2000; Rivera, 1997; Umali-Deininger & Schwartz, 1994). Important to the delivery of extension information is the communication method and role of extension agents; attributes of the communicators; and other factors internal to the extension system, including financial sustainability and the working conditions of staff. These important factors of extension service delivery and their impact on technology adoption are now reviewed.

Communication and role of extension personnel

Extension personnel are critical to the extension process. These are the mediators, in regards to the communication of the technology (Rogers 1983). They are in contact with the farmers and they transfer information about the technology, to the prospective adopters (Feder & Slade, 1993; Feder & Umali, 1993). According to

Guerin and Guerin (1994), the contact has to be dynamic and the flow of information must be two-way, from farmers to the extension organisations (about what information they need) and from the institutions where the new technologies originate to the farmers. Studies have shown that farmers, who have contact with extension personnel, are more willing to adopt new technologies, than those who do not (Adesina et al., 2000; Kassie et al., 2009; Udoh & Kormawa, 2009; Yaron et al., 1992). This is because extension personnel provide information about new technologies and this enhances the farmers' decisions to adopt them. Extension personnel can raise awareness and to some extent, change perceptions of the relevance and performance of an innovation (Pannell et al., 2006). Extension agents must be capable of more than just communicating messages to farmers. They should have certain attributes to do their work effectively and these will be reviewed in the following section.

Attributes of extension personnel

The critical attributes that the literature argues are important for extension personnel to be effective in facilitating technology adoption include technical knowledge, respect for farmers' knowledge and credibility (Belay & Abebaw, 2004; Boyd, 2003; Guerin & Guerin, 1994). Extension personnel need strong technical knowledge, since they provide technical advice, which applies more directly to the production activities of the farmers and to the actions needed to improve or sustain this production (Boyd, 2003; Guerin & Guerin, 1994). Technical knowledge also helps the extension personnel to identify and diagnose problems. Belay & Abebaw (2004) found that the adoption rate of modern agriculture practices, in south-western Ethiopia, were low because extension personnel lacked the technical knowledge, relating to the technologies. Similarly, Rahim M.Sail et al. (1990) found that one of the factors that led to the low adoption of current rubber technology, amongst Malaysian smallholders, was the lack of the extension personnel's knowledge and skills on current rubber production technology.

It is also important for extension personnel to respect the farmers' skills and knowledge (Guerin & Guerin, 1994). This is because extension programmes that ignore farmers skills and knowledge frequently do not succeed (Mwangi, 1998). Belay & Abebaw (2004) found that the adoption of modern agriculture practices, in south-western Ethiopia was low because extension personnel gave little consideration to the farmers' experiences and knowledge.

Extension personnel need to develop credibility with the farmers (Guerin & Guerin, 1994). Farmers are more likely to believe information about a new technology, if they perceive the extension personnel as being credible (Guerin & Guerin, 1994; Mwangi, 1998) and this may enhance their adoption decisions. Matthews-Njoku & Asiabaka (2004) and Pannell et al. (2006) found that the credibility of an extension agent positively influenced the adoption of recommended improved cassava technologies, in Nigeria and the adoption of agricultural conservation practices, in Australia. Promoting technologies, which meet farmers' needs, also encourages a positive attitude toward change and it improves the extension agents' credibility (Mwangi, 1998; Pannell et al., 2006). The constraints that extension personnel face are now discussed.

Constraints faced by the extension system

Agriculture extension systems, in developing countries, have faced a number of problems which have limited their effectiveness. One such constraint is the quality of infrastructure. Studies have shown that infrastructure, particularly the condition of transport and communication facilities, affects both the farmers and extension agents (Anderson & Feder, 2004; Leta, Murray-Prior, & Rola-Rubzen, 2004; Peterson, 1997). In developing countries, there are a large number of farmers who live in geographically dispersed communities, with sub-standard infrastructure (Anderson & Feder, 2004). These geographically dispersed areas are difficult to reach, due to bad roads and/or vehicles may be in short supply (Anderson & Feder, 2004; Leta et al., 2004). In either case, it is difficult for extension efforts to reach farmers with improved technology and (as a result) the adoption of improved technology is limited (Leta et al., 2004; Nzomoi et al., 2007; Peterson, 1997).

Communication infrastructure can impose additional constraints for extension organisations. Farmer access to mass media, such as publications, radio or television, may be limited, thus reducing the options available to extension organisations for communicating its messages (Peterson, 1997). At the same time, the extension agents may have little or no access to telephone and radio services for long-range communications. This can severely hamper their ability to organise and carry out field operations (Peterson, 1997).

The other constraints that hinder the effectiveness of public extension systems, in developing countries, are the limited staff and financial resources. Studies have shown that, in developing countries, the ratio of extension agents to farmers is low and (as a result) the number of farmers who need to be covered by the extension service is large and the cost of reaching them is often high (Agbamu, 2005; Anderson & Feder, 2004; Leta et al., 2004). This means that very few farmers have contact with extension agents. Contact with extension personnel has been found to be important in influencing farmers' decisions to adopt new technologies (Adesina & Zinnah, 1993; Udoh & Kormawa, 2009).

Extension personnel are often hindered by a lack of financial resources (Birkhaeuser, Evenson, & Feder, 1991; Birner & Anderson, 2007; Muyanga & Jayne, 2006). The financial resources, which they lack, include training, operational funds, reward and incentives system, salaries and transport. The number of staff in the public sector, in many developing countries, (including Zambia), is high and with budget restrictions which they have, the available resources such as training for the extension agents are limited: consequently, it is difficult for them to do their jobs effectively (Birkhaeuser et al., 1991; Birner & Anderson, 2007; Muyanga & Jayne, 2006).

The lack of operational funds contributes to the low morale of extension personnel. In developing countries, the extension systems also lack the reward and incentive systems needed to attract, retain and motivate extension personnel (Belay & Abebaw, 2004). A lack of motivation may make it difficult for extension personnel to be committed to their job and to work effectively (Anderson & Feder, 2004). Extension workers, in developing countries, also receive low salaries and this contributes to poor staff motivation (Leta et al., 2004). Further studies have shown that extension workers, in developing countries, do not have adequate transport for visiting farmers (Blanckenburg, 1982; Kassa, 1999; Leta et al., 2004; Van den Ban & Hawkins, 1996). As a result, they cannot deliver information about new technologies to the farmers (Blanckenburg, 1982; Kassa, 1999; Leta et al., 2004; Van den Ban & Hawkins, 1996).

A lack of supportive government policies also hinders the effectiveness of public extension systems, in some developing countries (Anderson & Feder, 2003). Government policies, in developing countries, in relation to such areas as the provision of credit, input and seed supplies, price incentives, marketing channels and human resources, are important in determining the effectiveness of extension systems. Extension agents do not have any influence on policy factors and (whilst they can give advice), the value of information is diminished, when there is a lack of a supportive policy environment (Anderson & Feder, 2003).

The other problem, identified by Anderson Feder (2004), within the public extension systems in developing countries, is the weak linkages between research, extension and the farmers (Anderson & Feder, 2004). The information on which the extension advice is based is often not generated within the extension organisation, but in separate systems, such as research institutes or universities. These research systems often put their agendas first, generally wanting recognition within the scientific community and their areas of priority are not necessarily aligned with what extension managers perceive as priorities: given their farm-level feedback (Kaimovitz, 1991). As a result, the technologies developed by research organisations are not specifically tailored to the problems faced by farmers (Mureithi & Anderson, 2002).

A lack of government support, commitment and or conflicting policy measures, is also another problem for extension organisations, in developing countries. A review of extension operations, in developing countries undertaken by the World Bank (Purcell & Anderson, 1997), pointed out that, in nearly one-half of the agriculture extension projects examined, a lack of commitment and support by senior government officials adversely affected implementation and funding. Extension services are usually comprised of a large number of public servants, who function at rural community level and governments are frequently inclined to utilise extension staff for other duties related to the farming population. Such duties include collecting statistics; administering loan paperwork and input distribution (for government-provided inputs); implementation of special programmes; and the performance of regulatory duties (Feder & Slade, 1993). As a result of this situation, the extension workers may not concentrate on their work of disseminating technology information to the farmers.

This may lead to low levels of technology adoption by farmers, due to a lack of information.

The prevailing extension approach used by an extension organisation will also have a significant impact on the nature of the adoption process used by farmers. The extension approach is now reviewed.

Extension approaches

Extension approaches are important in the transfer of information and knowledge to farmers and (as a result) they have an influence on the adoption of food security technologies. The approaches differ, in that some may target all farmers as one entity, whilst others use specific criteria in order to cater for the specific concerns of a targeted farmer group (Manig, 1992). In Zambia the extension approach which is currently in use is the participatory extension approach.

The participatory extension approach combines modern scientific knowledge with the indigenous knowledge of the farmers in order to enhance technology adoption (Belay & Abebaw, 2004). Studies have shown that ttechnologies which have been developed without the knowledge of farmers, in most cases, failed: what was required was the involvement of farmers in technology generation (Axinn, 1991). This led to the emergence of participatory approaches of extension, in the late 1980s. In this approach, farmers are seen as partners in research and extension and as the key players in the innovation process (Hagmann, Chuma, Murwira, & Connolly, 1999). The participatory technology development and dissemination approach makes research outcomes more useful, since it helps to meet the actual needs of farmers (Ison & Russell, 2000).

Participatory technology development incorporates the criteria farmers use for judging agricultural technologies (Horne & Stur, 1998), which are usually different from those perceived by researchers. For example, in the case of forage crops, researchers usually focus on adaptation and yield potential. Farmers, on the other hand, may select species based on such criteria as the "greenness of leaf in the dry season", "softness of leaf" or "hairyness of leaf" (Horne & Stur, 1998). For example, Horne & Stur, (1998) in Tuyen Quang province, Vietnam, found that farmers selected forage species for buffalo, based on palatability and softness of the leaf. An understanding of these criteria allowed the researchers to narrow down the types of species that the farmers needed.

The use of participatory extension approaches has led to an increased adoption for many technologies, in Africa. For instance participatory extension approaches, were used in the development and spreading of soil conservation practices, in Zimbabwe (Hagmann et al., 1999); in pasture management technology generation and dissemination, in South Africa (Botha & Stevens, 2003); in integrated soil fertility management, in Kenya (Baltissen, Wabwile, Kooijman, & Defoer, 2000); in irrigation and water use projects, in Zambia (Rivera, 2001); and in a FAO special programme for food security, in Tanzania (Rivera, 2001).

2.7 Summary/Conclusion

Food security is a situation that exists, when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. There are two main strategies that have been used to improve food security, in developing countries: 1) increasing on-farm food production and 2) increasing on-farm food production and income diversification. On-farm food production requires the adoption of improved technology, in order to increase food production. Therefore, technology adoption is very important in achieving food security.

Farmers' technology adoption decisions, however, are influenced by a number of interrelated factors. These include the characteristics of the technology; internal factors, which include personal and farm characteristics; and external factors such as policy and infrastructure. Critical to the adoption of this technology is the extension service, which is a major means of disseminating information about the technology. It is, therefore, important to improve the research, extension and farmer linkages, in order to promote food security, through the development of technologies that match the farmers' needs. Infrastructure and government policies are equally important as tools to enhance the extension services.

CHAPTER 3: RESEARCH METHODOLOGY

Introduction

This chapter contains a description of: the research strategy, the case study design, the sampling strategy, and the methods used in the collection of data, the data analysis and lastly the ethical considerations associated with the study.

3.1 Research Strategy

There are five research strategies that can be used to undertake research (Yin, 2003): Experiment; survey; archival analysis, history; and case study (Table 3.1). Yin (2003) suggested that a researcher should consider three criteria when deciding upon which research strategy to adopt: (1) the type of research question posed; (2) the extent of control the investigator has over events; and (3) whether or not the focus is on contemporary phenomenon within some real-life context.

Table 3.1 Conditions for selecting appropriate research strategy.

Strategy	Form of Research Question	Requires Control of Behavioural Events?	Focuses on Contemporary Events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where , how many, how much?	No	Yes
Archival analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case study	How, why?	No	Yes

(Source: Yin 2003)

In research strategies involving experiments, the researcher requires control over the behaviour of the research subjects and this is focused on contemporary events in an attempt to answer ‘how’ and ‘why’ research questions. Research strategies involving surveys and archival analysis do not require control over research subjects: they focus on contemporary events and they address the research questions to do with ‘who’, ‘what’, ‘where’, ‘how many’ and ‘how much’ type of questions. Historical studies using the ‘how’ and ‘why’ questions, do not require control over the research subjects and they do not focus on contemporary events. The case study approach is used to address the ‘how’ and ‘why’ questions and it focuses on contemporary events (Yin, 2003): and the researcher has no control over the subjects.

Given the aim of this research, which is to inform the development of more effective strategies for improving cassava technology adoption and food security in the southern province of Zambia, a case study was the most appropriate one to use for this research. A case study approach helps to determine the influence of multiple factors on the character of the research subjects whilst also providing opportunities for in-depth analysis of the case under study (Blaikie, 1995, 2000).

3.2 Case study design

According to Yin (2003), there are four types of case study designs: single-case (holistic) designs; single-case (embedded) designs; multiple-case (holistic) designs; and multiple case (embedded) designs. The holistic case studies are ones which merely examine one unit of analysis, such as an organisation or a programme (Yin, 2003). The embedded case studies are ones which involve studying more than one unit of analysis (Yin, 2003) and the unit of analysis defines the case study. This could be a group, an organisation, a process, a programme, or simply an object/event (Yin, 2003).

The design chosen for this study is an embedded single-case design, which was appropriate, given the in-depth analysis required and the amount of time available for the research. Although Yin (2003) stressed that multiple case study designs have the advantage of robustness, over a single case design, this can sometimes result in a trade-off in relation to depth, especially where resources and time are limited. The units of analysis include farm households and the extension organisations.

3.3 Case Selection

The research focused on Mazabuka district, which was chosen because it is one of the districts in the southern province of Zambia that is drought prone: and the promotion of cassava as a food security crop (by NGOs and Government) has been undertaken in this area. The mainstay of the people in this area is agriculture and also the researcher is familiar with the language spoken in this area. The case was also selected because it was easily accessible. According to Yin (2003), it is better to use a case which is more convenient, close and easy to access in order that the researcher can have more time and thereby develop a close relationship with the interviewees, in order to gather the information needed.

Within the district, two villages were selected, with the help of the NGOs and the Ministry of Agriculture and Cooperatives. The selection of the villages took into consideration ease of accessibility of the villages by the researcher. These villages were also selected because they were comprised of farmers: some who had adopted cassava and some who had not.

3.4 Sampling

The identification of individual farmers, who had adopted and not adopted cassava, in addition to key informants, was undertaken with the help of the Ministry of Agriculture and Cooperatives and NGOs working in the area. The farmers were selected based on ease of access for the researcher, since some of them lived in distant places.

Purposive and snowball sampling methods were used to select participants for interviews and observations (Ruane, 2004; Scheyvens & Storey, 2003). Purposive sampling was also used to include people of interest: in this case men and women. Snowball sampling also known as chain referral sampling is where participants or informants, with whom contact has already been made, use their social networks to refer the researcher to other people who could potentially participate in (or contribute to) the study (Goodman, 1961). In this study, snowball sampling was the most appropriate, since a list of farmers, who had (or had not), adopted cassava was not available. The use of other sampling strategies, such as simple random sampling, would have required a list of farmers.

The number of farmers interviewed was 40. The size of the sample was selected on the basis that it allowed the researcher to complete interviews given the time and resources available for the study. Both farmers who had adopted and those who had not adopted cassava were interviewed in order that the researcher could gain an understanding of the different decisions made by the farmers. The farmers were interviewed in their local language.

Amongst the 40 farmers interviewed, there were three opinion leaders. Opinion leaders, who were also key informants, are people whose social status in the community is considered to be above average and they are given due respect. These included a retired agriculture researcher, a teacher and a pastor. Opinion leaders help to provide insights into a matter and they can initiate also access to corroboratory or contrary sources of evidence (Spence, 1994). Ten of the farmers interviewed had adopted cassava, whilst 30 had not. An equal number of men and women were interviewed. The age of the farmers interviewed ranged between 22 and 60 years. The level of education varied: Some had attended primary school, whilst others had received a secondary school education. Some of the farmers interviewed were farming on customary land, whilst others leased land from the Zambia Sugar Company. Six of the farmers had adopted cassava leased land from the Zambia Sugar Company, whilst four were farming on customary land.

The researcher also interviewed two Ministry of Agriculture and Cooperatives officers, two agriculture extension agents working in the area and 2 representatives of NGOs in the area. The Ministry of Agricultural and Cooperatives and NGOs were interviewed because they are involved in agriculture in the district and they have played a major role in the promotion of cassava, in the district. They have also been working in these farming communities and they know the communities well. The Ministry of Agriculture and Cooperatives officers, extension agents and NGO representatives, were interviewed in English.

3.5 Data collection

Yin (2003) recommended the use of a protocol in case study research, in order to guide data collection. This protocol covers the field procedures, case study questions and data sources, through which these questions can be answered. The aim in this study was to: inform the development of more effective strategies for improving cassava technology adoption and food security in the southern province. In order to achieve this aim, a data collection protocol was developed from the literature review (Chapter 2). The data collection protocol consisted of a set of broad topic areas that were set out as questions (Yin, 2003). The broad topic areas covered the farmers, the Ministry of Agriculture and NGOs. In this study, the main source of data was primary data gathered through interviews. Secondary data was collected from documents and field observations (the data was collected between April and May 2010).

Primary data was collected through taped semi-structured interviews with farmers, extension officers, NGO representatives and Ministry of Agriculture and Cooperatives officers. Interviews were used because they provided an opportunity for a deeper understanding of the issues surrounding this study, from the participants' own perspective (Ritchie & Lewis, 2003). Prior to each interview, the researcher gave brief background information on what the research was all about. The participants were assured that their responses would be confidential. This was important, in order to prevent respondents from withholding information that may be important to the research (Foddy, 1996; Patton, 2002). The researcher used a tape recorder to record the interviews and this was placed at a distance from the participants. Permission to record each interview was sought from the respondents, before they were interviewed. One of the respondents refused to be recorded, but after reassurance that the interview was confidential and his name would not be revealed, he agreed. Field notes were taken as a backup for the taped interviews in case the recorders were damaged or did not function.

The researcher used an interview guide to guide the interview process (Appendix 1). The guide had fixed questions but the questions were open ended and interviewees could provide answers that they considered to be important, without any restriction (Bryman, 2001; Patton, 2002). Probing and clarification questions were also used, in order to obtain further detail about the various topic areas (Legard, Keegan, & Ward, 2003).

The researcher also used observations as a means of collecting data. Field observations are important, because information from documents and interviews can be misinterpreted (Tellis, 1997). Yin (2003) argued that observations form a useful supplement to other data collection techniques, in case study research. This involved carefully observing and listening. The researcher also visited and observed the farmers' cassava fields. A structured data protocol was not used to record the researcher's field observations but instead, field notes were taken about activities that were observed.

Secondary data was collected by using documents from the district and national offices of the Ministry of Agriculture and Cooperatives and the NGOs. The documents collected by the researcher included the district profile on agriculture, annual reports and district food security reports. The use of these documents was to substantiate and augment the evidence gathered from the other sources (Creswell, 1998; Thomas, 2003). Multiple sources were used to address the issues of validity and therefore improve the quality of the results (Yin, 2003), since the information collected from one source could be compared with information gathered from another source. The information gathered from the farmers and the opinion leaders was compared with the documents obtained from the Ministry of Agricultural and Cooperatives and the NGOs.

3.6 Data analysis

Qualitative data analysis was used for analysing the data collected for this study. Eight of the interview tapes were transcribed using Creswell's (1998) and Dey (1993) Data Analysis Spiral (Figure 3.1) in order to provide a basis for the analysis. The data analysis spiral involved the process of describing, classifying and connecting (Dey, 1993). The interviews that were transcribed included two cassava adopters, two non-adopters of cassava, one opinion leader, one Ministry of Agriculture and Cooperatives officer, one extension agent and one NGO personnel. The other interviews with the farmers were listened to, categories drawn out and each interview was summarised. In the process they were checked for accuracy, errors were corrected and new categories drawn out. Information was drawn from all the interviews, the supporting documents and observations, in order to present a view of all the relevant factors in this study.

The first step of transcribing the data was undertaken by typing the text from the interviews into word processing documents. The second step was to describe the situations and events and here the researcher perused through the entire body of data collected, in order to obtain an understanding of the entire data. At this time, notes were made that suggested possible categories and interpretations.

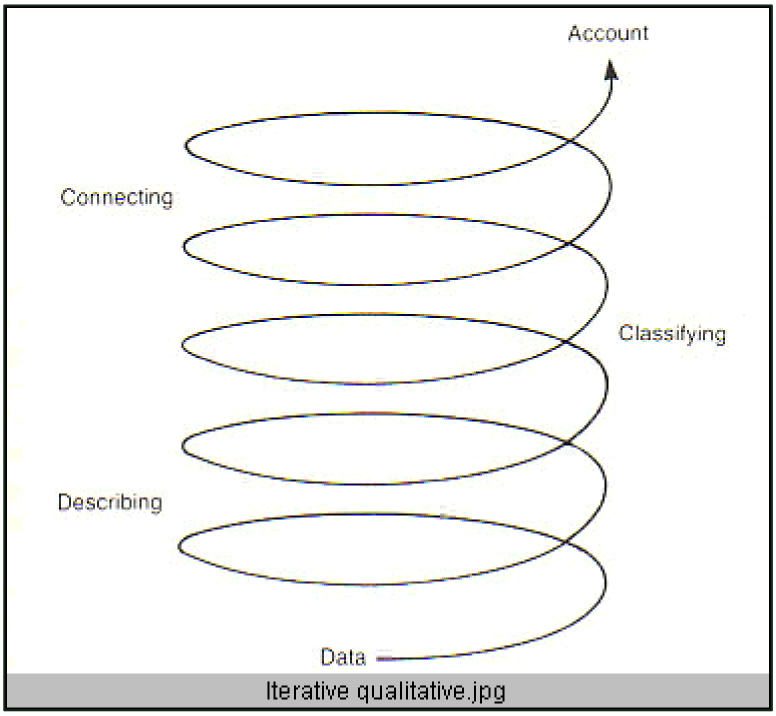

Figure 3.1The data analysis Spiral (Dey, 1993:53; Creswell, 1998:143)

Classification was the third step and the researcher identified general categories (and sub-categories) or themes (and sub-themes). The development of categories of information is an approach used to reduce the data to a manageable format for analysis (Creswell, 1998; Punch, 2005). An example of categorisation is shown in Table 3.2 and 3.3.

Table 3.2: Responses to the open-ended question (not in order). ***What are the reasons why you do not grow cassava?***

Participant responses
- There is nowhere to sell the cassava - It takes too long for it to mature as compared to maize - It is difficult to grow it, termites attack it in early establishment - There is no processing equipment for cassava - It is destroyed by livestock such as goats and cattle - Lack of government support in terms of price and market: too much emphasis has been placed on maize. - The taste is not good - My land is too small to grow cassava

Table 3.3: Table 2 Categorisation of responses to the open- ended question: ***What are the reasons why you do not grow cassava?***

Inductive categories	Participant responses
Infrastructure	- There is nowhere to sell cassava - There is no processing equipment
Characteristics of the technology	- It takes too long to mature - It is attacked by termites - Its destroyed by livestock - Do not like the taste
Farm characteristics	- My land is too small
Government policy	- There is no government support: - price and market

The farmers were asked their reasons for not growing cassava and they indicated that there was no market or processing equipment for cassava. The other reasons were that the period of maturity of cassava was too long and it was susceptible to termites. They did not like the taste of cassava and for those who had tried growing it, the cassava fields were destroyed by livestock. Other reasons included the small size of the land, which the farmers could not divide up to include cassava: and a lack of government support in terms of price and markets.

These factors were categorised as infrastructure; the characteristics of the technology; farm characteristics; and government policy. The final step of analysing the data was to integrate and synthesise the data according to collective points that addressed the purpose of the study. The data was analysed manually and this was because the researcher did not have enough time to learn how to use the qualitative data analysis software.

3.7 Ethical considerations

This research was assessed and approved as low-risk with no potential harm to the participants anticipated by the Massey University Human Ethics Committee (Appendix 2). The researcher ensured that the code of conduct of the Massey University Human Ethics Committee, which underlies any research involving human participants, was adhered to in this study (MUHEC, 2005). At the beginning of each interview, the participant was informed of the aims, methods and anticipated benefits of the research in order that they could decide to be part of the research, or decline. Oral consent was sought from the participants. The participants were informed that details which might allow them to be identified, would not be published, or made available to anybody who was not involved in the research, unless explicit consent had been given by them, or such information was already available in the public domain. The participants were also assured of confidentiality regarding the information provided. The researcher was also sensitive to the age, gender, culture, religion and social class of the participants.

3.8 Summary

A single case design was used for this study. The case area was Mazabuka district, which is a drought prone area, where government and NGOs have been promoting cassava. The selection of farmers was undertaken with the help of the Ministry of Agriculture and Cooperatives in the district in addition to NGOs working in the area. The selection of farmers took into consideration the accessibility of the farmers by the researcher.

Purposive and snowball sampling methods were used to select participants for interviews and observations. Primary data was collected through taped semi-structured interviews with farmers and key informants. Field observations were also used as a means of collecting data. Secondary data was collected by using documents from the district and national offices of the Ministry of Agriculture and Cooperatives and the NGOs. This data was analysed using qualitative data analysis. The results were then compared and contrasted with the literature and conclusions were drawn, which indicate any policy implications and/or possibilities for further research in the area.

CHAPTER 4:   CASE DESCRIPTION

4.1 Introduction

The study was undertaken in Mazabuka district (Figure 4.1), which is located 120km southwest of Lusaka the capital city of Zambia. The district is connected by a bitumen road to Lusaka, which is the largest potential market for the district. According to CSO (2000), the population of Mazabuka district was 240,116, the total urban population was 82,163 and the rural population was 157,953.

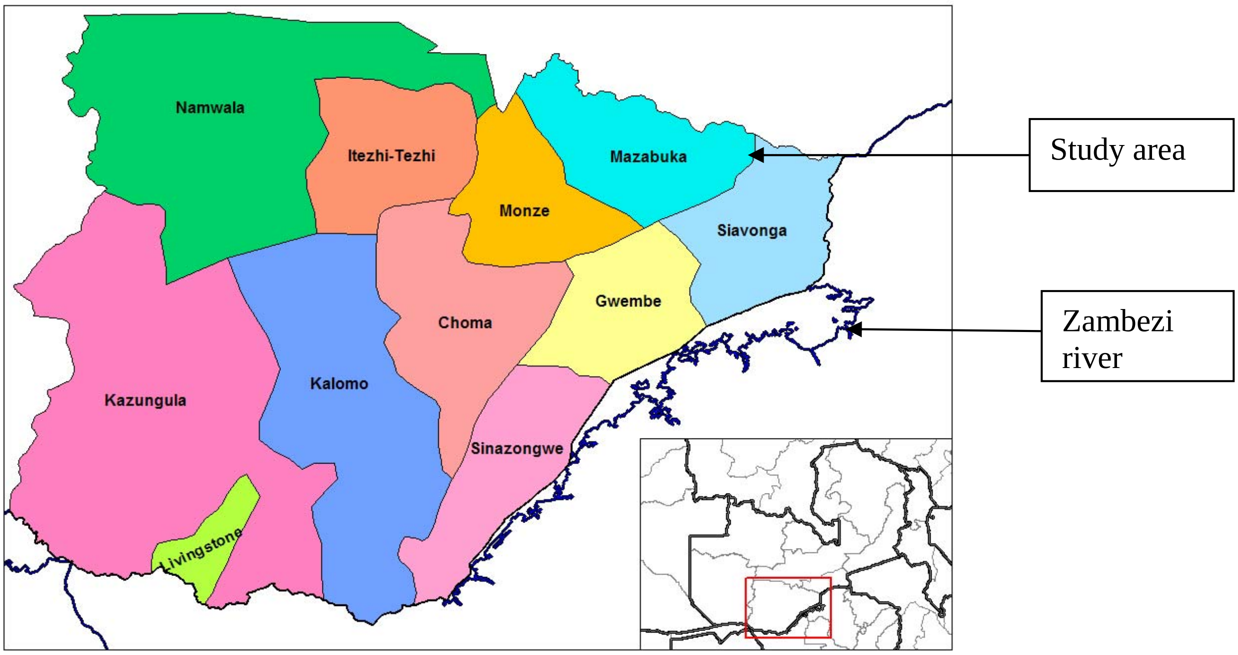

Figure 4.1: Map of southern province of Zambia showing the study area.
Source: Wikimedia Commons.

The total land area of Mazabuka is 6 444 km^2 (CSO, 2002), of which 4, 253 km^2 is arable land 2 900 km^2 is cultivated land. According to CSO (2000), state land covers 1 933 km^2 and customary land covers 4 511 km^2. The commercial farmers in the district are located on state land which has the best potential (Adams, 2003). These farmers are fortunate to be in the area with the most communications infrastructure. The smallholder farmers are located on customary land, on soils with lower potential and in areas that are less well connected to urban centres: and where marketing and physical infrastructure is less developed.

4.2 Climate

Mazabuka district lies within the tropical zone and the lowest average temperature in June and July (coldest months) is 10.2^{o}C (Met, 2002). The maximum temperatures are 32.5 degrees and these occur between December and February. The district receives less than 800mm of rainfall per annum (Met, 2002) and distribution of rainfall is erratic; drought is recurrent and under normal conditions the growing season lasts from 60 – 90 days.

The topography of Mazabuka is relatively flat and has brown red clay loams which are highly erodible. Small grains such as sorghum and millet are grown and in addition livestock rearing is successful in the district. However, maize is also grown by a large proportion of small-scale farm households in the district. Agricultural production is comparably lower than that in other areas of the country, which experience a higher rainfall (Murray & Mwengwe, 2005). Households frequently have to depend on food from outside the area, in order to meet their needs, for part of the year.

4.3 Ethnicity/poverty/literacy

The Batonga people are the largest ethnic group living in the district. This society is homogeneous amongst the ethnic groups in that they have similar access to land and the poverty levels are the same. Mazabuka district is characterized by high levels of poverty and low literacy levels (USAID, 2008). Statistics for literacy and numeracy rates in Mazabuka District were not readily available.

4.4 Livelihoods

The people's livelihood, in Mazabuka district, is mostly dependent on agriculture. Farming is generally undertaken by small holder farmers (MACO, 2007), who are generally subsistence producers of staple foods (mostly maize) with an occasional marketable surplus. These small-scale farmers depend on hand-hoe cultivation and they use little draught power usually depending on unpaid family labour (Saasa, 2003). There are 24,400 small holder farmer (households) in the district and these own less than 5ha of land each (MACO, 2007). They occupy an area of 825 km^2.

Other crops which they grow are groundnuts, sweet potatoes, Irish potatoes, cowpeas, sugar beans, cassava and bambara nuts. Livestock such as cattle, sheep and goats are important and food purchases are often financed through livestock sales; they can also gather fish from the Zambezi and Luangwa rivers and Lake Kariba. Agriculture is mainly dependent on natural irrigation, as access to water is low in many areas. Apart from farming, the farmers are also petty traders, food processors and they engage in informal labour markets. A number of them trade in buns or fritters and some have small shops (tuntemba) where they sell soap, cooking oil, sugar and cigarettes: others are involved in beer brewing.

There are 1 312 medium scale (emergent farmers) (MACO, 2007) and each family own between 5 and 20 ha. (98 km^2 in total). They produce maize and a few other cash crops for the local market. There are 94 commercial farmers in Mazabuka (MACO, 2007) and these occupy an area of 1 200 km^2. Each of these farmers own more than 20 hectares of land. Commercial farmers produce various crops for the local and export markets.

4.5 Infrastructure

The road infrastructure in the district is poorly developed. There are 37 feeder roads (413km) within the district and 12km of bitumen roads (Council, 2007). The rural areas are connected by feeder roads to the district's villages. The main market for the farmers' agriculture produce is the local communities where they live. However, some farmers sell their agriculture produce at urban markets and they transport their produce on bicycles or oxcarts. A few transport their produce using hired vehicles. There is a well established market for maize in the district. The government through the 'Food Reserve Agency' (FRA), buys maize from the farmers and stores it in its storage sheds. There are eight FRA storage sheds in the district (MACO, 2007). There is no established market for cassava and the farmers mostly sell it in within their local communities.

In the district there are a number of hammer mills which are used to process maize into maize meal. There are also few a farmers in the rural communities who own hammer mills and they operate them on a commercial basis. There are, however, no cassava processing machines. Very few of the cassava growers process it at household level. The cassava processing process is shown in Figure 4.2 to Figure 4.7. The photographs were taken from a ‘Food Crop Diversification Support Project’ (FoDiS) brochure, since the researcher could not witness any such events in the study area, during the interview period. The processing at household level is undertaken in the same way throughout the country.

The cassava is first peeled using knives (Figure 4.2).

Figure 4. 2: Fresh cassava roots and peeling
Source: Food Crop Diversification Support Project (FoDiS)

The cassava is then thoroughly washed in water. This is done using plastic drums or dishes (Figure 4.3).

Figure 4.3: Cassava being washed and cleaned
Source: Food Crop Diversification Support Project (FoDiS)

The peeled roots are placed in a drum or dish to ferment (Figure 4.4). Fermentation is complete when the roots soften. Soaking generally takes three to four days in hot weather and four to seven days in the cold season.

Figure 4.4: Cassava soaked in a dish
Source: Food Crop Diversification Support Project (FoDiS)

The cassava is then sliced using a knife or a grater (Figure 4.5).

Figure 4.5: Cassava being grated
Source: Food Crop Diversification Support Project (FoDiS)

Cassava is then placed in bags and stones are put on top of it to remove water. The cassava is then sun dried on a reed mat (Figure 4.6).

Figure 4.6: Cassava being dried on a reed mat

Source: Food Crop Diversification Support Project (FoDiS)

The dried cassava is then pounded. This is done manually using a mortar (Figure 4.7).

Figure 4.7: A man pounding cassava
Source: Food Crop Diversification Support Project (FoDiS)

In terms of agricultural extension, the district is divided into four agricultural blocks. Each block is headed by a block extension supervisor. The blocks are further sub-divided into camps which are staffed by extension officers. There are 31 camps in the Mazabuka district (MACO, 2007). Therefore, the camp is the lowest level of agricultural administration. Staff to farmer ratio is one extension worker to 787 farmers (MACO, 2007). This is high, since the average ratio in the country is one extension worker to 1700 farmers (Sheba, 1997).

4.6 Non-Governmental Organisations in Mazabuka district

There are a number of NGOs which have been working in Mazabuka district to improve food security. These include the 'Program Against Malnutrition' (PAM), PLAN Zambia and 'World Vision'. PAM has been working in drought prone areas including Mazabuka since 1995. They have been promoting and distributing cassava cuttings to small holder farmers. In 2000, PAM formed the Small Holder Access to Processing, Extension and Seeds Project (SHAPES) (Simwambana, 2005). SHAPES' overall objective was to encourage smallholder farmers to increasingly cultivate food security crops. This project was phased out in 2004 and since that time PAM has implemented a food security pack with government support.

The other NGO working in the district is Plan Zambia and its main goal is to reduce malnutrition and household poverty through improved household food security and family incomes (Ndiyoi, Simwambana, Chiona, & Ndhlovu, 2007). In order to contribute to the achievement of this goal, Plan Zambia supports increased and sustainable agricultural production, crop diversification and irrigation. In addition, it enables communities to access quality seed and it supports seed multiplication projects, in order to boost agricultural production. In the Mazabuka district, Plan Zambia, has distributed inputs such as cassava cuttings, beans and sweet potato seeds. It also gives cattle, goats, poultry and pigs to farmer groups. Due to the low adoption of the cassava in the district, Plan Zambia has stopped distributing cassava cuttings. World Vision has also been involved in the distribution of cassava cuttings to help improve food security in the area. All these NGOs employ their own people to oversee the distribution and promotion of cassava.

4.7 Government cassava program in Mazabuka

The Ministry of Agriculture started distributing cassava cuttings in the southern province including Mazabuka district, in the late 1990's (Chitundu, Haggblade, 2006). Cassava planting sticks were hauled in large trucks from the northern parts of the country, where cassava is grown for distribution to drier parts of the county. The agricultural extension officers were responsible for the distribution of the cassava cuttings to the farmers. These efforts however, did not involve any follow up activities, in order to assess the performance of the distributed cassava planting materials and the adoption by receiving households. As a result, these efforts were poorly documented at local level.

The Ministry of Agriculture then decided to change their mode of promoting cassava. In 2005, they partnered with PAM, a local NGO, in order to implement the 'Food Security Pack' (FSP) (Simwambana, 2005). This pack includes cereal seeds, legume seeds and root or tuber crop cuttings. In the Mazabuka district, the government and PAM have promoted the cultivation of cassava as a complementary crop in the case of maize failure. Due to fears of cassava poisoning from the high hydrogen cyanide content in some of the varieties, the strategy used for cassava distribution was based on the distribution of sweet varieties. The great bulk of the promotion efforts and resources have focused on distribution of cassava cuttings to food-insecure households for their subsistence consumption (Simwambana, 2005). These farmer households were identified by the agricultural extension officers who have been working in these areas.

4.8 History of Maize

Maize originated from Brazil and it came to Zambia with the Portuguese slave traders (Jones, 1959; Miracle, 1966). Due to its physical characteristics, it was the ideal crop for the slave trade. It has a hard outer shell and can withstand long storage periods without spoiling. In addition, due to its low water content, maize contains more calories per kilogram than many other crops, thus making it easy to transport large quantities of calories within small spaces.

The importance of maize in Zambia extends as far back as the 1900's during the colonial times. Maize policies in Zambia are tied to its history. In the 1900s, Zambia was colonised by the British and mining served as the main form of industrialisation (Brelsford, 1960). By the early 1920s, mining in Zambia was expanding and in order to feed the growing industrial population (i.e. non farming population), the colonial government had to look for reliable sources of food. During this time, African farming systems were disrupted by the colonial settlers (who acquired prime agriculture land) and also by the migration of males to work on the mines. As a result, the colonial government believed that African farming systems were not able to meet the country’s demand for food and they instituted policies that would encourage European settlement and maize production in the fertile plateau of southern Zambia (Colonial Report, 1946). Therefore, maize production and marketing was monopolised by the Europeans and the indigenous farmers were confined to their own traditional areas. As a result of these policies, maize became the staple food for the industrial population.

In the 1930s, there was a global recession which led to the closure of the mines and this led to a reduction in demand for maize and a decline in its price. Despite the local Zambians having lost their prime land, sales volumes (from their land) tripled from the 1920s through to the 1930s, whilst produce from the European settlers’ land only increased by 25 percent (Colonial Repor, 1951). Pressure from the Zambian farmers led the colonial government to establish the Maize Control Boards (MCBs) in 1936. This marked the beginning of Government interventions in maize marketing in Zambia. The MCBs favoured the European settlers at the expense of indigenous Zambians. The colonial government provided a market for the European settlers’ maize and they constructed a railway line that connected the European maize farms in the south with the copper mines in the central province. At the same time, Zambian farming was forcibly confined to ‘traditional areas’, in order to prevent Zambian farmers from encroaching on the European maize monopoly. Through these policies, maize became the dominant staple food in the country. These maize policies encouraged the growing of maize however; this was at the expense of other crops such as millet, sorghum and cassava.

In 1964, when Zambia obtained its independence the mainstay of its economy was copper mining (Seshamani, 1998). Revenue from the export of copper was used to finance domestic expenditure and the cost of importing food during years of shortages. During this time, maize was still the most important food crop and (since the majority of the population resided in rural areas) the post-colonial government used maize production incentives and input subsidies as a way of improving rural welfare.

In 1970, there was another global recession and the Zambian copper industry collapsed and this created problems for the government in terms of funding the maize policies (Woods, 1990). The Government 'ran out' of foreign exchange and it used loans to finance the operation of the MCBs for more than a decade. In 1980, interest rates were rising and copper prices on the international market remained low. It became increasingly difficult for the Government to service the loans required to support its MCBs. In 1992, the Zambian Government was forced by the international community into a structural adjustment programme and (as a result) it stopped its pan territorial pricing policy and reduced the amount of maize purchased from farmers. As a result of reduced intervention in maize production and marketing, farmers diversified into other crops. From 1990 to 1999 the area planted with maize declined by 22% whilst that planted with cassava increased by 65% (Zulu, Nijhoff, Jayne, & Negassa, 2000).

During the late 1990s, the Zambian people protested about the withdrawal of government support for maize production and marketing. In response to this protest, the government returned to pan-territorial pricing (in 2001) and formed the 'Food Reserve Agency' (FRA) which is a government buying agent. Its functions to purchase maize for the national food reserve at pan-territorial prices fixed by government (Seshamani, 1998). The agency operates crop purchase depots in many far distant areas of rural Zambia. This reduces farmer's transportation costs thereby enhancing their net earnings. The agency's programme also protects farmers from some socially insensitive traders who offer very low prices which work against sustained production and food security. In addition, FRA also distributes fertiliser and accepts maize as 'payment in kind' for the fertiliser (Govereh et al., 2002).

Although (at the beginning of 2001) the volumes of purchased maize had reduced, in 2005, the government became more involved in the marketing of maize (Govereh, Jayne, & Chapoto, 2008). The rationale behind renewed government involvement in maize marketing has been to provide renewed production incentives for maize and for Zambia to become self-sufficient (as a nation) in its primary staple foods. The channelling of the majority of producer and consumer subsidies into maize has been at the expense of other crops (Tschirley, Abdula, & Weber, 2006). Up to the present day, even though the magnitude of the intervention has been reduced from post-independence years, price supports and fertiliser subsidies for maize are in place, to such a degree, that nearly 50% of the total agricultural budget was devoted to the FRA and fertilizer support in 2005 (Jayne et al., 2007).

4.8.1 Uses for maize

Maize is generally used as food for people. In this case it's roasted or boiled and it is eaten on the cob. It is also processed into maize meal and made into nsima (thick dough made by boiling maize meal in hot water). Maize is also used for brewing beer and for animal consumption: There is processing infrastructure for maize in the study district.

4.9 History of Cassava

Similarly to maize, cassava (Figure 4.8) came to Africa with Portuguese slave traders during the 17th century (Sitko, 2008). It was introduced to the southern province of Zambia by the colonial government. This is unlike the northern province of Zambia where cassava was cultivated long before colonial occupation.

Unlike maize, cassava has high water content: it is bulky and it spoils quickly. These features did not make it attractive as a food crop. However, its ability to withstand drought conditions made it attractive to the colonial government, who made strenuous efforts to encourage the cultivation of famine reserve cassava gardens in every village in the southern province (Colonial Report, 1951). These strenuous efforts included penalizing farmers whose cassava gardens were smaller than a stone's throw in width (Haggblade & Zulu, 2003.). As a result of this colonial legacy, older people in southern Zambia still associate cassava with colonial oppression.

Figure 4.8: Cassava field in Mazabuka
Photographed by the researcher

4.9.1 Policies affecting Cassava

The Zambian government has influenced cassava production and marketing through its investment in research. The research stations have released two waves of varieties of cassava (Haggblade & Nyembe, 2007): the first wave in 1993 and the second in 2000 (Table 4.1). The new varieties are high yielding as compared to traditional varieties and four of the seven varieties are sweet.

Table 4.1 Cassava Varieties

Variety	Date	Yield(tons/ha)	Taste
Traditional	1600	7	Bitter
Bangweulu	1993	31	Bitter
Kapumba	1993	22	Sweet
Nalumino	1993	29	Bitter
Mweru	2000	41	Sweet
Chila	2000	35	Bitter
Tanganyika	2000	36	Sweet
Kampolombo	2000	39	Sweet

Source: Chitundu and Soenarjo (1997); Simwambana, Chiona, Chalwe, & Mutuna, 2004) .

Cassava is mainly consumed as a snack in the district. The sweet varieties are the ones being promoted in the Mazabuka district because they contain a low cyanide content, which means that the sweet cassava varieties are safe to eat as snacks and without processing, since the majority of the people do not have any knowledge regarding the processing of cassava. Sweet varieties are also said to taste better and have a good flavour as compared to the bitter varieties. Sweet varieties can also be processed into flour but the bitter varieties have an advantage in that they produce high quality flour with high content of dry matter, which can be used for human and industrial consumption (Oben & Menz, 1981).

In the Mazabuka district, there is a government research station, Nanga Research Station, which has been involved in research on vegetables, tree and plantation crops, irrigation engineering and pathology. In recent years the government has included the multiplication and distribution of cassava cuttings to its activities in the district.

4.9.2 Uses of cassava

Cassava leaves are consumed as a vegetable in the Mazabuka district (Figure 4.9). The cassava leaf is richer in protein and energy than rape, a commonly accepted Zambian vegetable (Hichaambwa, 2005). The leaves of cassava are pounded, to ensure that the cell walls of the leaf are ruptured. Once the leaves are pounded, they are cooked until they change colour.

Figure 4.9: Cassava leaves
Photographed by the researcher

Sweet cassava varieties that are sweet are consumed as fresh raw tubers (Figure 4.10) or boiled. As mentioned previously, this is the main way in which it is eaten in the district.

Figure 4.10: Fresh cassava tubers.
Photographed by the researcher

A few people dry the cassava, store it and eat it as fried and roast chips or they mill it into flour which they mix with maize meal to make nsima (Figure 4.11- figure 4.12).

Figure 4.11: Cassava chips
Source: Food Crop Diversification Support Project (FoDiS)

Figure 4.12: Packaged cassava meal
Source: Langmead & Baker Ltd (2003)

Dried cassava provides a cheap source of calories and it offers an attractive substitute for the wheat and maize products that are common amongst Zambia’s food, feed and industrial processors. In Zambia, a number of innovative farmers and feed companies are experimenting with cassava-based stock feed rations, as a means of lowering feed costs, which is the major cash expenditure in livestock production ((Haggblade & Nyembe, 2008). However this is not undertaken in the Mazabuka district since there are not any processing facilities.

4.9.3 Storage of cassava

Cassava has a shelf life of about 24-48 hours after harvest (Westby, 2002). It needs to be processed into storable form or it can be stored in the ground. The farmers in the Mazabuka district lack processing equipment and (as result) they store it in the ground. The farmers harvest the crop when it is needed. This flexibility in storage is one of the most important features, when the crop is used for food security. However, cassava roots have an optimum age after which there is loss in yield and impairment in flavour (Lancaster, Coursey, 1984). During storage, there is a danger that the roots will be infested by pathogens. There is also a danger that during storage, the land is tied up and cannot be used for other crops (Westby, 2002).

4.10 Seasonal Calendar

Maize seeds are sown in November when the rains start (Table 4.2). Since the Mazabuka district has a low rainfall, early maturing varieties which take 110 to 115 days, are planted. At planting, or two weeks after planting, basal dressing (NPK) is applied. At four to six weeks after planting, top dressing (urea or CAN) is applied. Weeding is done after planting or just before the second dose of fertiliser application and it is done manually. In February green maize is ready to be harvested. The main harvest starts in May and finishes in June. Thereafter, livestock is left in the fields to graze on the maize stalks until land preparation begins in October.

Table 3.2 Seasonal calendar for maize

	Maize planting -basal dressing	Maize-top dressing		Green harvest of maize			Main harvest		Livestock grazing			
Land Prep	Rainy Season											Land Prep
Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Year 1												

Cassava is planted at the same time as maize in November when the rains start (Table 4.3). Fertilisers and manures are usually not used by small-scale cassava growers because they cannot afford such additional inputs. Weeding is done every three to four weeks until two to three months after planting. Afterwards the canopy covers the soil and weeding is not necessary. Cassava is usually harvested 24 months after planting. Once the harvesting begins, it continues throughout the year. In the third year the cassava field is replanted.

Table 4.3 Seasonal calendar for cassava

<table>
<tr><td></td><td>Cassava planting</td><td colspan="2">Weeding</td><td colspan="3"></td><td rowspan="2">Cassava Harvested continuously</td><td rowspan="2">Replant in a staggered manner</td></tr>
<tr><td>Land Prep</td><td colspan="5">Rainy Season</td><td></td></tr>
<tr><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr- Dec</td><td>Jan- Dec</td><td>Jan- Dec</td></tr>
<tr><td colspan="7">Year 1</td><td>Year 2</td><td>Year 3</td></tr>
</table>

4.11 Comparing maize and cassava

When compared with other staple crops (cassava, sweet potato, sorghum), maize is more susceptible to drought, and its production may be hit substantially by bad weather (JAICAF, 2008). In addition, inputs such as chemical fertiliser and improved seeds are very important for achieving high yields: maize crops tend to fail without those inputs. Maize can be processed into maize meal which is used for *nsima*. Other products include beverages such as *maheu* or *munkoyo*. Maize is used as an ingredient for beer and it is also the main ingredient for *Chibuku*, a local alcoholic beverage which is generally consumed by the low-income and rural population.

The advantage of cassava is that it has a greater resistance to drought, as compared to maize. It can grow in low fertile soils and it has little requirements for inputs, including chemical fertilizers (Polson & Spencer, 1991; Prudencio & Al-Hassan, 1994). Comparing the yields of cassava and maize, cassava has an advantage in that it yields over 30 tons of fresh roots per hectare, or 9 tons of dry matter ,compared to 1.5 tons for maize (Barratt et al., 2006). Dividing by three, in order to account for a staggered harvest over a three-year cycle, this represents a 10 ton/ha annual yield, equivalent in calorie terms to three tons of maize.

Cassava can be consumed in various ways. The leaves can be eaten as a vegetable and the tubers can be eaten either as a raw snack or it can be boiled. It also has the potential for processing into foods such as cassava flour, chips and starch. Cassava meal can also be used as an additional ingredient with the staple food (nsima), which eliminates the necessity of changing traditional diets. Cassava can be consumed throughout the year in addition to providing a source of income for farmers since the harvest is not concentrate during a short period of time (JAICAF, 2008). However, cassava also has some disadvantages (JAICAF, 2008), for example, it requires a long period of growth before harvest (9-24 months), creating competition for land with other crops, where land is scarce. The bitter varieties require detoxification, and farmers need knowledge of relevant processing techniques, in order to detoxify them. Cassava quality deteriorates rapidly after harvest and it is more ‘bulky’ than maize, thus creating more difficulties for transportation and processing: Cassava does remain edible, when not harvested.

4.12 Summary

The Mazabuka district is in the southern province of Zambia. It is a drought prone area. Agriculture is the predominant activity in the district. Farming is generally undertaken by small-scale farmers and the main crop is maize. Other crops grown include groundnuts, sweet potatoes, Irish potatoes, cowpeas, sugar beans, cassava and bambara nuts. Livestock such as cattle, sheep and goats is also important for the farmers. The largest ethnic group in the district is the Batonga people. The society is homogeneous among the ethnic groups in that they have similar access to land and poverty levels are the same.

In terms of infrastructure, the Mazabuka district is poorly developed. There are few bitumen roads and most areas are connected by feeder roads. The main market for agricultural produce is the local market but a few farmers to urban markets. The transport generally used to transport the produce, is bicycles and oxcarts and a few farmers hire vehicles. The district has a number of hammer mills for processing maize but there are none for cassava.

Maize is the main crop grown but it does not do well since the area is drought prone. As a result, the government and NGOs, such as Plan International, PAM and World Vision, have been promoting the growing of cassava in the district. This has been achieved by distributing cassava cuttings and providing extension services. Cassava, which came to Africa with Portuguese slave traders during the 17th century, is being promoted, because it is drought tolerant, it does not require many inputs and it grows well in less fertile soils.

CHAPTER 5: FACTORS AFFECTING CASSAVA ADOPTION

Introduction

The purpose of this research is to inform the development of more effective strategies for improving cassava technology adoption and food security, in the southern province of Zambia. The first section offers an overview of the nature of cassava adoption in Mazabuka. The second section outlines factors that have led to the non-adoption of cassava. Several inter-related factors were found to affect adoption and these can be divided into three major categories: 1) characteristics of the technology; 2) internal factors such as personal characteristics of the farmers and their farm characteristics; and 3) external factors such as institutional factors, infrastructure, government policy and extension service delivery. Examining factors identified in the study, as affecting cassava adoption, it was found that they could be usefully categorised into internal and external factors. The third section will outline factors that have influenced farmers to adopt cassava and the constraints that are limiting the size of the benefits they could obtain from cassava.

5.1 Over view of adoption

The cassava promotion programme has been undertaken in Mazabuka district, since the late 1990s. The people involved have been the Ministry of Agriculture and Cooperatives and NGOs. The level of adoption of cassava technology was reported to be low: and this was confirmed by this research. Forty farmers were interviewed and only 10 of these had adopted cassava, whilst 30 farmers had rejected it. Amongst the non-adopters of cassava, five had adopted it in the past but, after it was eaten by termites, they stopped growing it. The farmers who had never tried it but still rejected it completely numbered 25.

Out of the 10 adopters interviewed, six had personal circumstances that differed from the other four adopters. These six adopters leased land from the Zambia Sugar Company. They were long term leases (more than 10 years) and these farmers were not allowed to grow maize, by the Zambia Sugar Company and this was a factor in influencing their choice of cassava.

5.2 Non- adopters of cassava

As mentioned previously, the non-adopters are people who are not growing cassava, when the researcher went into the field. The factors that influenced these farmers' decision not to adopt cassava can be classified into three main types: characteristics of the technology; internal factors; and external factors. These are outlined in detail in the following sections.

5.2.1 Characteristics of the cassava technology

Several characteristics of the technology were identified by those farmers who have not adopted cassava. These include the time of maturity; immediacy of reward/cash flow; storage characteristics; perceived benefits; susceptibility to termites; requirements for fencing; taste or palatability; management and input requirements; and culture and tradition.

The length of time it takes for cassava to mature was identified as a reason why the farmers did not want to grow it. The varieties available in the district were late maturing and they took approximately two years to reach maturity and begin producing roots for harvest. Some farmers believed that they had insufficient land to commit to a crop that took two years to reach maturity. For example, one of the farmers said "*My land is very small and I cannot plant both maize and cassava. Cassava takes 12 to 24 months to mature. This is too long for me to commit my land to it. If I grow cassava it would mean that the land available for me to grow other crops would be limited*".

Cash flow implications for farmers, relating to the two year production cycle of cassava, were also identified as a reason for non-adoption. Cassava took two years to reach maturity and therefore, this limited the cash flow available to the farmers. During that two year period, many of the farmers stated that they could grow two crops of maize and this would provide a much better pattern of cash flow. Some of the farmers indicated that they had to pay school fees for their children. The cash flow associated with cassava meant they would not be able to pay the school fees on time. One of the farmers stated: "*When I grow maize, I get my money within a short period* *of time and use it for any emergency as compared to a cassava grower who will be selling it over a long period of time."*

The lack of perceived benefits from cassava affected the farmers' decisions not to grow cassava. A number of non-adopters stated that they did not know of anyone who was growing cassava and making a profit. As a result they did not see the benefits of growing cassava. One of the farmers stated: "*If I have a big field of maize, I know that I will get more profit from selling it than the one who has a field of cassava."*

Cassava cannot be stored easily for a long period of time, after harvesting. However, it can be stored in the ground. The requirement for in-ground storage limited the adoption of cassava, because it meant that farmers could not use the land for alternative crops. The farmers interviewed said that the alternative crops, which were early maturing, helped them in receiving cash sooner compared to cassava, which took longer.

The susceptibility of cassava to white ants (termites), prior to sprouting, was an important factor that resulted in farmers not wanting to grow cassava. Termites were a problem throughout the case study area. These termites would eat the cassava cuttings before they sprouted. As a result, farmers were discouraged from growing it. Some of the farmers had attempted to grow cassava but, after crop failure due to termites, they did not want to grow the crop again.

The need for fencing to protect cassava fields also affected the levels of adoption. Cassava needs to be protected from livestock, which damage the plants through grazing. The non-adopters said that, after harvesting their fields of maize, they would let their livestock loose in the fields to feed on the maize stalks. This occurs at a time when the cassava crop is still actively growing and the livestock would tend to eat the cassava leaves and damage the crop.

The taste of cassava, which meant that people were not familiar with it, was one of the factors that influenced the farmers' decision not to grow cassava. Farmers who had not adopted cassava said that they were not used to the taste of the sweet cassava varieties, as a staple food. They were used to eating maize as a staple and they perceived it to taste better than cassava. They would eat the sweet cassava as a snack but they did not process it into cassava flour for making their staple food, nsima.

The non-adopters considered maize to be more management-intensive, compared with cassava. This includes planting, weeding and fertiliser application. Despite these requirements, the non-adopters still preferred to grow maize because they were familiar with the cropping practices. The non-adopters also said that maize required more inputs than cassava (fertiliser, seed, and labour for weeding and fertiliser application). These factors however, did not discourage them from growing maize since they made sure that they acquired the inputs.

The farmers' culture and tradition influenced the non-adoption of cassava. The non-adopters said that maize is used as an important gift, in addition to being an important source of food that can be given to other farmers, during traditional ceremonies and at functions. Through gift exchanges of maize, they create systems where they can reciprocate and then maintain their social relationships. The farmers also believed that, for one to be called a 'real farmer', they needed to grow maize. They attached a high value to the growing of maize. One of the farmers stated: "*Maize is what we take as contributions to funerals and people really appreciate. If I were to take other crops such as cassava, they would not appreciate it as much. As care givers we also give maize to people who are sick in the community. If they did not bring us cassava cuttings we would not miss them". They should have asked us the crops we wanted before bring cassava here."* This farmer even went on to suggest that promoting crops such as sweet potatoes and Irish potatoes would be more acceptable to them, than cassava.

5.2.2 Internal factors

The internal factors that influenced the non-adoption of cassava included the personal characteristics of their farmers and farm characteristics such as farm size. These are now outlined.

Personal characteristics of farmers

This research did not specifically explore the influence of personal characteristics, such as age, gender and education, on the adoption of cassava technology. However, the data collected did not suggest any clear link between any one or group of personal characteristics and the adoption of cassava technology. The age of the youngest farmer interviewed was 22 years, whilst the older ones were in their 60s. The level of education of the farmers varied. Some had attended primary school, whilst others had completed their secondary school education. There were an equal number of both females and males amongst the farmers interviewed.

Farm characteristics

The size of the farm, although not specifically mentioned, was a factor in influencing the farmers' decision not to grow cassava. The non- adopters on average, had three hectares of land and due to small size of their land, they felt that they could not divide their farms into different cropping systems. The adoption of cassava would mean that they would not be able to grow a diversity of other crops, like sweet potatoes and Irish potatoes.

5.2.3 External factors

Several external factors influenced the farmers' decisions not to adopt cassava technology. These included institutional factors: infrastructure; government policy; and extension service delivery.

Institutional factors

The institutional factors included membership of cooperatives, access to extension and access to inputs. Although many of the farmers were members of cooperatives or community groups, this did not positively influence their decision to adopt cassava. The non-adopters, who belonged to cooperatives, said that the cooperatives they belonged to were formed to access maize inputs and these groups did not discuss cassava as an option. A number of groups within the community were formed by NGOs, such as Plan International and initially the purpose of these groups was to give them credit for group enterprises and the purchase of goats and chickens. Later on, the NGO distributed cassava cuttings to the groups and told the people about the benefits of cassava. After undertaking monitoring and assessment, the NGO found that the farmers had not planted the cassava cuttings and thereafter, the NGO stopped distributing cassava cuttings.

Although the farmers had access to extension personnel, in most cases this did not positively influence the farmers' decision to adopt cassava. The farmers who had not adopted cassava said that they had heard about cassava as an alternative crop to maize. They were also aware of a promotion of the benefits of growing cassava which included the fact that cassava was drought tolerant, it required less fertile soils and it was more secure than maize, because it could be stored in the ground. This information was provided by NGOs and government extension agents. The NGOs, such as PAM and Care International, played a major role in disseminating information about cassava and the benefits of growing it. There were also cassava field days, which were held by NGOs. This was another forum which farmers attended in order to hear about the cassava. The farmers, however, said that they lacked information on how to correctly grow the cassava, manage it and utilise it.

The government, in conjunction with the 'Program Against Malnutrition' (PAM) and other NGOs, such as Plan International have been distributing food security packs, which consist of a cereal such as maize, a legume (beans), cassava cuttings and fertiliser to farmers. Their aim has been to promote food diversification. The farmers would, however, plant the cereal and the legumes but not plant the cassava. When the non-adopters were asked why they had not planted the free cassava cuttings, they said that the cassava cuttings were distributed too early in the year, before the rainy season. They decided to keep them but by the time the rains arrived, the cuttings were dead or they had been eaten by livestock, since they had stored them outside. A number of farmers mentioned that they had no interest in growing cassava: they were only interested in the cereal and legume in the food security pack.

Infrastructure

The infrastructure factors, which were important in influencing cassava adoption, include access to markets and access to processing equipment. Market access is one of the factors that affected these farmers' adoption decision. The non-adopters said that they did not grow cassava because there was no market for it. One farmers stated: "*I am not sure of the cassava market. I wonder if I were to grow it where I would sell it. I see those who grow it selling it to people in the community and a few customers who come from town but I do not think that market is enough*".

Access to processing equipment also affected farmers' decisions to grow cassava. In order to enhance the storage capacity of cassava outside the soil, the farmers needed to process the cassava. The non-adopters interviewed said that there was no processing equipment in the district. One of the farmers stated: "*Here in Mazabuka, I have not seen any Chigayo (hammer mill) for cassava. I only see milling equipment for maize. So even if I grow it, how can I make it into cassava meal? I do not have the capital to buy my own processing equipment.*

Government policy

Government policy also contributed to the low levels of cassava adoption. A key informant said that there was no government policy on cassava marketing in the district. The government has only been distributing cuttings and encouraging the production of cassava in the district. In contrast, the government has been providing subsidised inputs and a market for maize. In 1992, it withdrew subsidies on maize, to encourage the production of other crops, such as cassava. However, in 2005, the government reintroduced the subsidy for maize production and marketing. The rationale behind the renewed government involvement in maize marketing was to ensure that the country became self-sufficient in maize production, as a primary staple food. As a result of these policies related to maize, the farmers were more inclined to grow a crop that had full government support, in terms of production and marketing, than a crop (cassava) that did not have such support. By maintaining positive policies for which cassava is a substitute, the government has inhibited the adoption of cassava.

Extension related factors

This section describes factors which relate to the extension system. The research found that extension agents disseminated information through groups. The research also found that extension agents had constraints that affected their work. The use of farmer groups, as a method of disseminating information is outlined, in addition to factors that constrain the effectiveness of agricultural extension agents.

Use of groups

The agriculture extension officers and NGOs working in the area disseminated their information on cassava through farmers' groups. They got in touch with the contact farmer of the group, who then summoned the groups' members. Where there are no groups, they contacted the village headman or the chief. The extension agents and NGOs preferred working with groups of farmers since they were able to reach many farmers, within a short period of time. In this research, the results showed that group membership did not influence the farmers' decisions to adopt cassava.

Factors constraining agricultural extension agents

The constraints preventing extension agents from carrying out their work effectively were a lack of resources; poor road infrastructure; a lack of training; low motivation and morale; and bureaucratic processes. Of these constraints, the one which clearly influenced the adoption of cassava technology in this study was a lack of training.

The resource issues identified by extension personnel, as constraining their work, included a lack of vehicles and fuel. The extension agents said that they lacked dependable, official means of transportation, in order to fulfil their work. The motor bikes available were few and as a result, most of the personnel had no means of transport, on which to reach the farmers. The agents who had motor bikes did not have the adequate fuel needed to regularly visit the farmers. The allowance for maintaining the motor bikes was also very meagre and they had problems fixing the motor bikes, if they broke down. The settlement areas of farmers was approximately 30km or more between villages and these areas are connected by feeder roads, which are in substandard state and poorly maintained. During the rainy season, the roads became impassable. This substandard road infrastructure has also contributed to their motor bikes breaking down more often.

The extension agents said that they did not have any training on cassava production. In addition, they did not have any training materials that had been developed by research stations for teaching the recommended ways of planting cassava. Most of the farmers planted cassava by using their own methods. One of the agents stated: *I am a college graduate but I need to be trained in cassava production since it is a new crop that is being promoted. The periodic trainings can help me to update my knowledge levels as researchers on cassava are coming up with new things."* A lack of training for these extension agents resulted in farmers not having adequate information about how to grow cassava.

The extension agents had low motivation and morale. This was contributed to by a lack of supervision, poor accommodation and low salaries. One of the agents stated: "*I am not motivated to do my job as there is limited supervision from my supervisors at the district level. My supervisor visits me every 6-12 months and I receive limited feedback on my work."* The extension agents attributed the lack of supervision from their supervisors to a lack of adequate transport and fuel, for the supervisors to oversee their field work.

Substandard accommodation has also dampened the extension agents' morale to work. The government houses they lived in had no power and no running water. Low salaries also contributed to the low levels of motivation observed in the field staff. The agents mentioned that they are the poorest paid government officials. One of the extension officers stated: "*My salary is very little. It's even a wonder that I am able to survive on it. Worse still, the salaries do not come on time. Imagine this is the 10th of May and we have not yet been paid the April salaries. How can I be motivated to work like that? Instead of working, I am forced to do other things not related to my work which can bring me money so that I can feed my family."* Workers in Zambia are paid at the end of each month. The agents said that the government and others often blamed them if a programme did not succeed: however, if the programme was successful, they were never rewarded.

The bureaucratic system within government had an impact on the work of these extension agents. When farmers needed help, the agents had to report the farmers' needs to the district agricultural officer, who then reported this to the provincial agricultural officer. The provincial agricultural officer then reported to the national office and so on. Hence, despite the farmers facing problems which needed to be quickly overcome, they have to wait for a decision, from a high-level official, on how the problem should be overcome. One of the agents stated that: "*The farmers have been requesting us to ask the government to assist them with a market and processing equipment for the cassava and we have been conveying the message but nothing has been done to date. This has resulted in most farmers stopping to take the cassava promotions seriously. It has also made our work difficult as the farmers stop trusting us and think that we are not conveying their messages to the relevant authorities.*"

5.3 Adopters of Cassava technology

In the previous section, the factors that influenced the non-adoption of cassava were described. In this section, the reasons why some farmers have adopted cassava are explained, together with the means by which they have overcome many of the constraints to adoption, which were outlined in the previous section.

5.3.1 Characteristics of the technology

The farmers, who have adopted cassava, have adapted management of the crop to overcome or eliminate many of the issues that led others to reject cassava. These are now outlined.

The adopters interviewed said that the length of time to reach maturity of cassava was not an issue that prevented them from growing cassava. They divided their land in order that they had an area in cassava for two years and they had other parts of their land where they grew early maturing crops, such as maize. The farmers who adopted cassava stored it in the ground after it was ready for harvest: and they harvested it when it was needed. They accepted that this was the 'cost' of growing cassava and they knew that the piece of land planted in cassava would be unavailable for other crops, for two years.

In the early years of establishing their cassava fields, the farmers who adopted cassava relied on income from maize. Once they had established cassava within their cropping systems, they could generate satisfactory cash flow from selling both maize and cassava. In addition, the cassava had cash flow benefits above those of maize. This was due to the fact that they could harvest and sell cassava throughout the year. After the maize season was over, they could still generate a cash flow from their cassava crop. The other benefit of growing cassava was that the crop was more ‘secure’, than maize. Maize cobs were often stolen from the fields but cassava, as an underground tuber, is much more difficult to steal.

Termites were also a potential issue for farmers who adopted but they overcame this problem by using a higher planting density. This ensured that sufficient plants survived to establish a good cassava crop. An alternative approach was to plant the cassava crop during the rainy season. By the time the rains finished, the cassava would have already sprouted. Cassava planted in the rainy season has a high chance of survival, since the termites get moisture from the soil, which is their primary source of moisture: and not the cassava plant. The farmers do not use chemicals to control termites since the cost is high and they cannot afford this cost.

To overcome the problem of livestock damaging the cassava fields, the framers either fenced their fields using thorny hedges, a practice that deters livestock from eating the crop, or they used wire and stick fences to keep livestock off their cassava crops. Other farmers used goat dung, which they mix with water and pour around the perimeter of the fields, to deter livestock from grazing the cassava.

The taste of cassava was unfamiliar to the farmers and not favoured by them, but they mixed the cassava meal with the maize meal, when cooking the staple food, nsima. The nsima made from a mixture of cassava and maize meal tasted better than eating cassava nsima alone. Mixing the two also made their maize meal last longer.

Management and Input requirements

The farmers said that cassava required less management, compared to maize. Once planted, cassava only required occasional weeding and did not require very fertile soils and so they did not have to apply fertiliser. In terms of labour requirements, these farmers said that maize needed more labour for weeding and fertiliser application. It was advantageous to grow cassava for the adopters due to its low input and management requirements.

Production Risk

The adopters noted that an important reason for the adoption of cassava was its lower production risk, relative to maize. They also stated that maize required a high amount of rainfall for good yields. If there was drought, the yields were very low. Since they grew both maize and cassava, they did not worry about the low yields of maize since they had cassava to rely on. One of the farmers stated: "*I have three fields of cassava and each is about 0.03 hectares. I staggered the planting of the fields at an interval of one year. After two years of planting I started harvesting my fields one after the other. Doing this insures me against hunger in the event that maize does not do well. Cassava also helps me during the hungry season which is between December and February before the maize harvest.*"

Culture and tradition

The farmers who have adopted cassava had been prepared to change their way of life and add cassava to their farming system, given its benefits. They said that they had been growing maize alone over the past years and they had experienced periods of hunger, when there was a drought and the maize did not do well. As a result, when they heard about the drought tolerance nature of cassava, from the government, extension agents and fellow farmers, they decided to incorporate it into their farming systems.

5.3.2 Internal factors

Internal factors include personal and farm characteristics. Familiarity with the crop emerged as being important in influencing the adoption of cassava technology. This factor is now outlined.

Familiarity with the crop

Familiarity with the crop influenced the level of adoption. Some farmers who adopted cassava had migrated from cassava growing regions in Zambia. They had previously grown cassava whilst farming in these regions and after moving to the Mazabuka district they continued to do so.

Land Tenure

Land tenure was not one of the factors that influenced the adoption decision of the farmers. 60% of the cassava adopters interviewed were located on state land, which has been leased to the Zambia Sugar Company: and this company runs a sugar cane out-grower scheme. Under this scheme, the Zambia Sugar Company, in turn, leases the land to small- holder farmers who grow sugarcanes on its behalf. The sugar cane fields are far from the farmer's homesteads. They each have an area of land (0.5ha) around their homesteads but they are not allowed to grow maize, due to the conditions of their lease. The Zambia Sugar Company does not allow these farmers to grow maize near their homesteads, because maize attracts mosquitoes, due to the pollen that it produces. As a result of these restrictions, a number of these farmers had adopted cassava, to utilise this land resource. However, many of the farmers on leased land did not grow cassava, due to reasons already mentioned, such as a lack of markets and processing facilities and the long length of maturity. Conversely, there were some farmers who did not have leased land, but they still grew cassava because of the reasons already mentioned for those who had adopted cassava.

5.3.4 External factors

The external factors that contributed to the farmers' adoption of cassava include information on cassava; access to planting material; market access and the price of cassava; and access to processing equipment.

Information on cassava

The adopters received the information about cassava from the NGOs and government extension agents. Some of the farmers learnt about cassava from their friends. One farmer stated: "*I was motivated to grow cassava by my neighbour. He had a big field of cassava and I saw that he was making some income from selling cassava. I approached him and he taught me how to grow it.*"

Access to planting material

Access to planting material was not a positive influence for the non-adopters, because the planting material was distributed at the wrong time. However, the adopters overcame this problem by making small nurseries near their homesteads, which they watered until the rainy season. After the rains came, they expanded their fields. These farmers also relied on other farmers with already established fields for plant material.

Market access and price of cassava

Farmers who had adopted cassava confirmed that marketing was a problem and their market was limited to the local area. This situation occurred because transportation of fresh products from their farms, to distant and larger markets, was very costly and they could not afford it. As a result, these farmers sold their fresh cassava to nearby markets and some local customers went to the farmers to buy cassava. There were also a few customers who came from Mazabuka town in order to buy cassava. The lack of processing equipment prevented them from adding value to the cassava and selling it at a higher price. They also pointed out that processed products were easier and cheaper to transport to distant and larger markets, such as Lusaka, than the fresh cassava.

A lack of processing equipment resulted in them processing the cassava manually. They stated that manual processing was labour intensive and time consuming. As a consequence, they could only process small quantities of cassava and they had to sell the majority of the cassava in an unprocessed form. When asked what they thought about the benefits of processing cassava, one of the farmers stated: "*Processing would have helped me to store the cassava and maybe even sell it at a higher price*.' They also said that they did not have the funds to buy processing equipment.

5.4 Summary

In this chapter, the factors that affect adoption and the means with which the adopters overcame the constraints to adoption have been described. Some of the key factors that have been identified as affecting the adoption of cassava technology include the characteristics of the technology, such as the time of maturity; immediacy of reward/cash flow; storage characteristics; perceived benefits; susceptibility to termites; requirements for fencing; taste, management and input requirements; and culture and tradition. The internal factor that was identified as affecting cassava adoption was farm size while the external factors included institutional factors relating to infrastructure, government policy and extension service delivery.

CHAPTER 6: DISCUSSION

In this chapter, the factors that affect cassava adoption are compared and contrasted to the literature, in order to provide an understanding about the factors that affect adoption. The chapter begins with a classification of the case. This provides the context in which the results can be interpreted and compared to those of other studies. This is then followed by the overall trend of adoption in the district and the dual role of food crops. The factors that affect adoption will then be discussed and these will be divided into three parts. The first part will offer the characteristics of the technology, followed by the internal and external factors. Each category will be outlined followed by a discussion relating to each category. The final section will summarise the chapter.

6.1 Classification of the case

The purpose of this section is to describe the distinct characteristics of the case, in order to provide a context in which the results can be compared and interpreted, with those of other studies (Hartley, 2004; Rousseau & Fried, 2001). The case area is the Mazabuka district where farming (Table 6.1) is generally undertaken by small holder farmers, who own less than 5 ha of land (MACO, 2007). These farmers are mixed in age: young ones and old ones. The majority of the farmers are not educated and few have completed their secondary school education. There are no gender differeneces between men and women. The Batonga are the largest ethnic group in the district. Other minority groups have migrated into the district from other provinces in the country, including the cassava growing areas of the northern and north-western provinces. The society is homogeneous across the ethnic groups in that they have similar access to land and their poverty levels are the same. All of the farmers in the province own land under customary law and some lease additional land.

The small holders are subsistence producers of maize and they sell some of their maize when they have a surplus. The other crops which they grow include groundnuts, sweet potatoes, Irish potatoes, cowpeas, sugar beans, cassava and bambara nuts. They also have livestock such as cattle, sheep and goats, which they sell in times of need.

Table 6.1 Farmer and farm characteristics

Characteristic	**Case study classification**
Type of farmers	Mostly subsistence
Farm size	All have < 5 ha
Age	Mixed age
Education level	Primary and secondary education
Gender equality	Men and women
Ethnicity	Mostly Batonga with few migrants
Knowledge and experience in growing cassava	Some new migrants
Wealth	The levels of wealth are the same for all the smallholder farmers
Land tenure	All own some land and some lease additional land
Livelihood situation	Grow their own food also gain an income from trading surplus produce and informal labouring

Apart from farming, some of the farmers gain income from trading small items, or from informal labour.

The Mazabuka district falls within Agro Ecological Zone I (Table 6.2) and it receives less than 800mm of rainfall per annum (Met, 2002). The district is drought prone and since the main crop that is grown is maize, which requires high rainfall, the area constantly suffers from food shortages, particularly between December and February. In terms of infrastructure, the road infrastructure in the district is substandard and poorly developed. The main market for the farmers' agriculture produce in the district is the local communities where they live. Some farmers sell their agriculture produce to urban markets. There is a well-established market for maize in the Mazabuka district whilst for cassava the market is limited. There are a number of hammer mills which are used to process maize into maize meal. There are also a few farmers in the rural communities who own hammer mills, which process maize and they operate them on a commercial basis. There are, however, no cassava processing machines. Very few of the cassava growers process cassava at household level. Both cassava and maize planting materials are provided by the government.

Table 6.2 District and programme characteristics

Characteristic	**Case study classification**
Agro Ecological Zone I	receives < 800mm of rainfall/annum
Infrastructure:	
Road/transport	- Poor
Market access	- Maize –well developed - Cassava- limited-local
Processing facilities available locally	- Maize – yes - Cassava - no
Access to plant material for crop establishment	- Maize- yes - Cassava- yes
Programme	
Improving food security	Promoting cassava
Period of promotion	Over 10 years
Strategy	Food production- introducing a new drought tolerant crop
Extension	
Providers	Government and NGOs
Ratio of extension agents to farmer	1:787- High

The cassava programme is an intervention aimed at improving food security in the district. This programme effectively wants farmers to substitute a new crop (cassava which is drought tolerant), for their current crop (maize which is drought intolerant), which they have been growing for many years and which has a well-developed market, processing and is positively supported by Government policy initiatives. This programme has been on-going for over 10 years now. The strategy the government has been using is increasing food production through the introduction of a new crop that is drought tolerant. The government together with NGOs have been providing free cassava cuttings to the farmers. The government extension agents, in addition to NGO personnel have played an important role in the promotion of cassava. The staff member to farmer ratio is one extension worker to 787 farmers (MACO, 2007). This is high for the country, since the average ratio in the country is one extension worker to 1,700 farmers (Sheba, 1997).

The decision of the farmers to adopt cassava technology was based on comparison with the crop that it was meant to replace. The farmers compared the characteristics of maize (the existing technology) with cassava (substitute technology) (Table 6.3).

Table 6.3: Characteristics of maize and cassava

Characteristic	**Maize (**Existing technology)	**Cassava (**Substitute technology)
Growth cycle	3-6 months	24 months
Livestock	Can be grazed by cattle post-harvest	Damaged by livestock
Labour requirement	More labour intensive	Less labour intensive
Input requirements	Higher input requirement	Lower input requirement
Storage	Stored in bags	In-ground storage
Price	Guaranteed by government	Not guaranteed by government

Cassava takes approximately 24 months to grow, whilst maize only takes three to six months. After harvesting maize, farmers let their livestock graze the maize stubble, which they cannot do with cassava. Cassava fields need fencing to protect livestock from grazing it. Maize is more labour intensive than cassava. The labour is required for weeding, applying fertiliser and pesticides. In addition, maize has higher input requirements in the form of fertiliser. After harvest, maize can be stored in bags, while cassava is stored in the ground. The price of maize is also guaranteed for maize whilst for cassava it is not.

6.2 Agriculture extension, food security programmes and food security strategies

Agriculture extension has been used to enhance the improvement of food security in rural development programmes in developing countries, including Zambia (Anderson & Feder, 2004; Ison & Russell, 2000; Rivera & Qamar, 2003). Extension organisations help to devise strategies that will help with the achievement of such development programmes (Peterson, 1997).The cassava programme is an example of a programme that has used agricultural extension to improve food security in the Mazabuka district. However, the programme had little impact on improving food security since the majority of the farmers in the area did not adopt the cassava technology. This research was intended to find out how the adoption of cassava technology can be improved in order to assist the farmers improve food security. What was found was the failure of the cassava promotion programme. It was poorly designed in that there were only partial policies in terms of providing inputs and extension services. There was a lack of policy on marketing and processing of cassava.

The strategy being used to improve food security in the Mazabuka district is that of increasing food production through the growing of cassava. This research, however, found that the farmers' livelihoods were not only dependant on agriculture. Apart from farming, the farmers were petty traders and food processors and they engaged in informal labour markets. This is consistent with Gladwin (2001), who found that farmers in Africa had multiple livelihood strategies which they used to generate income: they used strategies such as agriculture, non-farm micro-enterprises and agricultural labour.

6.3 Dual role of food crops

One of the important findings in this study is that farmers in the Mazabuka district were reluctant to adopt cassava, because it would only *potentially* meet their need for food. The farmers wanted a crop that would not only meet their food needs but it would also be a source of income. The need for income for these farmers was as important as the need for food. This is consistent with Gladwin (2001) who stated that food security is a problem of low household income and poverty and not just food production. This result implies that farmers in a situation of food insecurity seek not only to grow adequate food for their family, but they also seek a source of income that will allow them to purchase other things which they need and value, including their children's education.

In the literature, cassava is defined as a new agriculture practice, which is for the majority of the farmers located in the case area (Feder, Just & Zilberman, 1985; Ogunlana, 2004). However, an important aspect of the farmers' response to cassava is related to the crop that it is designed to replace. Maize not only provides a food source for the household, it also importantly provides a source of income. It is against these two criteria that farmers judged the new crop. Although cassava has potential benefits, in terms of providing a more secure food source in times of drought, the lack of a market for cassava compared to maize influences their decision whether to adopt cassava. This government initiative is attempting to substitute a technology, which improves one aspect of the existing technology, but fails to meet the other qualities. The factors that affected adoption in this study indicate that it is difficult to separate the issue of food security and income.

6.4 Appropriateness of the cassava technology

The study has revealed that some of the reasons for non-adoption of cassava were the inappropriateness of the technology within the Mazabuka district. This is evident in the way the programme was developed. It was more of a top-down approach, rather than understanding the needs of the farmers, who were not involved in the development and dissemination of the technology that was intended to meet their needs. This is consistent with findings of Axinn (1991), that technologies that are developed without the knowledge and input of farmers were often not adopted.

When cassava technology was taken to the area, the programme only considered the fact that the Mazabuka district was a drought prone area and needed a crop that was resistant to drought, in order to improve food security. As a result, they only considered improving food security in the area. This research however, revealed that farmers were aware of other factors which they considered to be important. They compared the characteristics of cassava to the existing crop, maize. Maize had a readily available market and processing facilities and farmers could receive an income from selling it. Cassava, on the other hand, fell short of these factors and as a result, the farmers did not consider it to be appropriate. This supports the literature on the importance of understanding farmers' criteria for judging technologies in order that technologies that meet farmers' needs are developed and promoted (Guerin and Guerin, 1994; Horne & Stur, 1998).

6.5 Over view of adoption

Some farmers in the district have adopted cassava, others adopted and rejected it (due to pests) and the majority have rejected it. Sixty per cent of the adopters were located on land, which they leased from Zambia Sugar Company. Their circumstances were different from the non-adopters, in that these farmers were not allowed by the sugar company to grow maize. The adopters figured out a way of growing the cassava and overcame constraints that the non-adopters encountered. The adopters, in this case, could be called innovators. According to Rogers (1995, 2003) and Spence (1994) innovators are the first people to be persuaded that there is an advantage for them in incorporating a new technology into their way of life. In this study, however, the innovators are not just those who were persuaded of the advantages of the technology, they were innovative in finding practical solutions to overcome the same constraints that had led to the rejection of the technology by others. Some of the constraints they had to overcome had to do with the characteristics of the technology, such as the long time for maturity; storage characteristics; immediacy of reward/cash flow; susceptibility to termites; requirements for fencing; and taste.

The long time for maturity was not a problem for the adopters, since they had divided their land up, so that they had an area in cassava for two years and they had other parts of their land where they grew early maturing crops such as maize. The farmers who adopted cassava stored it in the ground, after it was ready for harvest and they only harvested cassava when it was needed. The adopters overcame the problems of cash flow by relying on income from maize, during the early years of establishing their cassava fields. Once they had established cassava within their cropping systems, they could generate an excellent cash flow from the selling of both maize and cassava.

The adopters overcame the problem of termites by using a higher planting density. In order to deter livestock from the cassava fields, the adopters fenced their fields or they used goat dung, which they mixed with water and poured around the perimeter of the field, to deter livestock from grazing the cassava. The taste of cassava was not a problem for the adopters, since they mixed the cassava meal with the maize meal, when cooking the staple food, nsima.

According to Rogers (1995), the adoption of a technology follows a normal distribution curve, over time: in this study, however, it did not. The promotion of cassava has been going on for over 10 years and the adoption rate has been low. This is consistent with the findings of Bass (1969) that diffusion of innovations does not follow a normal distribution. There are other internal and external factors influencing adoption, which make it dynamic and not evenly distributed. In addition, “Whatever the nature of the technology, not all people will accept it and of those who do, not all will adopt it at the same time” (Spence, 1994 p. 41).

6.6 Adoption process

According to Rogers (1995, 2003), over time, the potential adopters of a technology progress through five stages in the diffusion process. These are knowledge, persuasion, decision, implementation and finally, confirmation. These stages are also known as awareness, interest, evaluation, trial and adoption (Spence, 1994). This research suggests that these are a useful way to consider the farmers’ adoption process. Some of the farmers had gone from knowledge/interest into evaluation/trial or decision and then based on their own experiences either rejected or adopted it. In addition to Rogers’ (1995) stages, this research found that the farmers, who adopted the technology, actively adapted the technology package, which was originally provided to them, before adoption.

The extension agents and NGOs played an important role in making people aware of the cassava technology. Some of the farmers had developed an interest in the cassava technology, evaluated it and trialled it: but it was eaten by termites. Other non-adopters did not try it, in order to assess the potential benefits, before deciding not to adopt it: these farmers immediately rejected the cassava technology. This was due to the fact that, even though these farmers were told about the cassava technology by the extension agents, they did not feel a need for the technology. Hassinger (1959) argued that, when individuals are exposed to innovative messages they feel they do not need, such exposure will have little effect, unless the innovation is perceived as relevant to the individual's needs and it is consistent with the individual's attitudes and beliefs. The findings in this study show that an awareness of technology, an interest in it and even a trial of it, do not automatically guarantee adoption, when the technology is not appropriate to the needs of the farmers. There are also other factors that interfere with the adoption of technologies.

6.7 Factors affecting adoption

The factors that were found to influence adoption of cassava technology are consistent with some factors identified in the literature. The factors that affected cassava adoption were many, complex and interrelated. These included the characteristics of the technology (Batz et al., 1999; Ogunlana, 2004; Rogers, 1995) and internal factors, such as the personal characteristics of the adopters and their farm characteristics (Doss & Morris, 2001; Feder et al., 1985; Spence, 1994). In addition there are external factors such as institutional factors, the quality of infrastructure, government policy and extension service delivery (Eze et al., 2008; Feder et al., 1985; Kassie et al., 2009; Ogunlana, 2004). The factors that were found to be important for cassava adoption were characteristics of the technology; government policy; infrastructure; and some aspects of the extension system. These are discussed in the following section.

6.7.1 Characteristics of the cassava technology

The characteristics of technology, according to Rogers' (1995, 2003) model, that influence the adoption of technologies are relative advantage, compatibility, complexity, trialability and observability. Although the characteristics of the technology, according to Rogers (1995, 2003), were useful, they are somewhat simplistic and they do not adequately capture the complexity of the factors that contributed to the adoption of cassava in this study. Rogers' (1995, 2003) work identifies the characteristics as being discrete and he does not address the interrelated nature of these characteristics, within the adoption process. Farmers are also in different situations, which affect their adoption decisions, but this has not been reported by Rogers (1995, 2003). Guerin and Guerin (1994) noted the importance of recognising the different situations of farmers, in order to develop technologies that fit into various farmers' situations.

In this study, farmers' consideration of the relative advantage, compatibility, trialability, observability and complexity of cassava was found to capture the many attributes of the technology, influential in their decisions to adopt or not.These characteristics of the technology have also been identified by Azilla (2007) and Ogunlana (2004) as having an influence on the adoption of cassava technologies.

Relative advantage

Relative advantage of cassava was found to be a consideration influential to the farmers' decision to adopt cassava technology, because as previously stated, cassava was replacing an existing crop, maize, which farmers had grown for a long time. The literature reviewed did not address the issue of crop substitution and relative advantage. The staple crop currently grown by the farmers was maize: and this was perceived by non-adopters of cassava to have a relative advantage over cassava, in three key areas: 1) potential price and cash flow; 2) palatability; and 3) surety of crop establishment. This is consistent with the literature (Rogers, 2003) that farmers will adopt a technology that they perceive to be better.

Cassava took a long time to reach maturity (two years) and this limited the farmers' immediate cash flow, compared to maize, which matured within six months. The non-adopters also said that maize had an economic advantage, because the price was guaranteed, as compared to cassava. The taste of maize was perceived to be better than that of cassava. Cash flow and palatability were both factors that influenced the adoption of fish by households in Tanzania (Wetengere, 2009). However, fish was not a substitute food in this study. Both fish and cassava are a source of food for households: and a source of income. Farmers rely on maize for food and income and therefore, it is not surprising that palatability and income/cash flow are factors.

Where a crop technology is not a source of food the household relies on, palatability is probably not going to be as important an issue. This was the case with the new legume crops in Australia, where short term profitability was the primary motivator of adoption by farmers (Ghadim, Pannell and Burton, 2005). These findings reflect the nature of the technology and the circumstances of the adopters and their relationship with the technology. In developed countries, farmers do not tend to eat the food they produce. Palatability is not a criterion they would use in an adoption decision, compared to subsistence farmers in developing countries, where a large proportion of their crops are eaten as a staple: and a small surplus is sold.

The government support for maize and the existence of a maize market meant that the price of cassava was never likely to compete. The government support for maize also reduced the relative advantage of cassava and it contributed to its low adoption. This finding is consistent with the findings of Pannell et al. (2006) that relative advantage can be affected positively or negatively, by government policies (Pannell et al., 2006).

The non-adopters perceived the establishment of cassava as being more risky than maize, because cassava was more susceptible to termites, which destroyed the crop during establishment. The adopters overcame the risk of crop failure by having a high planting population. Conversely, cassava was considered to have a relative advantage over maize, in that it required less input and it was less likely to fail in droughts. However, these attributes were outweighed by the relative advantage of maize over cassava, for the majority of the farmers. As stated by Rogers (1995), farmers must see an advantage or expect to obtain greater utility if they are to adopt a new technology. However, as highlighted by this study, the process of assessing relative advantage is one of weighing up the pros and cons of the existing and new technology: and these may be many and varied. In this instance, cash flow and palatability were more important than input requirements and the ability to tolerate droughts.

Compatibility

According to Rogers (1995), compatibility is the degree to which an innovation is perceived as being consistent with the existing values, past experiences and needs of potential adopters. “An innovation can be compatible or incompatible with 1) sociocultural values and beliefs 2) previously introduced ideas and 3) client needs for the innovation” (Rogers 2003, p 240). Rogers, (1995) definition of compatibility has been expanded by Ogunlana (2004) to include compatibility with the existing farming system. This study, therefore, combines Rogers (2003) and Oglunlanas, (2004) definition of compatibility.

The growing of cassava was not compatible with the farmers' values. The farmers placed a strong value on the palatability of cassava. The palatability or taste of cassava was different from that of maize. Palatability was also identified earlier as being an important factor affecting the relative advantage. This shows the interrelatedness of the attributes of the technology, which has not been highlighted by Rogers (2003).

The growing of cassava was not compatible with the farmers' existing farming systems. This result is consistent with the findings of Ogunlana (2004) who found that farmers did not adopt technologies that were not compatible with their existing farming systems. The growing of cassava was quite different to growing maize. Cassava took two years to be ready for harvest and harvesting was undertaken in small portions, whilst maize took about six months to be harvested: and it was harvested all at once. The growing of cassava was also not compatible with other enterprises, such as livestock, which the farmers had. After harvesting their fields of maize, the farmers could allow their livestock into the fields, to graze on the maize stubble. They could not do this if they had planted cassava, since the cattle would eat the cassava and therefore planting cassava would require them to fence their fields. The growing of cassava was also not compatible with traditional processing techniques. It required a different processing method, which was laborious for the farmers. The growing of cassava was not also compatible with the farmers' culture and tradition and this impacted on their decision to adopt. This is consistent with Rogers (2003).

Trialability

Consistent with Rogers (1995, 2003), the ability of cassava to be tried out in a small way did encourage many farmers to initially adopt cassava and to trial it in their fields. However, in this instance, the results of the trials led to rejection and dis-adoption of the technology. This is consistent with Rogers, (2003) and Moser and Barrett (2003), who found that some individuals may discontinue the use of a technology, after being dissatisfied with the performance of the new idea or practice.

However, counter to this, some farmers identified the reasons for the failure and developed strategies to overcome them.

Observability

Observability is the level to which the outcome or benefits derived from new practices are seen by the prospective users (Rogers, 1995). The earlier the results from using a technology can be seen by the farmer, the better the chances of it being adopted (Rogers, 1995). In this case, the advantages of growing cassava were not going to be realised for two years. This length of time discouraged some of the prospective adopters, whilst some did adopt. This highlights the importance of individual farmers personal attributes in the technology adoption process.

Complexity

Complexity is the relative ease or difficulty with which the farmer can understand and use the innovation (Rogers, 1995). The production system of cassava was not considered complex as compared to that of maize. Cassava was thought to be easy to understand by the farmers and it did not require any improved skills about its cultivation: it also required fewer inputs. There were, however, some cassava post-production components, such as processing, storage and marketing that appeared to be complex for some of the farmers. The farmers needed to process cassava into various products and they did not have the knowledge of processing, or the processing equipment. In accordance with Batz et al. (1999), the number of activities that the farmers had to perform if they were to grow cassava, discouraged the prospective adopters from adopting. The farmers who had adopted cassava admitted that they had to perform a great many activities in order to process the cassava and: it was laborious.

6.7.2 Internal and external factors

The results of this research show that the factors that affected cassava adoption fitted into the internal and external framework of Chieochan, Lindley, & Dunn, (2000) and Gong & Beck, (1992). The most important factors that affected cassava adoption in this research are external factors. This is because the promotion of cassava was an initiative driven by the government and not the farmers themselves.

McNamara et al.'s (1991) categorisation of factors was only partially relevant, with farm structure and institutional characteristics being important for cassava adoption: but not managerial structure. Similarly, the categorisation of factors into human capital, production, policy and natural resource characteristics (Wu & Babcock, 1998) were also partially relevant for the cassava technology with human capital, production and policy being important: but not natural resource characteristics.

The social, economic and physical categories of factors influencing adoption (Kebede et al., 1990) were not appropriate to the factors influencing cassava adoption since there was an overlap of economic and social factors on internal and external factors, whilst physical factors (physical strength required to use the technology) were found not to be important in this study.

The research found that viewing factors in a logical framework is useful in terms of classification, but this way of viewing the phenomenon does not capture the complexity of the interactions that occur in relation to a farmer's decision to adopt cassava.

6.7.2.1 Internal factors

Internal factors identified in the literature include the personal characteristics of the farmers and their farm characteristics (Chieochan et al., 2000; Gong & Beck, 1992). The influence of the farmers personal characteristics such as age, gender and education, which have been identified in the literature as being influential in the adoption of some technologies (Feder, Lau, & Slade, 1987; Fernandez-Cornejo, Beach, & Huang, 1994; Fernandez-Cornejo & McBride, 2002; Franzel, 1999; Omonona, Oni, & Uwagboe, 2006), did not emerge as being important in this study. The reasons could be due to the fact that, there were few farmers who had adopted the technology and their circumstances were similar. There were also more important factors than the internal factors that affected their decisions to adopt cassava.

Farm characteristics

Farm characteristics likely to influence farmers' decisions to adopt a technology include farm size, labour availability and land ownership (Feder et al., 1985; Feder &

O'Mara, 1981; Ouédraogo et al., 2001). In this research, farm size and land ownership emerged as being important in the adoption of cassava technology.

Farm size

The significance of farm size in this study is not related to the relative adoption behaviour of farmers with small or large farms, as is identified in the literature (Boahene, et al., 1999; Fernandez-Cornejo, 1996; Ogunlana, 2004; Yaron, Dinar and Voet, 1992). This literature suggests that farm size is a proxy to wealth and larger farmers are more likely to adopt technologies since they can afford the cost of these technologies. In this study, farm size is simply the absolute small size of the subsistence farmers' farms and the implication of this for farmers. The farmers in this study are all small- scale farmers with small pieces of land. Their levels of wealth are low and also homogeneous. Farm size was only important in this study because some farmers thought that the size of their farms was too small and this limited the options for them, on the number of crops they could grow. They felt they could not partition their land and grow two crops rather than just maize. This result is similar to Brush & Mauricio (1992) who found that farmers with small farms are not likely to adopt new crops and diversify, because they are not able to partition their farm into different cropping systems, to grow both the new crop and other crops. However, for those who had adopted the cassava technology, this was not an issue since they divided their land and grew both cassava and maize.

Land tenure

Land tenure was not important in influencing the adoption of cassava but the requirements placed on the use of land that was leased, was a factor for the small number of farmers who had leased land. Most of the adopters interviewed were located on leased land and a few were on customary land. The farmers on leased land adopted cassava, due to the conditions of their lease. The Zambia Sugar Company, from whom they leased the land, did not allow them to grow maize near their homesteads and this 'condition' enhanced the adoption of cassava. In this instance, the term of the lease had no effect on the technology adoption, because the lease term was for over 10 years. Other studies by Feder et al. (1985); Juma et al. (2009) and Ouédraogo et al. (2001) have shown that the term of a lease can influence adoption (i.e farmers are less likely to adopt technologies that provided benefits beyond the period of their lease), but no mention has been made in the literature of the influence of the conditions of a lease on adoption of a new technology.

6.7.2.2 External factors

External factors that can influence the adoption of technology include government policy; social factors; institutional factors; the quality of infrastructure and extension service delivery (Eze et al., 2008; Feder et al., 1985; Fernandez-Cornejo & McBride, 2002; Kassie et al., 2009; Nkonya et al., 1997; Ogunlana, 2004; Zeller et al., 1998). In this study, the external factors that were important in influencing the adoption of cassava included government policy; infrastructure such as marketing and aspects of extension service delivery. These are now discussed.

Government Policy

Government policy is one of the major factors that influenced the non-adoption of cassava technology. Government policy only provided one small part of the farmers' needs, which was the provision of inputs and extension. Other policies, such as the provision of processing facilities; market infrastructure (local); transport infrastructure to supply non-local markets; and supportive policy for extension, were not there. This is similar to other studies that have shown that government policies can impact either positively or negatively on the adoption of technologies (Ahmed et al., 1992; Drechsel et al., 2005; Haggblade, 2004; Howard & Mungoma, 1996). The lack of the provision of a market and processing infrastructure could be explained by the fact that the government viewed cassava as a food crop only: and not as a source of income. This implies that there was a lack of understanding in the government of the circumstances and needs of these farmers. The results also imply that it is not only government policy which is directly related to a particular crop that is important, but the government policy which is related to an existing technology which is to be substituted.

Another important finding was that even though cassava was being encouraged to be grown in the Mazabuka district, the crop which it was supposed to replace (maize) was receiving more government support. There were processing facilities for maize and the government provided a market for it. This implies that policies that undermine the new crop that is being promoted must be avoided, when the aim is crop substitution. This is consistent with findings of a study by FAO (2001).

Institutional factors

Institutional factors include support provided by various institutions and organizations to enhance the use of new technologies (Negash, 2007). These factors include membership in an organisation (social organisation); access to extension; availability of inputs; and access to credit (Johnson & Masters, 2004; Kassie et al., 2009; Odoemenem & Obinne, 2010; Okuthe, Ngesa & Ochola, 2007; Omonona et al., 2006; E. J. Udoh & Kormawa, 2009). In this study, only access to extension emerged as important in influencing the adoption of cassava adoption. These factors are discussed in the following section.

Membership of Organisations

The literature argues that, membership of cooperatives influences the adoption of new technologies, since cooperatives serve as fora for access to information, credit and other productive inputs (Caviglia & Kahn, 2001; Deji, 2005; Kassie et al., 2009). However, in this study, it was not the case, because the farmers belonged to cooperative groups, whose objectives were not related to the cassava technology. The cooperatives to which the farmers belonged were mainly for the access of maize inputs. The growing of cassava, as an option, was not discussed at any cooperative meetings and hence, it did not assist the farmers' understanding of the crop. This result is consistent with the findings of Kuntashula, Ajayi, Phiri, Mafongoya, & Franzel (2002) who found that membership of cooperatives did not affect the adoption of improved tree fallow technology in Zambia, because the cooperatives did not discuss fallow technology.

Access to Extension

The literature clearly shows that access by farmers to extension services and therefore information about a technology, contributes to the adoption of technology, including cassava (Adesina et al., 2000; Honlonkou, 2004; Kassie et al., 2009). In this case, although farmers had some access to extension and were aware of cassava as an alternative to maize, the level of information they received about how to grow and use cassava was inadequate. Farmers were only told about the benefits of growing cassava. Nwankwo, Peters, & Bokelmann (2009) found that farmers do not adopt innovations, if they lack adequate knowledge regarding the innovation. Although this lack of information may have influenced farmers' decisions to reject cassava, some farmers did adopt cassava in spite of the inadequate information. The result implies that providing farmers with adequate information about technologies is important especially if the aim is crop substitution.

Access to inputs

Households that receive free inputs, in the form of planting materials, are more likely to adopt new technologies, than those that do not (Kohli & Singh, 1997; Mazvimavi & Twomlow, 2009). In this study, it was found that in spite of farmers being given free inputs, the level of cassava adoption remained low. This can be explained by the fact that the time, at which the inputs were distributed, was too early (before the rainy season) and by the time the rains came the cassava cuttings had dried and were no longer of use. Ehui, Lynam & Okike (2004) argue that for adoption of new technology to occur, farmers need to not only have access to the necessary inputs, but they should also be available at the correct time and place: and in the correct quantity and quality. The adopters overcame the problem of receiving the inputs early by making small nurseries near their homesteads, which they watered until the rainy season. After the rains came, they expanded their fields.

Access to credit

A substantial amount of literature shows that the availability of credit has a positive impact on adoption of technologies (Feder and Umali, 1993, Batz et al., 1999; El-Osta & Morehart, 1999). This literature states that any fixed investment, requires the use of a farmers' own or borrowed capital. In this study, however, access to credit was not important in influencing the adoption of cassava technology because the cassava inputs were distributed for free and farmers did not need credit to buy inputs.

Infrastructure

The quality of infrastructure in the Mazabuka district was another factor that influenced the farmers' decision to grow cassava. The infrastructure that was important was marketing infrastructure. The problem of marketing was also compounded by difficulties in transportation to the markets and lack of access to processing equipment. As stated earlier, farmers rely on their crops for food and a source of income therefore marketing infrastructure is important. The crop (maize) that cassava is intended to replace, has marketing infrastructure in place and as a result it can provide both food and income for the farmers.

Access to markets

A lack of market for cassava influenced its adoption as a food security crop because farmers would not receive similar levels of income from the sale of cassava as maize. The farmers originally grew maize and cassava was being promoted as a substitute crop and there was a well-developed market for maize. As a result, the farmers did not want to grow cassava, because they lacked a well-developed market for it. The market was small and the farmers only sold at the local market. They did not sell their cassava at the larger and distant markets, due to constraints such as a lack of transportation and lack of the ability to process it. The size of the local market was also small, because the locals did not have a culture of eating cassava, as a staple. Cassava was eaten as a snack and this meant that the quantities purchased by local people were also small. Due to this limited market, the farmers were concerned that, if everyone went into cassava production, the markets would become saturated and prices would fall. This is consistent with Sturm & Smith (1993) who found that a limited market led to the low adoption of alternative crops, in Bolivia.

The difficulties found transporting the harvested cassava, from the farms to the markets, was another issue which contributed to the poor marketability of cassava. This was so because cassava is a bulky crop in nature. This is consistent with the findings of Azilah (2007) in Ghana. This district has a poor road network and as a result smallholder farmers have to depend on inefficient forms of transportation. The farmers generally carry their produce on their heads to local markets. Few of the farmers have access to animal drawn carts or bicycles. Poor road nework also meant that farmers could not access the larger potential markets in the larger cities. A poor transportation system constrains the activities of farmers in terms of marketing as found by Azilah (2007) in Ghana. When a crop is bulky and difficulty to transport, this will probably be an issue. The adopters of cassava carried their produce on their heads to markets and a few used bicycles.

Cassava is a perishable product once harvested, if it is not processed. Consistent with Staal et al. (1997), the perishability of cassava reduced the time available for marketing and it raised the risks of spoilage, for farmers. The problem of perishability was worsened by the fact that farmers did not have processing and storage facilities. Once the farmers harvested their cassava, they had to sell it immediately. As highlighted by Jeon & Halos, (1991, 1992), processing reduces the bulkiness of cassava and extends its shelf life and therefore, it reduces the transportation cost, in addition to adding value to the product. Processed products can be sold at a higher price and the farmers can receive a higher income. In these studies, as in this research, cassava was not solely a food security crop: but it was both a food crop and a source of income and therefore the ability to process the crop was important, if income was to be gained from it.

Extension service delivery

Extension service delivery involves the adequate and timely provision of information to farmers in order that they can adopt new technologies, if they suit their socio-economic and agro-ecological circumstances (Anderson & Feder, 2003). Important to the delivery of extension information is the communication method; attributes of the communicators; and other factors internal to the extension system, including financial sustainability and the working conditions of staff members. In this study, it was found that extension workers had constraints, although it was not clear the extent to which the constraints affected the adoption of cassava technology. These are now discussed.

Constraints of the extension System

The constraints that were identified in this research that influenced the adoption of cassava include lack of resources such as training and weak research, extension and farmer linkages. Many authors have also noted that lack of resources also affects the extension agents morale and level of commitment for work (Anderson & Feder, 2004; Leta et al., 2004).

The extension workers conceded that they did not have any regular training in cassava technology and they also lacked training materials. Training, according to Boyd (2003) and Guerin & Guerin (1994), improves the technical knowledge of extension workers. A lack of training was a limitation to the extension agents undertaking their work effectively (Birkhaueser, evenson & Feder, 1991; Birner & Anderson, 2007) and this affected the adoption of cassava technology.

The findings in this research have revealed poor linkages between the users of the technology (farmer) and those who developed and extended it. The cassava technology was developed by the research stations and there was limited involvement from farmers. This was evident in that farmers mentioned that they should have been asked about the crops they wanted to grow, before cassava was introduced to their area. They stated they would rather be given other crops, such as sweet potatoes and Irish potatoes, than cassava. This supports the literature on the importance of ensuring that farmers are involved in the technology generation process (Axinn, 1991; Belay & Abebaw, 2004; Horne & Stur, 1998).

6.8 Summary

In this chapter, the factors that affect cassava adoption were compared and contrasted to the literature in order to provide an understanding about the factors that affect adoption. One of the important findings was that farmers needed a crop that provided both food and income. Cassava only provided farmers with food, except for a small number of farmers who were able to market locally: but a very limited market.

The factors identified, which influenced adoption, were many and interrelated. These included the characteristics of the technology; internal and external factors, such government policy; infrastructure and aspects of the extension service delivery. The characteristics of the technology, in terms of relative advantage regarding the time of maturity, susceptibility to termites, taste and price, were important in influencing the farmers' adoption decisions. Compatibility, in terms of the requirement for fencing, time of maturity and taste, also influenced their adoption decisions. In the case of observability, the benefits of cassava could not been easily observed and this discouraged the farmers from adopting it.

A lack of government policy also had an impact on the farmers' adoption decisions. The policy of government and other NGOs to provide free cassava planting materials was only a small part. Other supporting policies, such as market provision and processing infrastructure were not present. The policies to support cassava were also undermined by other policy measures in support of maize. The quality of infrastructure such as access to markets was important in influencing the farmers' adoption decision. The farmers did not have access to markets and (as a result) they were discouraged from growing cassava.

The extension service delivery was constrained by a lack of resources, such as training. As a result of this, extension agents had problems in delivering adequate information about the new technology to the farmers. The research, extension and farmer linkages were also weak. This resulted in farmers not showing a great deal of interest in adopting the cassava technology since they did not have any input into the development of the technology and it appeared to be inappropriate to their situation.

CHAPTER 7: SUMMARY AND CONCLUSION

This chapter outlines the main research findings and the conclusions of the study. In addition, sections assess the research methods used and identify further research that will build on this research.

7.1 Main research findings

The objective of the research was to identify and describe the factors that affect cassava adoption in Mazabuka district, which is located in the southern province of Zambia. A single case study approach was used in order to achieve this objective. One of the important findings of this research was that farmers did not adopt cassava because it would only meet their need for food. The farmers wanted a crop that would meet both their need for food *and* income.

The promotion of cassava was a strategy being used to increase food production in Mazabuka district. However, the research found that the livelihood of farmers in Mazabuka was not only dependant on agriculture: These farmers had other micro-enterprises and they were also engaged in informal labour.

The factors that affected adoption were many, complex and interrelated. These factors were categorised as characteristics of the technology, internal and external factors relevant to farms. The farmers compared the characteristics of cassava with those of maize, before making their adoption decisions. The characteristics of cassava which affected its adoption were taste; cash flow/immediacy of reward; time of maturity; storage characteristics; susceptibility to termites; and requirements for fencing. Internal factors that emerged as having an influence on the adoption of cassava technology where linked to farm size and land tenure.

The external factors which were important in influencing the adoption of cassava were government policy, infrastructure and extension service delivery. Government policy could be seen to be supportive of maize in terms of processing and marketing and unsupportive of cassava. Infrastructure, such as access to markets and access to processing equipment, was also an important factor. Some aspects of the extension service delivery such as training were also important.

A summary of the factors identified to have influenced the adoption of cassava is provided in Table 7.1.

Table 7.1 Factors influencing the adoption of cassava technology.

Main factor	Area of influence
Characteristics of cassava comparative with maize	- Taste - Cash flow - Time of maturity - Storage - Susceptibility to termites - Requirements for fencing
Farm characteristics	- Farm size/small - Land tenure/conditions of lease
Infrastructure	- Lack of processing facilities - Lack of marketing facilities
Government policy	- Supportive of maize-processing/marketing - Unsupportive of cassava
Extension service delivery	- Lack of training in cassava

7.2 Conclusion

The research question that guided this research initially was: how can the adoption of cassava technology be improved in order to enhance food security in southern province of Zambia? This question assumed that the cassava technology promoted by the government and NGOs was an appropriate food security crop that met the needs of the farmers. The research results showed that this was not a case of low adoption, but a case of a flawed government programme in terms of the technology it had selected to promote.

The research found as has previous studies, that the factors that affected cassava adoption were many, complex and interrelated and specific to the particular context and characteristics of the technology and farmers in southern province of Zambia. The factors that affected cassava adoption included characteristics of the technology, internal and external factors including, land tenure, government policy, marketing infrastructure and aspects of the extension service.

The characteristics of the technology that affected cassava adoption included taste; cash flow/immediacy of reward; time of maturity; storage characteristics; susceptibility to termites; and requirements for fencing.

The competing government policies that support an existing crop and not a new substitute crop undermine the likelihood of adoption of the new crop. Maize processing and marketing was supported directly through government policy, whereas cassava was not.

Consistent with other research, personal characteristics of farmers including age, education and gender were not influential in cassava adoption. The framework on factors that affect adoption in the literature focuses on factors as independent concepts and not on their interrelatedness. This is a weakness in the literature as it relates to food security technologies like cassava.

This research revealed that small-scale farmers in a food insecurity situation decide whether to adopt a new alternative food crop or not by comparing its advantages/disadvantages with the existing crop grown. The farmers compared the characteristics of maize which was an existing crop with the characteristics of cassava, a substitute crop.

Small scale farmers in southern province of Zambia rely on crops not only as a reliable food source for the household, but also as a source of income and hence evaluate all new crops in terms of these dual characteristics.

A new finding highlighted by this research is that for leased land, it is not only the time period of the lease that is important, but also the conditions imposed on the leasee's use of land that will also influence the adoption decisions of farmers. This research supports the literature that land tenure is an important factor in technology adoption.

Cassava can be grown as an alternative food source for southern province of Zambia. A small number of farmers overcame the constraints and developed practices to grow cassava successfully. However, most of the farmers who adopted and continued to grow cassava, farmed on leased land on which they are unable, as a condition of the lease, to grow maize. Further, the farmers have access to a small market for cassava. This finding supports the influence of individual innovativeness and circumstances on farmers' adoption decisions.

The research also highlights that it is not only the provision of inputs that is important for a broad scale adoption of a food security crop, but also the time at which these inputs are distributed.

In the promotion of a new substitute crop to enhance food security, if extension agents lack training and therefore knowledge in how to grow, harvest and further process the crop, this will limit farmers' knowledge of the crop and affect their adoption decisions.

7.3 Policy Implications

There are a number of policy related issues that have been raised by this research. The government has to put in place a number of policies in order to improve adoption of cassava technology and food security in southern province of Zambia. In particular, the implementation of policy needs to address the following issues:

Addressing food insecurity in the southern province of Zambia through the growing of cassava requires the development of markets and processing facilities for the crop. A deliberate policy needs to be put in place by the government. By being able to meet people's needs, both for cash and for food, cassava, like maize, would become a more viable choice for farmers. The immigrants with experience of growing cassava could be used for demonstrations.

Farmers had other sources of income, which they relied upon, apart from agriculture. They engaged in the selling of livestock and cooking oil, in addition to sugar, cigarettes and other items. This, implies that stakeholders (Government and NGOs) promoting food security should look for ways to improve returns to farmers' resources within a broader context, which includes the use of multiple livelihood strategies, such as agriculture and micro-enterprises.

The policy on cassava focussed on creating awareness about cassava and provision of plant materials but it ignored the provision of technical information. Since cassava is a new crop, there is need for extension agents to have technical knowledge on the establishment, growing, harvesting and processing of cassava so that they can provide adequate information to the farmers.

The cassava promotion program was an initiative by government to improve food security. It is top-down in nature. There is need to change the agricultural-development approach, from one that is top-down to one that is bottom-up. The adoption of a bottom-up approach by the stakeholders, in relation to food security, would require that the research agenda be determined by farmers' preferences, rather than those of the experts. This means that a needs assessment of the farmers' circumstances should be undertaken, before promotion of any crops, rather than the experts merely choosing a crop for them. An analysis of the impact of changing crops should also be undertaken.

Extension discipline needs to move away from a typology of factors approach to the development of theory that describes the complex interactions that affect the adoption of technologies

7.4 Evaluation of the research methodology

This section evaluates the research methodology, its appropriateness and what aspects could be improved, in order to answer the research question. A case study approach was found to be appropriate for identifying and describing the factors that have influenced cassava adoption, in the southern province of Zambia.

The choice of a single case study (instead of a multiple case one) was appropriate, because there was need for an in-depth understanding of the farmers' experiences. Data was collected between April and May 2010 through interviews with 40 farmers and six key informants. In addition to the interviews, documents and field observations were collected for analysis. The organisation and analysis of these materials from this case study took the researcher five months to complete. The researcher would not have been able to conduct a multiple cases study to this depth, given the time and resources that were available.

The case was selected because this was a drought prone area and cassava promotion was taking place at that time. The livelihood of the people in this area was also agriculture dependant. In addition, the researcher was also familiar with the local language. The case revealed many factors that were not indicated in the secondary documents that were gathered.

Some problems occurred during the data collection, including the fact that the farmers were busy in their fields and it was difficult for the researcher to find the farmers at home in order to schedule an appointment for the interviews. The number of non-adopters contacted was more than those who had adopted because it was difficult to find farmers who had adopted cassava since they were few in number.

The use of semi-structured interviews allowed for a guided conversation between the farmer and the researcher. These semi-structured interviews were supported by field observations and documents and this allowed the researcher to triangulate the data and collect additional useful information. The use of multiple sources of data was important for triangulation, because the researcher only spent a limited time in the field and she did not have the opportunity to revisit the field sites in order to verify the findings.

The use of tape recorders was very important to this study, due to the quantity of data involved and the informal nature of the interview process. It would have been difficult to capture the data only through the use of field notes. Some key informants were, however, not comfortable with the use of a tape recorder. The researcher reassured the key informants about the confidentiality of the interviews and she also attempted to develop a rapport with the participants, in order to gain their confidence and trust.

The purposive and snow-ball sampling method was important in helping the researcher to access farmers who had (and those who had not) adopted cassava. The use of a qualitative data analysis procedure was helpful in identifying categories and important relationships. It provided for a rigorous and systematic analysis of the data. All the tapes were repeatedly listened to, in order to provide an accurate summary of the data.

7.4 Further Research

There is a need to further investigate the factors affecting cassava adoption in the southern province of Zambia. This study was limited to the Mazabuka district and a relatively small population. Expanding the number of districts and size of samples within each district, would be extremely helpful in confirming the results presented in this research.

Further research into the livelihoods of farmers is needed, since this may help in finding various ways of addressing food security, other than solely concentrating on agriculture. Further research into the adopters of cassava technology is also important, in order to understand their reasons for doing so.

REFERENCES

Abadi Ghadim A K, Pannell D J, & Burton M P. (2005). Risk, uncertainty and learning in adoption of a crop innovation. Agricultural Economics 33, 1–9.

Abara, I., & Singh, S. (1993). Ethics and Biases in Technology Adoption: The Small-Farm Argument. *Technological Forecasting and Social Change, 43*, 289-289.

Adams, M. (2003). Land tenure policy and practice in Zambia: issues relating to the development of the agricultural sector. *Draft document for DFID, Lusaka Zambia*.

Adesina, A., & Baidu-Forson, J. (1995). Farmers perceptions and adoption of new agricultural technology:evidence from analysi in Burkina Faso and Guinea West Africa.

Adesina, A., Mbila, D., Nkamleu, G. B., & Endamana, D. (2000). Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameroon. *Agriculture, Ecosystems & Environment, 80*(3), 255-265.

Adesina, A. A., & Zinnah, M. (1993). Technology characteristics, farmers' perceptions and adoption decisions: A Tobit model application in Sierra Leone. Agricultural Economics 9: 297–311.

Agbamu, J. (2005). Problems and prospects of agricultural extension service in developing countries. *Agric. Ext. Nigeria*, 159-164.

Agwu, A., & Anyaeche, C. (2007). Adoption of improved cassava varieties in six rural communities in Anambra State, Nigeria. *African Journal of Biotechnology, 6*(2), 089-098.

Ahmed, M., A Salih, & Sanders, J. (1992). *"The Impact of Hageen-Dura I in Sudan."Paper presented at The Symposium on the Impact of Technology on Agricultural Transformation in Africa, Oct. 14-16, 1992, Washington, D.C*

Ahmed, R., & Hossain, M. (1990). *Developmental impact of rural infrastructure in Bangladesh Research Report No. 83*. Washington, DC.: Intl Food Policy Research Inst.

Anderson, J., & Feder, G. (2003). *Rural extension services*: World Bank, Agriculture and Rural Development Department and Development Research Group, Rural Development.

Anderson, J., & Feder, G. (2004). Agricultural extension: good intentions and hard realities. *The World Bank Research Observer, 19*(1), 41.

Annor, S., & Kusi, C. (2008). Factors influencing the adoption of grasscutter production in the Brong Ahafo region of Ghana. *Livestock Research for Rural Development, 20*(9).

Axinn, G. H. (1991). Potential Contribution of FSRE to Institutional Development. *Asian Farming Systems Association, 1*, 69 -78.

Azilah, M. E. (2007). *Adoption of cassava technology for sustainable livelihoods : a thesis presented in partial fulfilment of the requirements for the degree of Master of Applied Science in Rural Development at Massey University, New Zealand*

Baidu-Forson, J. (1999). Factors influencing adoption of land-enhancing technology in the Sahel: lessons from a case study in Niger. *Agricultural Economics, 20*(3), 231-239.

Baltissen, G., Wabwile, E., Kooijman, M., & Defoer, T. (2000). 'Facilitating Learning Processes in Agricultural Extension: Lessons from Western Kenya', Managing Africa's Soils, Working Paper No. 20, International Institute for Environment and Development, London.

Barratt, N., Chitundu, D., Dover, O., Elsinga, J., Eriksson, S., Guma, L., . . . Locke, F. (2006). Cassava as drought insurance: Food security implications of cassava trials in Central Zambia. *Agrekon, 45*(1), 106-123.

Bass, F. (1969). "A new product growth model for consumer durables". *Management Science., 15* 215-227.

Batz, F., Peters, K., & Janssen, W. (1999). The influence of technology characteristics on the rate and speed of adoption. *Agricultural Economics, 21*(2), 121-130.

Belay, K., & Abebaw, D. (2004). Challenges facing agricultural extension agents: A case study from south-western Ethiopia. *African Development Review, 16*(1), 139-168.

Binswanger, H., & Pingali, P. (1988). Technological Priorities for Farming in Sub-Saharan Africa. *The World Bank Research Observer,* 81-98.

Binswanger, H. P. (1989). *The policy response of agriculture. Proceedings of the World Bank Annual Conference on Development. World Bank*. Washington D.C.

Birkhaeuser, D., Evenson, R., & Feder, G. (1991). The economic impact of agricultural extension: A review. *Economic Development and Cultural Change*, 607-650.

Birner, R., & Anderson, J. (2007). How to make agricultural extension demand-driven?: The case of India's agricultural extension policy. *IFPRI discussion papers*.

Blanckenburg, P. (1982). The training and visit system in agricultural extension. A review of first experiences. *Quarterly Journal of International Agriculture, 21*(1), 6-25.

Boahene, K., Snijders, T., & Folmer, H. (1999). An Integrated Socioeconomic Analysis of Innovation Adoption The Case of Hybrid Cocoa in Ghana. *Journal of Policy Modeling, 21*(2), 167-184.

Bonabana-Wabbi, J. (2002). *Assessing factors affecting adoption of agricultural technologies: The case of integrated pest management (IPM) in Kumi district, Eastern Uganda.* Virginia Polytechnic Institute and State University.

Botha, C., & Stevens, J. (2003). The need for changes in veld management technology generation and dissemination. *South African Journal of Agricultural Extension, 28*, 108.

Boyd, B. (2003). Competencies for leaders of volunteers during the next decade: A national delphi study. *Journal of Agricultural Education, 44*(4), 47-56.

Brandner, L., & Straus, M. (1959). Congruence versus Profitability in the Diffusion of Hybrid Sorghum. *Rural Sociology, 24*, 381-383.

Brelsford, W. V. (Ed.). (1960). *Handbook to the Federation of Rhodesia and Nyasaland. Published for the Federal Information Department.* London, United Kingdom: Cassell and Company Ltd.

Brush, S., & Taylor Mauricio, R. (1992). Technology adoption and biological diversity in Andean potato agriculture. *Journal of Development Economics, 39*(2), 365-387.

Bryman, A. (2001). *Social research methods*. Oxford: Oxford University Press.

Bussolo, M., Godart, O., Lay, J., & Thiele, R. (2007). The impact of coffee price changes on rural households in Uganda. *Agricultural Economics, 37*(2-3), 293-303.

Caswell, M., Fuglie, K., Ingram, C., Jans, S., & Kascak, C. (2001). Adoption of agricultural production practices: lessons learned from the US Department of Agriculture Area Studies Project. *Agricultural Economics Reports*.

Caviglia, J., & Kahn, J. (2001). Diffusion of Sustainable Agriculture in the Brazilian Tropical Rain Forest: A Discrete Choice Analysis*. *Economic Development and Cultural Change, 49*(2), 311-333.

Central Statistical Office (CSO). (2003). Agriculture Analytical Report. Lusaka, Zambia: Republic of Zambia.

Chieochan, O., Lindley, D., & Dunn, T. (2000). Factors affecting the use of Information technology in Thai agricultural cooperatives: a work in progress. *The Electronic Journal of Information Systems in Developing Countries, 2*(0).

Chitundu, D., & Soenarjo, R. (1997). Cassava Field Production Guide. Mansa: Luapula Livelihood and Food Security Programme: Seed Multiplication Component.

Chitundu, M., Droppelmann, K., & Haggblade, S. (2006). A Value Chain Task Force Approach for Managing Private-Public Partnerships: Zamiba's Task Force on Acceleration of Cassava Utilization. *International Development Collaborative Working Papers*.

Chizuni, J. (1994). Food policies and food security in Zambia. *Nordic Journal of African Studies, 3*(1), 46-52.

Clarke, L. J., & Friedrich, T. (2000). Increasing food production and protecting resources: the role of agricultural engineers. agricultural Engineering Branch, agricultural support ASytstems Division. Food and Agriculture Organisation: Rome.

Colonial Report. (1951). Colonial Reports Northern Rhodesia: Lusaka, Northern Rhodesia: The Government Printer.

Colonial Report. (1946). Colonial Reports Northern Rhodesia: Lusaka, Northern Rhodesia: The Government Printer.

Cornejo J, & McBride W. (2002). Adoption of bioengineered crops, Agricultural Economics Report n˚ 810, Washington DC, USA. Development and Cultural Change, 34: 351.

Cramb, R. A., & Nelson, R. A. (1998). Investigating constraints to the adoption of recommended soil conservation technology in the Philippines. In F.W.T. Penning de Vries, F. Agus, and J. Kerr (eds). Soil Erosion at Multiple Scales. CAB International, Wallingford, UK. p. 99 -120.

Creswell, J. (1998). *Qualitative inquiry and research design: Choosing among five traditions*: Sage Publications, Inc.

CSO. (2000). Government of the Republic of Zambia . Main Zambia Census Report. Vol 10.

CSO. (2008). Government of Zambia:The Monthly. Volume 64, Lusaka, Zambia.

Dadi, L., Burton, M., & Ozanne, A. (2004). Duration analysis of technological adoption in Ethiopian agriculture. *Journal of Agricultural Economics, 55*(3), 613-631.

Daku, L. (2002). *Assessing farm-level and aggregate economic impacts of olive integrated pest management programs in Albania. PhD. Dissertation. Virginia Polytechnic Institute and State University.*

De Janvry, A. (1973). A socioeconomic model of induced innovations for Argentine agricultural development. *The Quarterly Journal of Economics, 87*(3), 410-435.

Deji, O. (2005). Membership of Co-Operative Societies and Adoption Behavior of Women Farmers: Implication for Rural Development. *J. Soc. Sci, 10*(2), 145-147.

Devereux, S. (1993). Goats before ploughs: dilemmas of household response sequencing during food shortages. In: Institute for Development Studies Bulletin 24, Institute for Development Studies, Brighton, UK.

Devereux, S. (1999). Making less last longer: Informal safety nets in Malawi. In: Institute for Development Discussion Paper 373, Institute for Development Studies, Brighton, UK.

Dey, I. (1993). *Qualitative data analysis: A user-friendly guide for social scientists*: Routledge.

Dorward, A., Kydd, J., Morrison, J., & Urey, I. (2004). A policy agenda for pro-poor agricultural growth. *World Development, 32*(1), 73-89.

Doss, C., Mwangi, W., Verkuijl, H., & De Groote, H. (2003). Adoption of maize and wheat technologies in East Africa: Synthesis of findings of 22 case studies. CIMMYT (International Maize and Wheat Improvement Center), Mexico.

Doss, C. R., & Morris, M. L. (2001). How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. *Agricultural Economics, 25*, 27-39.

Drechsel, P., Olaleye, A., Adeoti, A., Thiombiano, L., Barry, B., & Vohland, K. (2005). Adoption driver and constraints of resource conservation technologies in sub-saharan Africa. *Berlin: FAO, IWMI, Humbold Universitaet*.

Eade, D., & Williams, S. (1995). *The Oxfam handbook of Development and Relief* (Vol. 2). Great Britain: Oxfarm.

Ebukiba, E. (2010). Economic analysis of cassava production (farming) in Akwa Ibom State. *Agriculture and Biology Journal of North America*.

Ehui, S. K., Lynam, J., & Okike, I. (2004). Adapting social science to the changing focus of international agricultural research. Proceedings of a Rockefeller Foundation. ILCA social science research fellows workshop held at ILCA, Addis Ababa, Ethiopia, 14-18 November 1994. ILCA, Addis Ababa, Ethiopia.

El-Osta, H., & Morehart, M. (1999). Technology adoption decisions in dairy production and the role of herd expansion. *Agricultural and Resource Economics Review, 28*(1).

Eze, C., Ibekwe, U., Onoh, P., & Nwajiuba, C. (2008). Determinants Of Adoption Of Improved Cassava Production Technologies Among Farmers In Enugu State Of Nigeria. *Global Approaches to Extension Practice: A Journal of Agricultural Extension, 2*(1).

FAO. (1978–81). Report on the Agro-ecological Zones Project. Vol. 1. Methodology and results for Africa. World Soil Resources Report 48/1, Food and Agriculture Organization, Rome.

FAO. (2000). Handbook for defining and setting up a food security information and early warning system. Food and agricultural Organisation: Rome. .

FAO. (2002). Zambia food balance sheet. Rome: FAOSTAT: Food and Agriculture Organisation

Feder G, & Umali DL. (1990). The Adoption of Agricultural Innovations. A Review of Technological Forecasting and Social Change, 43, 215-239.

Feder, G., Just, R., & Zilberman, D. (1985). Adoption of agricultural innovations in developing countries: A survey. *Economic Development and Cultural Change, 33*(2), 255-298.

Feder, G., Lau, L., & Slade, R. (1987). Does agricultural extension pay? The training and visit system in northwest India. *American Journal of Agricultural Economics*, *69*(3), 677-686.

Feder, G., & O'Mara, G. (1981). Farm size and the diffusion of green revolution technology. *Economic Development and Cultural Change*, *30*(1), 59-76.

Feder, G., & Slade, R. (1984). The acquisition of information and the adoption of new technology. *American Journal of Agricultural Economics, 66*(3), 312-320.

Feder, G., & Slade, R. H. (1993). "Institutional Reform in India: The Case of Agricultural Extension." The Economics of Rural Organizations., 530-542.

Feder, G., & Umali, D. (1993). The adoption of agricultural innovations: a review. *Technological Forecasting and Social Change, 43*(3-4), 215-239.

Fernandez-Cornejo, J. (1996). The microeconomic impact of IPM adoption: theory and application. *Agricultural and Resource Economics Review, 25*(2).

Fernandez-Cornejo, J., Beach, E., & Huang, W. (1994). The adoption of IPM techniques by vegetable growers in Florida, Michigan and Texas. *Journal of Agricultural and Applied Economics*, *26*, 158-158.

Fernandez-Cornejo, J., & McBride, W. (2002). Adoption of bioengineered crops (agricultural economic report 810). *Washington, DC: United States* Department of Agriculture Economic Research Service.

Foddy W. (1996). Constructive questions for interviews and Questionnaires: Theory and Practice in Social Research. Cambridge: Cambridge University Press.

Franzel, S. (1999). Socioeconomic factors affecting the adoption potential of improved tree fallows in Africa. *Agroforestry Systems*, *47*(1), 305-321.

Gabre-Madhin, E., & Haggblade, S. (2001). Successes in African agriculture: results of an expert survey. International Food Policy Research Institute. Washington DC.

Geroski, P. (2000). Models of technology diffusion. *Research Policy, 29*(4-5), 603-625.

Ghadim, A., Pannell, D., & Burton, M. (2005). Risk, uncertainty, and learning in adoption of a crop innovation. *Agricultural Economics, 33*(1), 1-9.

Gibbs, M., Lindner, R., & Fischer, A. (1987). The discovery of innovations by farmers. *Journal of the Australian Institute of Agricultural Science, 53*, 254-261.

Gilbert, R. A., Sakala, W. D., & Benson, T. D. (2002). "Gender Analysis of a Nationwide Cropping System Trial Survey in Malawi." African Studies Quarterly 6, no.1.

Gladwin, C., Thomson, A. M., Peterson, J. S., & Anderson, A. S. (2001). Addressing food security in Africa via multiple livelihood strategies of women farmers. *Food Policy, 26*(2), 177-207.

Gladwin, C. H. (1980). A theory of real-life choice: Applications to agricultural decisions, in P. Barlett (ed.), Agricultural decision making, Anthropological contributions to rural development, pp. 45-86. Orlando: Academic Press.

Gladwin, H., & Murtaugh, M. (1980). The attentive-preattentive distinction in agricultural decision making, in P. Barlett (ed.), Agricultural decision making, Anthropological contributions to rural development, pp. 115-136. Orlando: .

Godoy, R., O'Neill, K., McSweeney, K., Wilkie, D., Flores, V., Bravo, D., . . . Cubas, A. (2000). Human capital, wealth, property rights, and the adoption of new farm technologies: The Tawahka Indians of Honduras. *Human Organization, 59*(2), 222-233.

Gong, H., & Beck, R. (1992). *Factors Affecting the Adoption of Bovine Somatotropin by Kentucky Dairy Farmers: This report is a contribution to the North Central Region Dairy Marketing Research Project NC-198, "Analyses of Selected Economic Factors Affecting the Long Run Viability of the Northern Dairy Industry."*.

Goodman, L. (1961). Snowball sampling. *The Annals of Mathematical Statistics, 32*(1), 148-170.

Gottret, M., Henry, G., & Duque, M. (1993). Going beyond dichotomous adoption: the case of cassava technology on the Atlantic Coast of Colombia. *Working Document (CIAT).*

Govereh, J. (2007). Trends in Smallholder Production in Zambia. Food Security Project Working Paper. Lusaka: Michigan State University.

Govereh, J., Jayne, T., & Chapoto, A. (2008). Assessment of alternative maize trade and market policy interventions in Zambia. *International Development Collaborative Working Papers. Retrieved 13/5/2010, fromhttp://ideas.repec.org/p/ags/midcwp/54492.html*.

Govereh, J., Jayne, T., Nijhoff, J., Shawa, J., Haantuba, H., Belemu, A., Banda, A. (2002). Developments in fertilizer marketing in Zambia: Commercial trading, government programs and the smallholder farmer *International Development Collaborative Policy Briefs:Retreived 25/5/2010, from http://econpapers.repec.org/paper/agsmidcpb/54604.htm*

Guerin, L., & Guerin, T. (1994). Constraints to the adoption of innovations in agricultural research and environmental management: a review. *Australian Journal of Experimental Agriculture, 34*(4), 549-572.

Haggblade, S. (2004). *Building on successes in African agriculture*: IFPRI Retrieved 5/5/2010, from http://www.ifpri.org/publication/building-successes-african-agriculture.

Haggblade, S., & Nyembe, M. (2007). Commercial dynamics in Zambia’s cassava value chain : Cassava Transformation in Southern Africa (CATISA). *Food Security Research Project Working Paper*.

Haggblade, S., & Nyembe, M. (2008). Commercial dynamics in Zambia’s cassava value chain. *Food Security Research Project Working Paper, 32. Retrieved on 2/2/2010, from* http://ageconsearch.umn.edu/handle/54491.

Haggblade, S., & Zulu, B. (2003.). *“The Recent Cassava Surge in Zambia and Malawi.” Conference Paper No.9* Paper presented at the InWent, IFPRI, NEPAD, CTAconference on “Successes in African Agriculture” Pretoria.

Hagmann, J., Chuma, E., Murwira, K., & Connolly, E. (1999). Putting Process into Practice: Operationalizing Participatory Extension’,Agricultural Research and Extension Network Paper No. 94, Overseas Development Institute, London.

Hahn, S. (1989). *An overview of traditional processing and utilization of cassava in Africa. Outlook on Agriculture, 18(3): 110-118.*

Hantuba, M. (2002). Agricultural in Zambia, A reality and the way forward, Economic association of Zambia.

Harper, J., Rister, M., Mjelde, J., Drees, B., & Way, M. (1990). Factors influencing the adoption of insect management technology. *American Journal of Agricultural Economics, 72*(4), 997-1005.

Hartley, J. (2004). Case study research. *Essential guide to qualitative methods in organizational research*, 323-333.

Hassinger E. (1959). "Stages in the Adoption process". Rural sociology, 24, 52-53.

Helms GL, Bailey D, & Glover TF. (1987). Government programs and adoption of conservation tillage practices on nonirrigated wheat farms. American Journal of Agricultural Economics 69, 786–795.

Henry, G., & Gottre, M. (1995). Cassava technology adoption: constraints and opportunities. *Cassava Breeding. Agronomy Research and Technology Transfer in Asia*, 410.

Hichaambwa, M. (2005). Commercialization of Cassava for Increased Food Security; Indicative trends and patterns towards commercialization. Food and Agriculture Organization of the United Nations, Lusaka, Zambia.

Hiebert LD. (1974). Risk Learning and the adoption of fertiliser responsive seed varieties. American Journal of Agricultural Economics, 56, 764-768.

Honlonkou, A. N. (2004). Modelling adoption of natural resource management technologies: The case of fallow systems. Environment and Development Economics. *9* 289–314.

Horne P, & Stür W. (1998). Participatory Approaches to Agricultural Technology Development in Sloping Lands. Retrieved 1/2/2011 from http://www.agnet.org/library/eb/462/.

Howard, J., & Mungoma, C. (1996). Zambia's stop-and-go revolution: the impact of policies and organizations on the development and spread of maize technology. *Food Security III Papers*.

IITA. (1990a). Cassava in Tropical Africa. A reference manual. Ibadan, Nigeria: International Institute of Tropical Agriculture.

IITA. (1990b). Cassava in Tropical Africa: A reference manual. International Institute of Tropical Agriculture. Ibadan, Nigeria.

Ison, R., & Russell, D. (2000). *Agricultural extension and rural development: breaking out of traditions*: Cambridge University Press.

JAICAF. (2008). *"The Maize in Zambia and Malawi":Japan Association for International Collaboration of Agriculture and Forestry*. Tokyo: Sozosha, Ltd.

Janssen, W., & Wheatley, C. (1985). Urban cassava markets:: The impact of fresh root storage. *Food Policy, 10*(3), 265-277.

Jayne, T., Govereh, J., Chilonda, P., Mason, N., Chapoto, A., & Haantuba, H. (2007). Trends in agricultural and rural development indicators in Zambia. *Food Security Country Working Papers*.

Jayne, T., Govereh, J., Mwanaumo, A., Nyoro, J., & Chapoto, A. (2002). False promise or false premise? The experience of food and input market reform in Eastern and Southern Africa. *World Development, 30*(11), 1967-1985.

Jeon, Y. W., & Halos, L. (1991). Performance of IITA-developed cassava postharvest technologies. *Paper-American Society of Agricultural Engineers (USA)*.

Jeon, Y. W., & Halos, L. (1992). Pilot testing of improved cassava processing technologies in Nigeria: A case study. *Scott, Gregory J.; Wiersema, Siert; Ferguson, Princess I.(eds.). Product development for root and tuber crops.*

Jimenez, E. (1995). Human and physical infrastructure: Public investment and pricing policies in developing countries. *Handbook of development economics, 3*, 2773-2843.

Johnson, M., & Masters, W. (2004). Complementarity and sequencing of innovations: new varieties and mechanized processing for cassava in West Africa. *Economics of Innovation and New Technology, 13*(1), 19-31.

Jones, W. O. (1959). *Manioc in Africa* (Vol.). California, USA: Stanford University Press.

Juma, M., Nyangena, W., & Yesuf, M. (2009). Production Risk and Farm Technology Adoption in Rain-fed Semi-Arid Lands of Kenya: Kenya Institute for Public Policy Research and Analysis.

Just, R. E., Zilberman, D., & Rauser, G. C. (1980). "A Putty-Clay Approach to the Distributional Effects of New Technology Under Risk." In Operations Research in Agriculture and Water Resources, edited by D. Yaron and C. Tapiero. New York: North Holland Publishing Company.

Kaimovitz, D. (1991). The Evolution of Links between Research and Extension in Developing Countries, In W.M. Rivera and D.J. Gustafson (eds.), Agricultural Extension: Worldwide Institutional Innovation and Forces for Change, Elsevier, Amsterdam, pp. 101-12.

Kambikambi, T. (2004). CROPWAT exercise report for Zambia. *project report. retrieved 3/4/2010 from: www.ceepa.co.za/docs/CDPNo39.pdf*

Kang, B., & Akinnifesi, F. (2000). *Agroforestry as alternative land-use production systems for the tropics: Natural Resource Forum 24:137-151*.

Karki, L., & Bauer, S. (2004). *Technology adoption and household food security: Analyzing factors determining technology adoption and impact of project intervention by small holder peasant in Nepal*.

Kassa, B. (1999). Constraints to effective extension work in Ethiopia : the insider' view, Alemaya University of Agriculture Dire Dava, Alemaya, Ethiopia. Rural and Tropag.

Kassie, M., Zikhali, P., Manjur, K., & Edwards, S. (2009). Adoption of Organic Farming Technologies: Evidence from Semi-Arid Regions of Ethiopia. *Working Papers in Economics*.

Kaura, M. S. (1967). *A scale to measures farmer's attitude towards Artificial Insemination* M.Sc, Punjab Agriculture University, Hassir.

Kebede, Y., Gunjal, K., & Coffin, G. (1990). Adoption of new technologies in Ethiopian agriculture: The case of Tegulet-Bulga district Shoa province. *Agricultural Economics, 4*(1), 27-43.

Kennedy, E. T., & Bouis, H. E. (1993). *Linkages between agriculture and nutrition: implications for policy and research*: Intl Food Policy Research Inst.

Ker, A. (1995). *Farming systems of the African savanna: a continent in crisis*: Idrc.

Khanna, M. (2001). Sequential adoption of site-specific technologies and its implications for nitrogen productivity: A double selectivity model. *American Journal of Agricultural Economics, 83*(1), 35-51.

Khush, G. (1999). Green revolution: preparing for the 21st century. *Genome, 42*, 646-655.

Kidd, A., Lamers, J., Ficarelli, P., & Hoffmann, V. (2000). Privatising agricultural extension: caveat emptor. *Journal of Rural Studies, 16*(1), 95-102.

Kinnucan, H., Hatch, U., Molnar, J., & Venkateswaran, M. (1990). Scale neutrality of bovine somatotropin: ex ante evidence from the Southeast. *Southern Journal of Agricultural Economics, 22*(2), 1–12.

Kohli, D., & Singh, N. (1997). The green revolution in Punjab, India: The economics of technical change. Technical report. Conference on Agriculture of the Punjab at the Southern Asian Institute, Columbia University.

Krishna, V., & Qaim, M. (2007). Estimating the adoption of Bt eggplant in India: Who Benefits from public–private partnership? *Food Policy, 32*(5-6), 523-543.

Kristjanson, P., Place, F., Franzel, S., & Thornton, P. K. (2002). Assessing research impact on poverty: the importance of farmers' perspectives. *Agricultural Systems, 72*(1), 73-92.

Kuntashula, E., Ajayi, O. C., Phiri, D., Mafongoya, P., & Franzel, S. (2002). Factors influencing farmers' decision to plant improved fallows: A study of four villages in Eastern Province of Zambia. In: Kwesiga F., Ayuk E. and Agumya A. (eds), Proceedings of the 14th Southern African Regional Review and Planning Workshop, 3–7 September 2001, Harare, Zimbabwe, ICRAF Regional Office, Harare, Zimbabwe, pp. 104–110.

Langmead & Baker Ltd. (2003). Cassava - A Market Research Study: Prepared for the Smallholder Enterprise and Marketing Programme (SHEMP), Zambia.

Langyintuo, A., & Mungoma, C. (2008). The effect of household wealth on the adoption of improved maize varieties in Zambia. *Food Policy, 33*(6), 550-559.

Latham. (1997). Human nutrition in the developing world. Food and Agriculture Organisation: Rome.

Legard, R., Keegan, J., & Ward, K. (2003). In-depth interviews. *Qualitative research practice: A guide for social sciences students and researchers,* 138-169.

Leta, R., Murray-Prior, R., & Rola-Rubzen, M. (2004). *Factors constraining extension workers effectiveness in improving horticultural production: a case study from West Timor Indonesia*.

Lubwama, F. (1999). Socio-economic and gender issues affecting the adoption of conservation tillage practices. *Conservation Tillage with animal traction. A resource book of Animal tarction Net work for Eastern and Southern Africa (ATNESA). Harare, Zimbabwe. 173pp*.

Lungu, J. (2003). *Animal Genetic Resources Policy Issues in Zambia*. Paper presented at the Strengthening Capacity for Developing Policies Affecting Genetic Resources: Rome, Italy.

Luswishi Small Scale Farmers. (1997). 'Letter to the Editor' In the Zambian Farmer, July/August 1997. 2:6, p14.

MACO. (2007). Mazabuka District Agricultural Report, Ministry of Agricultural and Cooperatives.

MAFF. (2000a). Agricultural Statistics Bulletin. Early Warning Unit, Ministry of Agricultural Food and Fisheries, Zambia.

MAFF. (2000b). Impact assessment of root and tuber research in Northern Zambia. Soils and Crops Research Branch, Farming Systems and Social Sciences Division. Chilanga, Zambia: Mt Makulu Central Research Station.

Mahajan, V., Muller, E., & Wind, Y. (2000). *New Product Diffusion Models*.

Manig, W. (1992). Development and transfer of appropriate technologies for peasant farmers in developing countries: Analysis of linkages between FSR and T and V system organizations. *Agricultural Systems, 38*(2), 209-219.

Mansfield C. (1966). Industrial Research and Technological Innovations. New York: Norton.

Marra M, Pannell DJ, & Abadi Ghadim A. (2003). The economics of risk, uncertainty and learning in the adoption of new agricultural technologies: where are we on the learning curve? Agricultural Systems 75, 215–234.

Marsh, S., Pannell, D., & Lindner, R. (2000). The impact of agricultural extension on adoption and diffusion of lupins as a new crop in Western Australia. *Australian Journal of Experimental Agriculture, 40*(4), 571-584.

Matthews-Njoku, E., & Asiabaka, C. (2004). Relationship between farmers' knowledge about improved cassava production technologies and adoption. *Journal of Agriculture and Social Research (JASR), 3*(2), 12.

Maxwell, S., & Frankenburger, T. (1992). Household Food Security: Concepts, Indicators, Measurements, UNICEF/IFAD, New York/Rome.

Mazvimavi, K., & Twomlow, S. (2009). Socioeconomic and institutional factors influencing adoption of conservation farming by vulnerable households in Zimbabwe. *Agricultural Systems*.

McNamara, K., Wetzstein, M., & Douce, G. (1991). Factors affecting peanut producer adoption of integrated pest management. *Review of Agricultural Economics, 13*(1), 129.

Mendola, M. (2007). Agricultural technology adoption and poverty reduction: A propensity-score matching analysis for rural Bangladesh. *Food Policy, 32*(3), 372-393.

Met. (2002). Zambia Meteorological Department.. Climate Summaries for Mazabuka, Zambia.

Minten, B., & Barrett, C. (2008). Agricultural technology, productivity, and poverty in Madagascar. *World Development, 36*(5), 797-822.

Miracle, M. (1966). *Maize in tropical Africa*: University of Wisconsin Press, Madison.

Miranowski JA, Hrubovak J, & Sutton J. (1991). The effects of commodity programs on resource use. In ‘Commodity and resource policies in agricultural systems’. (Eds N Bockstael, R Just) pp. 275–292. (Springer-Verlag: New York, NY).

Moser, C., & Barrett, C. (2003). The Complex Dynamics of Smallholder Technology Adoption: The Case of SRI in Madagascar.

MUHEC. (2005). Code of Ethical Conduct for Research, Teaching and Evaluations Involving Human Patrtcipants. Retrieved 30 March, 2010, from http://www.massey.ac.nz/massey/research/research-ethics/human-ethics/code/code.cfm.

Mureithi, J., & Anderson, J. R. (2002). Farmer-Extension-Research Interfaces. Chapter 11 of Rockefeller Foundation/KARI book on Agricultural Research in Kenya, Nairobi, in process.

Murray, M., & Mwengwe, E. (2005). Food security and markets in Zambia. *Humantarian Exchange Magazine*.

Muyanga, M., & Jayne, T. (2006). Agricultural extension in Kenya: practice and policy lessons. *International Development Collaborative Working Papers*.

Mwangi, J. (1998). The role of extension in the transfer and adoption of agricultural technologies. *Journal of International Agricultural and Extension Education*, 3-68.

Ndiyoi, M., Simwambana, M. S. C., Chiona, M., & Ndhlovu, M. (2007). Food Crop Diversification Support Project for Enhancement of Food Security in Zambia (FoDiS).

Negash, R. (2007). *Determinants of adoption of improved haricot bean production package in Alaba special Woreda, Southern Ethiopia.* M Sc, Haramaya University.

Nkonya, E., Schroeder, T., & Norman, D. (1997). Factors affecting adoption of improved maize seed and fertiliser in northern Tanzania. *Journal of Agricultural Economics*, *48*(1-3), 1-12.

Ntege-Nanyeenya, W., Mugisa-Mutetikka, M., Mwangi, W., & Verkuijl, H. (1997). *An assessment of factors affecting adoption of maize production technologies in Iganga District, Uganda*: Cimmyt.

Nweke, F. (1988). *Cassava production prospects in Africa*. Ibadan: Iita.

Nweke, F. I. (1994). Processing potentials for cassava production growth in Africa. COSCA Working Paper No. 11 Collaborative Study of Cassava in Africa, IITA, Ibadan, Nigeria.

Nzomoi, J., Byaruhanga, J., Maritim, H., & Omboto, P. (2007). Determinants of technology adoption in the production of horticultural export produce in Kenya. *African Journal of Business Management, 1*(5), 129-135.

Oben, D., & Menz, K. (1981). Prospects for low cyanide cassava in Nigeria. *Food Policy, 6*(3), 197-200.

Odoemenem, I., & Obinne, C. (2010). Assessing the factors influencing the utilization of improved cereal crop production technologies by small-scale farmers in Nigeria. *Indian Journal of Science and Technology, 3*(1), 180-183.

Ogunlana, E. (2004). The technology adoption behavior of women farmers: The case of alley farming in Nigeria. *Renewable Agriculture and Food Systems, 19*(1), 57-65.

Öhlmér, B., Olson, K., & Brehmer, B. (1998). Understanding farmers' decision making processes and improving managerial assistance. *Agricultural Economics, 18*(3), 273-290.

Okuthe, I., Ngesa, F., & Ochola, W. (2007). Socio-economic determinants of adoption of improved sorghum varieties and technologies among smallholder farmers in Western Kenya.

Omobolanle, O. (2007). Socio-economic conditions of peasant farmers: the case of agricultural technologies' sustainability in southwest Nigeria. *African Journal of Agricultural Research, 2*(9), 441-446.

Omonona, B., Oni, O., & Uwagboe, A. (2006). Adoption of improved cassava varieties and its welfare impact on rural farming households in Edo State, Nigeria. *Journal of Agricultural & Food Information, 7*(1), 39-55.

Orr, A., & Orr, S. (2002). *Agriculture and micro enterprise in Malawi's rural south*. London, UK.: Overseas development institute (ODI). Agricultural research & extension network (AgREN)

Ouédraogo, E., Mando, A., & Zombré, N. (2001). Use of compost to improve soil properties and crop productivity under low input agricultural system in West Africa. *Agriculture, Ecosystems and Environment, 84*(3), 259-266.

Pannell, D. (2001). *Explaining non-adoption of practices to prevent dryland salinity in Western Australia: Implications for policy. In 'Land degradation'. (Ed. A Conacher) pp. 335–346. (Kluwer:Dordrecht).*

Pannell, D., Marshall, G., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture, 46*(11), 1407-1424.

Patton, M. (2002). *Qualitative research and evaluation methods* (3rd ed.): Sage Publications, Inc.

Peters, P. (1992). Monitoring the Effects of Grain Market Liberalization on the Income, Food Security and Nutrition of Rural Households in Zomba South, Malawi. Harvard Institute for International Development, Cambridge, MA.

Peterson, W. (1997). The context of extension in Agricultural and Rural Development: In Improving Agricultural extension: In B. E. Swanson, R.P. Bentz & A.J. Sofranko (Eds), Improving Agriculture Extension: A reference Manual: (3 ed). Rome: FAO.

Polson, R., & Spencer, D. (1991). The technology adoption process in subsistence agriculture: The case of cassava in Southwestern Nigeria. *Agricultural Systems, 36*(1), 65-78.

Pretty, J. N. (1995). *Regenerating agriculture: Policies and practice for sustainability and self reliance*. London: Earthscan.

Prudencio, Y., & Al-Hassan, R. (1994). The food security stabilization roles of cassava in Africa. *Food Policy, 19*, 57-57.

Punch, K. (2005). *Introduction to social research: Quantitative and qualitative approaches*: Sage Publications Ltd.

Purcell, D. L., & Anderson, J. R. (1997). Agricultural Extension and Research: Achievements and Problems in National Systems, A World Bank Operations Evaluation Study, World Bank, Washington, DC.

Rahim M.Sail, Shah, R. B., Kobat, R. S., Ibrahim, A. G., Muhammad, A. F., Munammad, M., . . . Ha ji Wan Saleh, W. M. (1990). Smallholeders Practices Constraints and Needs to Appropriate Technology Generation, Development and Adoption. The Care of Rubber Smallholders in Peninsular Malaysia. Rubber Research Institute of Malaysia And University Pertaninan Malaysia.

Rahm, M., & Huffman, W. (1984). The adoption of reduced tillage: the role of human capital and other variables. *American Journal of Agricultural Economics, 66*(4), 405-413.

Ritchie, J., & Lewis, J. (2003). *Qualitative research practice: A guide for social science students and researchers*: Sage Publications Ltd.

Rivera, W. (1997). Agricultural extension into the next decade. *The Journal of Agricultural Education and Extension, 4*(1), 29-38.

Rivera, W. (2001). Agricultural and Rural Extension Worldwide: Options for Institutional Reform in the Developing Countries, FAO, Rome.

Rivera, W. M., & Qamar, M. (2003). *Agricultural extension, rural development and the food security challenge*: Food and Agriculture Organization of the United Nations Rome.

Rodriguez, J., Molnar, J., Fazio, R., Sydnor, E., & Lowe, M. (2008). Barriers to adoption of sustainable agriculture practices: change agent perspectives. *Renewable Agriculture and Food Systems, 24*(01), 60-71.

Rogers, E. M. (1995). *Diffusion of innovations* (4 th ed.). New York: The Free Press.

Rogers, E. M. (2003). *Diffusion of innovations* (5 ed.). New York: Free Press.

Rousseau, D., & Fried, Y. (2001). Location, location, location: Contextualizing organizational research. *Journal of Organizational Behavior, 22*(1), 1-13.

Ruane, J. (2004). *Essentials of research methods: a guide to social science research*. Maiden, USA: Blackwell publishings.

Ryan, B., & Gross, N. C. (1943). The diffusion of hybrid seed corn in two Iowa communities. *Rural Sociology, 8*, 15-24.

Saasa, O. (2003). Macro Study-Agricultural Intensification in Zambia: The Role of Policies and Policy Processes. *Lusaka, Zambia, Institute of Economic and Social Research, University of Zambia*.

Sahn, D. (1989). 1 A Conceptual Framework for Examining the Seasonal Aspects of Household Food Security. *Seasonal variability in Third World agriculture: the consequences for food security*, 1.

Saka, J., Mhone, A., Mkambira, J., Brimer, L., Bokanga, M., Mahungu, N., . . . Rosling, H. (1998). Correlation between cyanogenic glucoside content and taste of fresh cassava roots. *Tropical Agriculture 75*(1-2), 169-173.

Sanginga, P., Adesina, A. A., Manyong, V. M., Otite, O., & Dashiell, K. E. (2007). “Social impact of soybean in Nigeria’s southern Guinea savanna.”IITA: Ibadan, Nigeria.

Scheyvens, R., & Storey, D. (2003). *Development fieldwork: a practical guide*: Sage Pubns Ltd.

Schultz, T. (1975). “The Value of the Ability to Deal with Disequilibria.” Journal of Economic Literature *Journal of Economic Literature, 13*, 827-846.

Seshamani, V. (1998). The impact of market liberalisation on food security in Zambia. *Food Policy, 23*(6), 539-551.

Shampine, A. (1998). Compensating for information externalities in technology diffusion models. *American Journal of Agricultural Economics, 80*(2), 337.

Sheba, M. (1997). Using the library for problem solving in African agriculture. *Information development, 13*(3), 132-134.

Simutowe, F., & Zeller, M. (2006). The impact of access to credit on the adoption of hybrid maize in Malawi: an empirical test of an agricultural household model under credit market failure. Munich Personal RePec Archive (MPRA) Paper No. 45. September

Simwambana, M. (2005). Study on Cassava Promotion in Zambia. Study prepared for the Task Force on Accelerated Cassava Utilisation. Lusaka: AgriculturalConsultative Forum and Agricultural Support Project.

Simwambana, M., Chiona, M., Chalwe, A., & Mutuna, S. (2004). Basic Cultural Practices of Cassava (Manihot esculenta Crantz) Crop Production in Zambia. Solwezi: Ministry of Agriculture and Cooperatives.

Sitko, N. (2008). Maize, food insecurity, and the field of performance in southern Zambia. *Agriculture and human values*, *25*(1), 3-11.

Sodiya, C., Lawal-Adebowale, O., & Fabusoro, E. (2007). Effect of Private and Public Extension Services on Adoption of Promoted Cassava-Based Technologies in Ogun State, Nigeria. *Journal of Agricultural & Food Information, 8*(1), 35-47.

Spence, W. R. (1994). *Innovation. the communication of change in ideas, practices and products* (1 ed.). Great Britain: Alden Press, Oxford.

Staal, S., Delgado, C., & Nicholson, C. (1997). Smallholder dairying under transactions costs in East Africa. *World Development, 25*(5), 779-794.

Steinerb, T., Scheggc, R., & Murphy, J. (2005). *Investigating Domain Name Diffusion across Swiss Accommodation Enterprises*.

Stout, B. *Handbook of energy for world agriculture* Essex: Elsevier Science Publishers Ltd.

Sturm, L., & Smith, F. (1993). Bolivian farmers and alternative crops: Some insights into innovation adoption* 1. *Journal of Rural Studies, 9*(2), 141-151.

Swanson, B., & Samy, M. (2002). Developing an extension partnership among public, private, and nongovernmental organizations. *Journal of International Agriculture and Extension Education, 9*(1), 5-10.

Teklewold, H., Dadi, L., Yami, A., & Dana, N. (2006). Determinants of adoption of poultry technology: a double-hurdle approach. *Livestock Research for Rural Development*, *18*(3), 2006.

Tellis, W. (1997). Introduction to case study. *The qualitative report, 3*(2), 1-11.

Tesfaye, B. (2003). Understanding Farmers: Explaining Soil and Water Conservation in Konso, Wolaita and Wello, Ethiopia. Tropical Resources Management Papers No.41.Wageningen University: The Netherlands.

Thapa, S. (2009). "Gender differentials in agricultural productivity: evidence from Nepalese household data." University of Trento, Department of Economics working paper: Trento, Italy

Thomas, R. (2003). *Blending qualitative & quantitative research methods in theses and dissertations*: Corwin Pr.

Tiruneh, A. (2001). *Gender differentials in agricultural production and decision-making among smallholders in Ada, Lume, and Gimbichu Woredas of the Central Highlands of Ethiopia*: Cimmyt.

Tjornhom, J. (1995). Assessment of policies and socio-economic factors affecting pesticide use in the Philippines. MS. thesis, Virginia Polytechnic Institute and State University.

Tschirley, D., Abdula, D., & Weber, M. T. (2006). "Toward Improved Maize Marketing and Trade Policies to Promote Household Food Security in Central and Southern Mozambique." Research Report No. 60E, Ministry of Agriculture Directorate of Economics, Republic of Mozambique.

Udoh, E. J., & Kormawa, P. M. (2009). Determinants for cassava production expansion in the semi-arid zone of West Africa. *Environment, Development and Sustainability, 11*(2), 345-357.

Udoh, J. E., & Omonona, T. B. (2008). Improved Rice Variety Adoption and its Welfare Impact on Rural Farming Households in Akwa Ibom State of Nigeria. *Journal of New Seeds, 9*(2), 156-173.

Umali-Deininger, D., & Schwartz, L. (1994). *Public and private agricultural extension: beyond traditional frontiers*: World Bank Publications.

United Nations. (2010). Technology and Innovation Report: Enhacing food security in Africa through science, technology and innovation.

USAID. (2008). *The Salvation Army/Zambia Chikankata Child Survival Project: Third annual/midterm evaluation report*.

Van den Ban, A. W., & Hawkins, H. S. (1996). *Agricultural Extension* (2 ed.). Oxford: Blackwell Science Ltd.

Waller, B., Hoy, W. C., Henderson, J., Stinner, B., & Welty, C. (1998). Matching innovations with potential users, a case study of potato IPM practices. *Agriculture, Ecosystems and Environment, 70*(2-3), 203-215.

Wenham, J. (1995). *Post-harvest deterioration of cassava: A biotechnology perspective*: Food and Agriculture Organization of the United Nations.

Wiggins, S. (2000). Interpreting changes from the 1970s to the 1990s in African agriculture through village studies. *World Development, 28*(4), 631-662.

Williams, J. (2008). *Adoption of conservation agriculture in Malawi. Masters project submitted in partial fulfillment of the requirements for the Master of Environmental Management degree in the Nicholas School of the Environment of Duke University.*

Woods, A. (Ed.). (1990). *The Dynamics of Agricultural Policy and Reform in Zambia.* . Ames, IA: Iowa State University Press.

Wu, J., & Babcock, B. (1998). The choice of tillage, rotation, and soil testing practices: economic and environmental implications. *American Journal of Agricultural Economics, 80*(3), 494-511.

Yaron, D., Dinar, A., & Voet, H. (1992). Innovations on family farms: the Nazareth region in Israel. *American Journal of Agricultural Economics, 74*(2), 361-370.

Yin, R. K. (2003). *Case study research* (3 ed. Vol. 5). London, New Delhi: Sage Publications Ltd.

Zeller, M., Diagne, A., & Mataya, C. (1998). Market access by smallholder farmers in Malawi: Implications for technology adoption, agricultural productivity and crop income. *Agricultural Economics, 19*(1-2), 219-229.

Zepeda, L. (1990). Adoption of Captial Versus Management Intensive Technologies. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie, 38*(3), 457-469.

Zulu, B., Nijhoff, J., Jayne, T., & Negassa, A. (2000). Is the Glas Half-Empty or Half Full? An Analysis of Agricultural Production Trends in Zambia. *International Development Collaborative Working Papers*.

Appendix 1 Interview Guide

Interview guide for farmer participants

Personal data

- Name
- Age
- Education
- Size of the farm
- Size of household
- Land ownership

Farming systems of the farmers

- Crops grown
- Livestock kept
- Other income generating activities

Factors affecting adoption with regards to:

- Information sources
- Accessibility of planting material
- Availability
- Distance to marketing centres
- Membership of cooperatives

Post harvest handling

- Home consumption
- Processing
- marketing

Adopters of cassava

Factors that have led to adoption

Non- adopters

Factors that led to non-adoption

Interview Guide for Key Informants

Ministry of Agriculture Officers and Extension workers

Personal information

- Education
- History and involvement in cassava program
- Role in the community
- Extension approach

Factors influencing their effectiveness

- Resources available (transport, accommodation, training)
- Frequency of meeting with farmers
- Distance to farmers
- Number of farmers covered

Factors affecting adoption from perspectives of key informants

- Reasons they think farmers have adopted cassava
- Reasons they think farmers have not adopted cassava

NGOs

- The role of the NGO in the community
- How long they have been promoting cassava
- Reasons they think farmers have adopted cassava
- Reasons they think farmers have not adopted cassava

Appendix 2 Ethics Approval Letter

MASSEY UNIVERSITY

13 April 2010

Tionenji Phiri
37/23 Amesbury Street
PALMERSTON NORTH

Dear Tionenji

Re: Factors Affecting Cassava Adoption in Southern Province of Zambia

Thank you for your Low Risk Notification which was received on 7 April 2010.

Your project has been recorded on the Low Risk Database which is reported in the Annual Report of the Massey University Human Ethics Committees.

The low risk notification for this project is valid for a maximum of three years.

Please notify me if situations subsequently occur which cause you to reconsider your initial ethical analysis that it is safe to proceed without approval by one of the University's Human Ethics Committees.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

> *"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.*
>
> *If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor John O'Neill, Director (Research Ethics), telephone 06 350 5249, e-mail humanethics@massey.ac.nz".*

Please note that if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to provide a full application to one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

J. O'Neill

John G O'Neill (Professor)
Chair, Human Ethics Chairs' Committee and
Director (Research Ethics)

cc Ms Janet Reid
Institute of Natural Resources
PN433

Prof Peter Kemp, HoI
Institute of Natural Resources
PN433

Dr David Gray
Institute of Natural Resources
PN433

Massey University Human Ethics Committee
Accredited by the Health Research Council

Te Kunenga ki Pūrehuroa

Research Ethics Office, Massey University, Private Bag 11222, Palmerston North 4442, New Zealand
T +64 6 350 5573 +64 6 350 5575 **F** +64 6 350 5622
E humanethics@massey.ac.nz animalethics@massey.ac.nz gtc@massey.ac.nz
www.massey.ac.nz