ADOPTION OF CASSAVA TECHNOLOGY FOR SUSTAINABLE LIVELIHOODS

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ABSTRACT

The RTIP was part of efforts to improve the livelihood security of resource poor farmers in Ghana. The focus of the programme included the introduction of the new cassava varieties, that have the potential to improve yields and consequently to improve household income levels. However, the low level of sustained adoption of the technology has raised questions relating to the project.

A single case study was used to investigate the factors that influenced farmers' reasons for adopting and continuing or discontinuing the use of the new cassava varieties. Semi-structured interviews were used in the data collection, which was conducted between May and June 2006. Farmers who had adopted or not adopted the cassava technology and key informants, including opinion leaders and agricultural extension agents, were interviewed. A qualitative data analysis procedure was used in the analysis of the information gathered.

The findings of this study revealed many interrelated factors, which influenced the initial adoption of the cassava technology and the sustained use of the new cassava varieties. The factors, which were identified as influencing the initial adoption decision of farmers, were related to the cassava technology, whilst other external factors relating to the farmers and their circumstances, in addition to situational factors and extension contacts, were found to have influenced the sustained use of the new cassava varieties. The new cassava varieties have a proven potential to improve the livelihood security of the farmers, through income generation, provided they have access to credit, processing and reliable markets. Inadequate institutional support with resources, for extension agents, influenced the effectiveness of service delivery.

The findings suggest that development interventions, intended to improve the living standards of farm households, need to consider the complex nature of the farmers' circumstances, in their planning and implementation of the projects, if the needs of the target group are to be met.

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ABBREVIATIONS

AgSSIP - Agricultural Sub-Sector Improvement Programme

COCOBOD – Ghana Cocoa Marketing Board

FAO - Food and Agricultural Organisation

FASDEP – Food and Agriculture Sector Development Policy

GATSBY – Rice Project

GNAFF - Ghana National Association of Farmers and Fishermen

GHC – Ghana cedi

GPRS – Ghana Poverty Reduction Strategy

GTZ – German Technical Corporation

HDI – Human Development Index

IFAD - International Fund for Agricultural Development

MOFA - Ministry of Food and Agriculture

MUHEC – Massey University Human Ethics Committee

NAEP - National Agricultural Extension Project

NERICA – New Rice for Africa

NGO – Non-Governmental Organisation

NZD – New Zealand Dollar

PSI – President's Special Initiatives

RTIP - Root and Tuber Improvement Programme

UNDP – United Nations Development Programme

USAID – United States Agency for International Development

USD – United States of America Dollar

Exchange rate: 1 US Dollar = 9,622.70 Ghanaian Cedi

1 Ghanaian Cedi (GHC) = 0.0001039 US Dollar (USD)

1 New Zealand Dollar = 6,549.88 Ghanaian Cedi

1 Ghanaian Cedi (GHC) = 0.0001527 New Zealand Dollar (NZD) (Ghanaweb.com, 2007a).

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Chapter One: Introduction

This chapter outlines the purpose and significance of this research and highlights the importance of agriculture in the development of the economy of Ghana. It also introduces the Root and Tuber Improvement Programme. In addition, the problem statement and the research question and objectives are outlined, together with a description of the thesis structure.

1.1 Research Background

Ghana is a West African country situated on the Greenwich Meridian near the equator. The total land area is 238,686 km^2 and the terrain is made up of plains and scrubland, rain forest and savannah (Ghanaweb.com, 2006a). The country has a tropical climate with an average temperature of 30° C. It has a population of about 22,409,572 million people, with an estimated growth rate of 2.07% (2006) (CIA-The World Factbook, 2007).

Ghana is classified amongst the world's low-income economies (World Bank, 2006). The real growth rate of the Gross Domestic Product was estimated at 5.7% in 2006 (CIA-The World Factbook, 2007) and the Gross National Income per capita was approximately US$450 in 2005 (World Bank, 2006). In 2003, the UNDP Human Development Index (HDI) ranked Ghana as 129th amongst 175 countries, with a HDI of 0.567 (IFAD, 2005b). It was estimated that nearly 40% of Ghanaians were living below the poverty line, with the majority being rural households (IFAD, 2005b). For this reason, concerted efforts were being made to ensure sustained poverty alleviation was achievable, through strategies targeted at the rural sector (IFAD, 2005b; MOFA, 2002a).

In 1994, as part of a long term goal of alleviating poverty and Ghana becoming a middle income country by the year 2020, a National Development Policy Framework termed, 'Vision 2020', was developed by the Government of Ghana (IFAD, 2005b). In line with 'Vision 2020', an Interim Poverty Reduction Paper was formulated for 2000-2002. By building and improving on this paper, the Ghana Poverty Reduction Strategy (GPRS) for 2003-2005 was then developed (IFAD, 2005b). The priorities set out in this strategy included rural development and the modernisation of agriculture. The focus of these

priorities included: infrastructural development in collaboration with other ministries, government departments and agencies; development and dissemination of appropriate technology; and a general improvement in the extension service delivery (IFAD, 2005b; MOFA, 2002b). In accordance with the GPRS, MOFA developed the Food and Agriculture Sector Development Policy in 2002, with a sector-wide approach to development in the agriculture sector, in order to help and enhance poverty reduction (IFAD, 2005b; MOFA, 2002b).

Agriculture plays a major role in sustaining Ghana's economy and most importantly the livelihoods of a significant proportion of the population (MOFA, 1999). Over 90% of the country's food needs are obtained from agriculture (AFAMIN, 2002; MOFA, 1999) and in addition, agriculture contributes significantly to the provision of raw materials for agro-based industries and export products, thus generating valuable foreign exchange earnings (AFAMIN, 2002; MOFA, 2002a; Owusu-Ansah, Owusu, & Ofcansky, 2005). In 2006, approximately 37.3% of Ghana's GDP came from agriculture, with the remainder coming from industry (25.3%) and services (37.5%) (CIA-The World Factbook, 2007). An estimated 70% of Ghana's labour force gains employment and income from agriculture (AFAMIN, 2002; MOFA, 2002a; Owusu-Ansah *et al.*, 2005). Agriculture is particularly important for farm households because they rely on it to provide food security, poverty alleviation, income generation and employment opportunities (MOFA, 1999).

In an effort to improve their livelihoods and to cope with difficult situations, farm households will engage in livelihood adaptation (Carswell, 1997; Ellis, 1998, 2000a, 2000b; Scoones, 1998). The types of strategies, generally adopted to improve livelihoods, include agricultural intensification and extensification, migration and diversification into off-farm activities (Carswell, 1997; Ellis, 1998, 2000a, 2000b; Scoones, 1998). Due to their continuous reliance on agriculture, households may intensify their agricultural production systems by the adoption of new practices and improved crop varieties and/or an increase in the level of inputs, in order to produce more from the same amount of land (Carswell, 1997; Ellis, 1998, 2000a, 2000b; Scoones, 1998). Alternatively, they can extend their production by accessing more land for production (Carswell, 1997; Ellis, 1998, 2000a, 2000b; Scoones, 1998). In the process of diversification, households or individuals tend to engage in off-farm and non-farm activities, in order to make a living. Members of a household can also migrate to a new environment, within or outside the

country, as a strategy to help cope with the situation, through remittances to those members who remain (Carswell, 1997; Ellis, 1998, 2000a, 2000b; Orr & Mwale, 2001; Scoones, 1998).

Cassava is a staple food crop in Ghana, which is grown in most parts of the country, with its cultivation being mainly carried out by subsistence smallholder farmers (MOFA, 2002c). It is estimated that about 1.55 million farm households cultivate approximately 726000 hectares of cassava, with yields of around 11.8 tonnes per hectare (MOFA, 2002c). Cassava is one of the root and tuber crops that support the economy. Approximately, 40% of the Gross Domestic Product comes from the total contribution of agriculture (Ghanaweb.com, 2006b), with cassava alone contributing 22.5% of the total agricultural GDP (Ghanaweb.com, 2004).

Cassava is described as a famine crop (Prudencio & Alhassan, 1994) or last resort food crop (Howeler, Oates, & Allem, 2001), because it is so important in ensuring food security (Saka et al., 1998). Some farm households produce cassava to bridge the gap between seasons of hunger or to serve as a food reserve, which they can then fall back on during times of drought, pest infestation or general crop failure (Prudencio & Alhassan, 1994). Others engage in its cultivation in order to raise their household income levels, when there is demand and therefore marketing opportunities for the crop (Prudencio & Alhassan, 1994). The adoption and use of improved varieties of cassava is a livelihood strategy that has the potential to sustain and improve farm household livelihoods in Ghana (AFAMIN, 2002; IFAD, 2007; MOFA, 2002c). The production and sale of cassava and its products can also help to ensure sustainable and increased income for farmers and processors (Ghanaweb.com, 2000b; IFAD, 2007).

As part of efforts to improve the livelihoods of rural households, the Government, in collaboration with the International Fund for Agricultural Development (IFAD), instigated the Root and Tuber Improvement Programme (RTIP) in January 1999, in order to develop and distribute improved varieties of root and tuber crops for farmers and particularly cassava (IFAD, 2004, 2005b; MOFA, 2002c). The aim was to increase farm production and thereby increase food security and household incomes for rural households. The RTIP was implemented by the Ministry of Food and Agriculture (MOFA), with a number of

internal departments, including the Extension Services Directorate playing a role (IFAD, 2004; MOFA, 2002c).

The primary roles of MOFA include the formulation of appropriate agricultural policies, planning and co-ordination and the monitoring and evaluation of agricultural programmes, generally for the economic development of the country (Ghanaweb.com, 2007b). The ministry aims to improve agriculture productivity and therefore increase household incomes and employment opportunities for Ghanaians. In addition, this will effectively contribute to the balance of payments and the establishment of an effective linkage between agriculture and industry (Ghanaweb.com, 2007b). MOFA is structured in accordance with the government's decentralisation policy and the national secretariat is in charge of finance and administration, policy planning, monitoring and evaluation at the national level, together with human resource development and management, statistics, information and public relations and research activities (Ghanaweb.com, 2007b).

The regional and district directors of agriculture (DDAs) oversee the administration and management of the regional and district agricultural development units, respectively (Ghanaweb.com, 2007b; MOFA, 2003). The DDAs also implement district level agricultural development programmes and establish and update district profiles (MOFA, 2003). Staff development programmes are designed and implemented in collaboration with Regional Directors of Agriculture (RDAs), whilst ensuring that the training and technical support for agricultural extension agents are carried out effectively (MOFA, 2003). In addition, DDAs also liaise with related organisations in the implementation of agricultural programmes at the district level.

At the administrative level below the DDA, is the district development officer (DDO), who works to ensure the timely implementation of planned activities. The DDOs monitor and evaluate the programme of work for the extension agents (MOFA, 2003). They also help with the establishment of the district profiles and assist the extension agents to develop work calendars and programmes and they are also involved in data collection (MOFA, 2003). The agricultural extension agents are in charge of operational areas within the district. The operational areas consist of a number of communities, which are selected on the basis of their nearness to each other, thus allowing easy access by extension agents. Selection is also based on the size of the traditional area, within which the communities

are located (MOFA, 2005b; Personal communication with District Director of MOFA, 2006).

The extension agents advise farmers in the use of appropriate technologies and educate them in farm management practices (MOFA, 2003). Extension agents also identify farmer groups and establish working contacts with these groups. They assist in problem identification and provide advice relating to possible solutions. Field days and farm demonstrations for farmers are facilitated by the extension agents, who also carry out data compilation which can help forecast pest or disease occurrences (MOFA, 2003). The MOFA seeks to respond to the specific needs of farmers, particularly the rural poor, as part of poverty alleviation efforts (MOFA, 2003). These concerted efforts are being made to ensure that farmers use environmentally sustainable agricultural practices and to help increase productivity in the sector, whilst encouraging private sector participation in extension service delivery (MOFA, 2003). The RTIP was one of the livelihood improvement programmes implemented by the MOFA, to promote the use of new cassava varieties, in order to ensure food security and increased incomes for farm households (MOFA, 2002c, 2004c).

Although, the RTIP has achieved some of the goals for its implementation, the adoption rate by farmers, for the introduced cassava technology, has been low in some districts where the programme has been implemented (Asafo, 2001). Also, it has been identified that the degree to which the resource poor farmer (the majority of whom are women) have benefited from the programme needs to be reviewed (IFAD, 2005b). This is because, even though the programme was to target resource poor farmers, their level of participation in the programme has not been encouraging for the programme organisers (IFAD, 2004, 2005b, 2007; RTIP, 2004).

The aim of nation-wide multiplication and distribution of the new cassava varieties was achieved. Further research has been conducted and some other new cassava varieties have been released for multiplication, with work continuing on the development of even more new types (IFAD, 2005b). In addition, integrated pest management practices were extended to the farmers, whilst farmer field schools were also set up to enhance training and improve skills. A number of agricultural service staff were given in-service training, in order to increase efficiency in the service delivery of MOFA and to improve farmer

access to extension agents (RTIP, 2004). However, other aspects of the programme, particularly regarding poverty reduction and post-harvest handling, where processing and marketing are major issues, are still to be reviewed (IFAD, 2005b). Generally, women feature predominantly in cassava processing and also in other non-farm self-employment activities, which are a major source of income and livelihood sustainability (RTIP, 2004). Conversely, less progress was made with women's participation in the RTIP activities (IFAD, 2005b).

The IFAD Office of Evaluation conducted an interim evaluation of the RTIP (IFAD 2005). Based on this interim evaluation, the Core Learning Partners, in an agreement at the completion point, recommended a second phase of the RTIP (RTIP, 2004). This Core Learning Partners committee supervised the interim evaluation (IFAD 2005b). Their recommendations were for more attention to be directed towards the development of other root and tuber crops, besides cassava. They also recommended that the monitoring and evaluation staff should be strengthened in the various regions of the country (IFAD, 2005b).

According to the interim evaluation, although some of the original objectives were achieved, attention to other goals needed to be reorganised. The efforts made towards poverty alleviation were found to be inadequate (IFAD, 2004). The interim evaluation also indicated that farmers faced difficulties in marketing the excess output of cassava in the local markets. Therefore, it recommended a reduction in the pace of distributing the plant materials (IFAD, 2004). The project partners did not consent to this idea but they agreed to continue the distribution of plant materials at the same pace, in the expectation of a positive change in future prices and demand for outputs (IFAD, 2005b).

The interim evaluation further suggested a move from the research and production of root and tuber crops to the processing and marketing components, as part of the poverty alleviation strategy (IFAD, 2005b). In this way, issues relating to post-harvest handling and marketing could be addressed, whilst new marketing opportunities would be developed (IFAD, 2004). It also recommended that an analysis should be conducted on the cost of plant material multiplication, at the same time determining a new approach to multiplication and distribution of the new varieties (IFAD, 2004). It suggested that the analysis should be done in cognisance of the farmers' needs and preferences, storage and

processing options, the absorption capacity of local markets and other alternatives to the marketing of products locally (IFAD, 2004, 2005b). This would then help provide more varieties to meet the farmers' needs and settings.

As stated previously, the rationale underlying the cassava technology dissemination programme was to help increase incomes and ensure food security, thus leading to sustained livelihoods for the people, particularly, resource poor farmers (IFAD, 2007; MOFA, 2002c). The programme helped to develop and make available plant material, for new cassava varieties, which were then distributed to farmers for planting (IFAD, 2005b). However, the level of adoption was lower than expected. It was estimated that the technology adoption rate in Ghana is low, particularly for technologies requiring external input applications, although farmers had become aware of the technologies (Amezah & Hesse, 2003).

Studies on cassava technology adoption, in some other African countries such as Nigeria and Malawi, also indicated a low level of adoption (Johnson & Masters, 2004; Johnson, Masters, & Preckel, 2005; Polson & Spencer, 1991). Although, the interim evaluation reports provide some indication of the difficulties within the RTIP programme, there is still limited understanding as to what has influenced the adoption and non-adoption of the new cassava varieties by farmers.

1.2 Problem Statement

A significant proportion of rural farm households in Ghana are living below the poverty line. In an effort to improve the livelihoods of rural households, the Government of Ghana and IFAD initiated the Root and Tuber Improvement Programme in 1999. The introduction of new cassava varieties was a key element of the programme. Notwithstanding the potential benefits from the adoption of the new varieties, adoption rates by farmers have been lower than expected. There is little information relating to the reasons for the low levels of adoption, which could assist in the improvement of the programme in the future.

1.3 Research Question

How can the District level transfer and adoption of cassava technology be improved?

1.4 Research Objectives

The objectives were to identify:

- The factors that have influenced the adoption and non-adoption of the new cassava varieties by farmers.
- The ways that the transfer and adoption of the new cassava varieties can be improved, given the factors influencing adoption,

1.5 Thesis Structure

This research project identifies the factors that influenced the adoption and use of cassava technology in Hohoe District and analyses how the extension initiative can be improved at the district level. The review of literature, relating to the adoption of agricultural technology and extension activities, are presented in Chapter Two. The research methodology, data collection and analysis procedures, used in the conducting of the case study, are justified and described in Chapter Three. Chapter Four provides a background description of the case under study and Chapter Five outlines the research results. The research results are then compared and contrasted with the reviewed literature and this is discussed in Chapter Six. The conclusions on the main findings from the study and a discussion on the possibilities for further research in this area are presented in the Chapter Seven.

Chapter Two: Literature Review

This chapter reviews the literature, which is relevant to this study. The role of agricultural extension in rural development and its importance in terms of technology development and transfer processes are described in the following sections. In subsequent sections, factors that influence technology transfer and the adoption process, the characteristics of technology, the extension process itself, in terms of service delivery and farmer characteristics that influence adoption decisions, are also reviewed. The benefits of technology adoption and the livelihood strategies employed by households, as coping mechanisms, are outlined in the final sections.

2.1 Agricultural Extension

Agricultural extension is increasingly gaining attention as a strategic instrument in the agricultural and rural development process (Anderson & Feder, 2004; Leeuwis & Van den Ban, 2004). Agricultural extension can be variously defined since it encompasses a range of activities. However, it can be defined as being the provision of information to farmers, relating to developed technologies, which can enable them to make sound decisions about new ideas and practices (Leeuwis & Van den Ban, 2004). It aims to improve the accessibility of information for farmers and to help these farmers acquire knowledge and skills relevant to their farming situations, in order to increase farm production and productivity, as a means of improving the wellbeing of farm households in developing countries (Von Blanckenburg, 1982).

Over the years, farm management practices for livelihood improvement and resource sustainability have been promoted through agricultural extension activities (Von Blanckenburg, 1982). Although, an extension service is not a solution to the myriad of agricultural development challenges in developing economies, concerted efforts are being made to intensify awareness about its potential in livelihood improvements, in terms of improving the knowledge and skills of farmers concerning agricultural activities (Anderson & Feder, 2004; Marsh, Pannell, & Lindner, 2004).

Although estimates of the return on investment of agricultural extension are difficult to separate from those of agricultural research and other institutional support, research has shown that the returns on investment in extension vary across both developed and developing countries (Marsh *et al.*, 2004). In both developed and developing countries, it was estimated that the returns ranged from 34% to nearly 80% (Marsh *et al.*, 2004). In the United States, for instance, studies have shown an over 100% return on extension investment, but the overall rates of return on investment in public extension, between 1950 and 1982, was 20% in the USA (Anderson & Feder, 2004). In developing economies, extension investments have been found to generate from 5% to over 50% return rates (Anderson & Feder, 2004; Marsh *et al.*, 2004).

2.2 Agricultural Extension and Rural Development

A number of theoretical and empirical studies have shown how agricultural extension has been used as part of rural development strategies (Fenichel & Smith, 1992; Ison & Russell, 2000). However, most of these studies did not provide the specific roles of extension in rural development. Agricultural extension is often indicated as part of an integrated approach to rural development programmes, with efforts being made to promote and support sustained economic growth (Fenichel & Smith, 1992). This integrated approach involves the integration of many services, including health, agriculture, education and other social services within an intervention programme. Extension organisations help to devise strategies that will help achieve the objectives of such development programmes (Peterson, 1997). As a result, livelihood improvement and resource sustainability programmes have been promoted through agricultural extension activities, as part of an integrated approach at the local level (Von Blanckenburg, 1982).

Some rural development programmes do not achieve their set objectives, as a result of inadequate coordination of activities and poor specification of the scope of the projects. An analysis of an integrated rural development project in Zambia revealed a failure of the project, due to a lack of collaboration between donors and the government and poor specification of project content and capacity (Fenichel & Smith, 1992). Also, some of the poverty reduction interventions at the household levels, that were directed towards more

market-oriented agriculture, favoured the average poor instead of the chronically poor and this was due to poor targeting (Bebbington, 2005).

2.3 Extension Process

The extension process comprises the six main stages in the innovation-development process identified by Rogers (2003; 138). The innovation-development process, according to Rogers (2003), is composed of all the activities and arrangements carried out from the need identification stage, through to research, development and the commercialisation of research outcomes. It also includes the diffusion and adoption of the innovation and its consequences (Rogers, 2003). In the process, a need or problem is identified, based upon which research is conducted and an innovation is then developed to meet the needs of prospective adopters (Rogers, 2003). The outcomes of the research are published and then communicated to farmers for adoption, with varying impacts (Rogers, 2003). The technology adoption process, within the innovation development process, is the aspect of focus for this study.

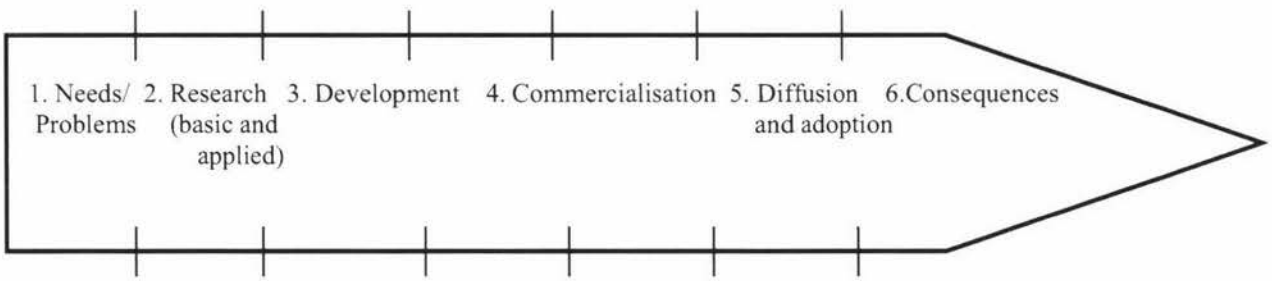

Figure 2.1: Six main stages in the innovation development – adoption process (Rogers, 2003: 138)

2.4 Agricultural Technology Adoption

Agricultural technology has been found to have the potential to increase the output of farmers (Feder *et al.*, 1985), when it is well implemented. To that effect, efforts have been geared towards the development and transfer of appropriate agricultural technology by development and research institutions, in order to increase farm production and enhance

farm productivity (Ersado, Amacher, & Alwang, 2004). Adoption of these improved practices is considered necessary to enhance agricultural productivity and promote sustainable livelihoods, through food security and poverty alleviation amongst rural households. This, it is claimed, will help achieve economic growth in the long term (Ersado *et al.*, 2004).

Various terms and definitions are used in the literature to refer to the idea, practice or object perceived to be 'new' by a potential adopter. Guerin & Guerin (1994) agreed with Rogers' (2003:12) definition of innovation as "an idea, practice or object perceived as new by an individual or other unit of adoption". They defined innovation in terms of how it is viewed by the farmers, whilst making a decision to adopt or reject it. Some other studies used 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; Rahman, 2003; Rauniyar & Goode, 1992).

A technology can therefore be an innovation and thus a new idea, technique or object. It is usually understood to be composed of hardware (the object component) and software (the idea) (Guerin & Guerin, 1994; Rogers, 1995, 2003) but it can also be entirely made up of information and then only software (Guerin & Guerin, 1994; Rogers, 1995, 2003). Ison and Russell (2000) gave a brief definition of technology being the "application of scientific knowledge to practical tasks". This definition, however, seems to be directed more towards the meaning of the idea or the software component of the technology, rather than the other aspect. In the case of Ison & Russell (2000), such a definition will be applicable to technologies which are entirely ideas or information only, unless the scientific knowledge is captured within a piece of hardware.

Agricultural technology may be in the form of improved management practices, new machinery, new methods of cultivating specific crops, new breeds of livestock and improved crop varieties that may be more resistant to some pests and diseases, higher yielding and earlier maturing. The term innovation is often used synonymously with technology (Rogers, 2003) and the term technology will be used from this point onward in this study to also mean innovation.

Adoption is a decision by an individual to use an introduced technology as the best available alternative (Rogers, 2003). According to Feder *et al.* (1985:256), adoption is "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 full potentials". Adoption is not a one off decision but a process in which the individual finally decides to use the introduced idea or technique, after a thorough assessment has been carried out (Spence, 1994).

Guerin & Guerin (1994:550), defined technology adoption as "the implementation of the already transferred knowledge about a technological innovation and is the end product of the technology transfer process". Technology adoption involves a mental process that the individual goes through, when he/she becomes aware of information regarding the idea, technique or object that is perceived to be new. The process continues until decisions are made to use or reject the new idea, technique or object (Rogers, 2003). In the process, as the potential adopter becomes aware of the new idea, he/she forms attitudes towards it, thus leading to the decision to adopt or reject or implement and confirm the decision (Rogers, 1995, 2003).

According to Rogers (1995, 2003) and Leeuwis & Van den Ban (2004), the technology adoption process involves five stages: knowledge, persuasion, decision, implementation and confirmation. Spence (1994), on the other hand, indicated awareness, interest, evaluation, trial and adoption as the stages involved in the adoption process. Although termed differently, the steps described by all authors are similar, with just small differences.

The knowledge stage is when an individual becomes aware of the existence of a technology as he/she receives information about it and understands how it works (Rogers, 1995, 2003). Spence (1994), however, described this stage as an awareness stage. The individual may obtain the information through mass communication channels, such as radio, television, news papers, etc. or through other written materials and interpersonal contacts (Spence, 1994).

The persuasion stage is when the individual changes his/her attitude towards the technology that has been introduced. Spence (1994) refers to this stage as the interest stage The attitudinal change may be favourable or unfavourable for the adoption or

rejection of the technology (Rogers, 1995, 2003; Van den Ban & Hawkins, 1996). The individual may tend to seek detailed information about the technology and examine its application, with regards to his/her circumstances (Spence, 1994). This might be due to the interest that has been developed by the introduced idea. According to Spence, (1994) at this stage the person has the motivation to search for further for information and hence it is called the interest stage.

The decision stage in the adoption process is when the individual engages in activities that will consequently lead to the adoption or rejection of the new idea or technique (Rogers, 1995, 2003; Van den Ban & Hawkins, 1996). The person may try the technology on a small scale, in order to verify its potential benefits in relation to their particular situation (Rogers, 2003). The extent to which the technology can be trialed is also crucial in promoting its adoption. Spence (1994) considers this stage occurs when the individual has undertaken some mental evaluation of the new idea before trying it in regard to the potential benefits and possible disadvantages.

At the implementation stage, the individual begins to completely apply or to use the new idea or technique (Rogers, 1995, 2003). People often seek more information regarding the new idea, to find out whether they have made the right decision by adopting the technology or not, and they also seek other information in relation to how to use it (Van den Ban & Hawkins, 1996). However, Spence (1994) considered this stage as a trial stage and the implementation of the new idea is done on a smaller scale, whilst Rogers (1995, 2003) regarded it as a time for full implementation, since the decision has been already taken. In that case, it may imply that Spence still considered the fact that some individuals would like to try the new idea before finally deciding to adopt or reject it, depending on the outcome.

The confirmation stage is when the individual seeks more information towards supporting and reinforcing the decision he/she has made or discontinues the use of the new idea as he/she faces conflicting situations (Rogers, 1995, 2003). Adopters, who are sometimes confronted with conflicting messages from change agents or peers, regarding the new practice they have adopted, tend to discontinue using the new practice (Van den Ban & Hawkins, 1996).

The time taken by prospective adopters in the adoption process may vary from one person to the other, depending on personal characteristics and external influences. 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; Feder *et al.*, 1985; Rogers, 1995). Individuals identified as 'innovative' are those who have a shorter adoption decision period than the late adopters or they are conservative individuals (Rogers, 2003). Those individuals slowest to adopt have been labelled 'laggards', with the vast majority of adopters falling into the categories of early adopters and late adopters (Rogers, 1995, 2003).

Some adopters may discontinue the use of a new idea or practice after the adoption (Rogers, 2003). The discontinuance of a technology, according to Rogers (2003), may be a result of the individual adopter being dissatisfied with the performance of the new idea or practice. It may also be due to the fact that the person has found a new practice that surpasses the existing one and as such they would like to replace it (Rogers, 2003). Spence (1994) indicated that such a rejection could happen immediately after the acceptance of a technology, if there is a better alternative.

2.5 Factors Affecting Technology Adoption

The attainment of food security, poverty reduction and economic growth, for most developing countries, depends mainly on employing more effectual farming techniques, that facilitate agricultural productivity and environmental sustainability (Ersado *et al.*, 2004). Against this background, the development of an appropriate agricultural technology is essential for agricultural growth and development. The adoption of such technology is a process which is influenced by three major factors and these are: the characteristics of the technology; the attributes of adopters; and the processes involved in the development and dissemination of the new idea or practice by the research and extension organisation (Boahene *et al.*, 1999; Ersado *et al.*, 2004; Feder *et al.*, 1985; Ogunlana, 2004; Rogers, 2003).

However, it must be noted that the factors that may be influential on the adoption of one technology may not have the same influence on other technologies (Guerin & Guerin, 1994). For instance, factors that may affect the adoption of a new practice, such as the use of a new irrigation facility, may not be the same as those that will limit the adoption of a new crop variety.

2.5.1 Characteristics of Technology

Rogers' (1962; 1995; 2003) well-known and widely acknowledged work classified five attributes of an agricultural technology that will influence adoption behaviour of prospective adopters. These attributes are relative advantage, compatibility, complexity, trialability and observability (Rogers, 1962, 1995, 2003). The relative advantage of a technology, from the potential users' point of view, is the extent to which the new idea or practice is better than the idea or practice it is intended to replace (Rogers, 1995, 2003). Some the examples of relative advantage are the cost of the new technology, the pest and disease resistance level and the maturity period of a new crop, and the technology being technically and economically better than the one it replaces (Feder, Just, & Silberman, 1981; Guy Henry, Izquierdo, & Gottret, 1994). The perceived benefits that would be obtained from adopting the technology could also play a significant role in its adoption. The expected profit, to be obtained from the adoption of crossbred-cow technology in Tanzania, was found to have influenced its adoption (Abdulai & Huffman, 2005).

Trialability is the extent to which a technology can be tested on a small scale, prior to a greater commitment being made (Rogers, 1995, 2003). Trials enable the individual to evaluate the new idea and relate it to his/her circumstances and to consider the potential benefits and problems (Spence, 1994). It was indicated that farmers are keen to adopt a technology which they have first trialed, on a limited basis on their farm, compared to one they have to adopt on a larger scale, which might fail (Ogunlana, 2004). The extent to which a technology can be gradually implemented, without a huge capital investment from the outset, is also important, in order to enhance the adoption in general (Floyd *et al.*, 2003; Rogers, 2003; Spence, 1994). This means that if a farmer can practice the introduced technology on a smaller scale, with less capital investment compared to the existing one, it may enable that farmer to decide whether to adopt or reject the new idea (Floyd *et al.*, 2003).

Compatibility is the degree to which an improved technology is consistent with the farmer's existing community values, religious beliefs, traditional management objectives and the needs of prospective adopters (Rogers, 1995, 2003). In this way, the technology should be consistent with existing farm practices and values, in terms of access to complementary inputs (Floyd *et al.*, 2003). The ease with which the farmers can integrate the new practice into their farming system and access other relevant inputs would help in its adoption (Ogunlana, 2004).

The complexity of a technology is the extent to which it is perceived by a farmer as easy or difficult to understand and use (Floyd *et al.*, 2003). Technologies that can be easily understood and used are adopted more rapidly, than those for which that the adopters would have to develop new skills and understanding, in order to use them (Ogunlana, 2004; Rogers, 1995, 2003).

Observability is the level to which the outcome or benefits derived from new practices are easily 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. Therefore, the visibility of results of any new practice is important in enhancing the adoption-decision process. For instance, a review of constraints to technology adoption, carried out in New South Wales, showed that farmers readily adopted a new wheat variety and a new herbicide which were introduced to them because the results were highly obvious (Guerin & Guerin, 1994). It is also important that observable increases in yield are transformed into increased income or profit, in order to sustain adoption (Guerin & Guerin, 1994). The area of sustained adoption was not covered in Rogers' (1995; 2003) attributes and thus the extent to which the attributes he identifies are influential on the sustainability of adopted of technologies is not clear.

The appropriateness of technologies introduced to farmers will influence the level of use of these technologies by farmers. The technology's appropriateness may be linked to an inherent attribute of the technology (Rogers, 2003), but it will also be linked to other factors related to the broader requirements and also the implications of adopting the technology by the farmers (Garforth & Usher, 1997; Hall, Bockett, Taylor, Sivamohan, & Clark, 2001; Röling & Pretty, 1997; Spence, 1994). Access to complementary inputs, for

a particular technology that has been introduced, is crucial to its use. If farmers have difficulty accessing complementary inputs for an introduced technology, such a technology may seem inappropriate to the farmers' circumstances, since they cannot use it (Garforth & Usher, 1997). A typical example is the Green Revolution technology that could not be adopted because farmers could not afford the fertiliser and other inputs within the technological package (Campbell & Barker, 1997; Leeuwis & Van den Ban, 2004).

In addition, if potential users of the introduced technology cannot access detailed information about the technology, they may not be able to use it and as such it will be rendered inappropriate (Garforth & Usher, 1997). Peterson (1997) also indicated the need to focus interventions on socio-cultural factors and the affordability of the introduced technologies, to make them more appropriate for farmers who are less endowed with resources. The involvement of the potential users of research outcomes in the technology development and a better linkage between these actors may promote the adoption of introduced technologies, since they will meet the needs of farmers (Hall *et al.*, 2001).

The mode of the extension service delivery is also important to the success of extension initiatives. Some of the challenges faced by extension organisation in service delivery are reviewed, in addition to the importance of agricultural extension agents in the technology dissemination and adoption process, in terms of the timely communication of information about the technology to farmers. The later section outlines the extension agent's role in the dissemination and adoption of improved agricultural practices.

2.5.2 Extension Service Delivery

Effective extension service delivery, which consists of the provision of information and technical advice to farmers (CORAF, 2001; Von Blanckenburg, 1982), faces a number of challenges. Government policies and new ideas and thinking influence extension activities, particularly in the public extension system, with regards to service delivery (Anderson & Feder, 2004; Swanson, 1997). A number of these factors are a result of the nature of the communication linkage between the major actors in the technology

development and the dissemination and utilisation processes. Others are internal factors, including financial sustainability and the working conditions of staff.

Extension agents play a very important role in the technology adoption process, by transferring information about a technology to the prospective adopters (Feder *et al.*, 1985; Feder & Umali, 1993; Yaron, Dinar, & Voet, 1992). They can act as mediators between researchers and farmers and they can convey research outcomes to the farmers (CORAF, 2001). They also feed information back to researchers from farmers, concerning the introduced technologies (CORAF, 2001).

Studies have shown that, through interactions with extension agents, some farmers become more willing to adopt a technology than those farmers who could not or did not have contact with the extension agents (Feder et al., 1985; Feder & Umali, 1993; Johnson et al., 2005; Ogunlana, 2004; Yaron et al., 1992). This is because, since the extension agents interact with the farmers, they provide detailed information about the introduced technology and thereby they eliminate any possible doubt the farmers may have about the technology. Consequently, the farmers are able to assess the information and make decisions to adopt or refuse the introduced technology (Feder *et al.*, 1985; Feder & Umali, 1993; Johnson *et al.*, 2005; Ogunlana, 2004; Yaron *et al.*, 1992). In addition, extension agents help farmers to access information and acquire knowledge, which the farmers might not be able to do without the extension contacts (Von Blanckenburg, 1982).

The extension agents need to develop credibility with the farmers and also be technically competent, in order to incur their trust (Guerin & Guerin, 1994). This would indirectly enhance the efficiency of the extension service delivery and strengthen their relationship with the farmers. It is important for the extension agents to also understand the farmers' circumstances and to know their needs, in order that they can introduce technologies, which will meet the farmers' needs (Guerin & Guerin, 1994). They further need to ensure that the extension message is conveyed clearly so that it is understood by the farmers and it is perceived as being useful (Guerin & Guerin, 1994). It is important that the information is presented to a target group and that the right message is delivered, received and understood without any distortion (Nagel, 1997).

It is also important that appropriate technology is transferred to the appropriate place and at the time deemed necessary, since this would demonstrate the effectiveness of the extension service delivery (Anderson & Feder, 2004). For instance, the transfer of information and knowledge about an improved crop variety to farmers, by extension agents, would increase the rates of adoption, when complete information on the technology is received together with ready access to plant material and other inputs (Guy Henry & Gottret, 1995). This can also help to avoid delays in decision-making, which can be costly to the farmer.

The ratio of extension agents to farmers is a factor that affects farmers' access to extension driven information. In many developing countries this ratio is low, with a small number of extension agents, often poorly resourced, being required to try and deliver services to large numbers of farmers or farm households, often over a large geographical area (Anderson & Feder, 2004). As a result, extension agents tend to be selective in contacting farmers, which usually results in benefits for the large scale and well-endowed farmers (Anderson & Feder, 2004; Nagel, 1997; Swanson, 1997). However, the inability of extension agents to reach all farmers cannot always be blamed on the extension agent-farmer ratio but it also dependent to some extent on the fact that the extension agents prefer working with contact farmers and others who have previously been working contacts. For instance, in Zambia, despite the use of the T & V system, the extension agents did not extend field messages to non-contact farmers (Fenichel & Smith, 1992), since the extension agents tended to work with farmers with whom they had existing contacts.

The nature of the linkages between research, extension and farmers is a key factor, that will influence the effectiveness of extension and the usefulness or otherwise of new ideas and practices developed by research (Khosa, Van Averbeke, Bohringer, & Albertse, 2002; Snapp, Blackie, & Donovan, 2003). The quality of the linkages between extension agents and agricultural researchers can affect the flow of information from farmers to researchers, when extension agents are the primary linkage between them (CORAF, 2001). This three way relationship can be influenced by many interlinked factors or by one major factor (Garforth & Usher, 1997).

A strong co-ordination between these actors and even with NGOs have helped smallholder farmers in Malawi to improve their techniques in the production of high quality paprika and it has also encouraged them to venture into new marketing opportunities (Snapp *et al.*, 2003). Also, through similar collaborative work with farmers, a new variety of crop that meets industrial standard and farmer needs has been discovered (Snapp *et al.*, 2003). Poor linkages limit the input of farmers in the development of the technology and hence it makes it difficult for researchers to develop technologies which are appropriate for the farmers' circumstances (Guerin & Guerin, 1994; Khosa *et al.*, 2002).

The literature strongly advocates for and provides evidence of the importance of open and effective communication between research and farmers, from the early stages of technology development through to the adoption and evaluation (Deshler, 1997; Guerin & Guerin, 1994). The success of extension programmes or interventions depend on the level of participation by the beneficiaries. Farmer participation in project evaluation would also help to tailor interventions to meet their needs (Deshler, 1997; Guerin & Guerin, 1994). The compatibility of technology with farmers' values and situations would also enhance its adoption (Rogers, 2003).

Technologies should be relevant and beneficial to farmers, therefore researchers need to be able to incorporate the farmers' concerns into their programmes and they should also have an understanding of the farmers' social and economic circumstances within the technology development process (Campbell & Barker, 1997; Guerin & Guerin, 1994). It is only then that farmers will adopt and engage in a sustained and long-term use of the improved technologies. For example, despite the increase in yields of improved cassava varieties introduced in Zaire, there was low level of adoption, since the women could not handle the increased yields with the associated increase in their workload (Campbell & Barker, 1997).

It is also important that new crop varieties introduced to farmers are suitable to their farming environment (Snapp *et al.*, 2003). This is because the conditions under which farmers operate may be different from the situation under which the research station trials a particular technology (Campbell & Barker, 1997). Therefore, the technology may be rendered inappropriate if it does not fit into the farmers' environment (CORAF, 2001;

Hall *et al.*, 2001). In such situations, extension investments, made in the dissemination of the new practice or idea, may not be beneficial.

It may not be impossible for the complex needs of farmers to be met if research work is limited to only one crop or product (Eponou, 1998). Also, when research activities are focused on one commodity, in order to recover costs, other users of research outcomes may be disadvantaged. Consequently, such technologies are likely to be unsuitable for some farmers. It is important that research activities, regarding the development of any commodity, for example improved crop variety, consider a whole range of aspects, in order to meet the needs of users (Eponou, 1998). For example, when working on yield improvement of a crop, research work must consider the issues of drought resistance, early maturity and improvement in disease tolerance (Eponou, 1998).

Financial constraints, coupled with the low morale of the extension workers due to inadequate motivation, amongst other things, can also can hamper extension service delivery (Anderson & Feder, 2004; Nagel, 1997). Government spending on agricultural extension services has been dwindling in some developing countries, due to economic difficulties. This sometimes leads to the termination of extension projects for which donor support cannot be extended (Anderson & Feder, 2004; Nagel, 1997). In addition, government leaders, who are less committed to agricultural extension activities, tend to reduce their budget allocation to extension services (Anderson & Feder, 2004). In some cases, extension workers may be engaged in other activities, which are politically motivated, thereby affecting the services regarding the information delivery and transfer of knowledge to farmers. This may also exacerbate their already complex extension work (Nagel, 1997).

Resources availability and financial constraints also hinder the mobility of extension agents, thereby affecting their efficiency in service delivery (Anderson & Feder, 2004; Nagel, 1997). In such situations, timely information delivery and the supervision and facilitation of activities, such as field days and demonstrations are hampered. Also, field messages or information may be rendered outdated, where there are seasonal variations with regards to information on production of a particular crop variety (Anderson & Feder, 2004). Lack of incentives also affects the morale of the extension agents such that most of them tend to seek alternative income sources for survival (Anderson & Feder, 2004;

Nagel, 1997). The low motivation of extension agents may make it difficult for them to be committed to their duties which may then also affect their efficiency Anderson & (Anderson & Feder, 2004; Nagel, 1997).

Infrastructural development is equally important, in order to enhance extension service delivery (Peterson, 1997). Availability of communication facilities will help the extension agents to carry out field operations in relation to the introduced technology. It will also help to communicate, on time, the relevant information to farmers about the technology. Poor road networks can also hamper extension activities (Peterson, 1997; Vanclay, 1992). These may prevent extension agents from providing timely assistance to farmers, thereby affecting the farmers' adoption decisions.

The prevailing extension approach, used by an extension organisation, will also have a significant impact on the nature of the adoption process by the farmers. The next section reviews some of these extension approaches.

2.5.2.1 Extension Approach

Various extension approaches are used in the organisation of agricultural extension activities (Manig, 1992; Tripp, 1990). The traditional transfer of technology (TOT) model (Rogers, 1995; 2003) saw users of research outcomes not being involved in the technology development and transfer process. Empirical evidence has shown the deficiencies of this model and led to the proposal of a practical approach to the process, by adopting a more participatory model to extension (Black, 2000; Ison & Russell, 2000; Jules N Pretty, 1995). Chambers (1993) prescribed the Farmer First approach, which encouraged farmers' participation in the technology development and transfer process.

The participatory technology development and dissemination concept does not only make research outcomes more useful, since it helps to meet the needs of farmers, but it also encourages the farmers to develop a high self-esteem and confidence in the sharing of ideas with others to help solve related problems (Ison & Russell, 2000). For instance, under the farming systems research, which takes a more participatory approach than TOT, farmers were involved in problem identification and analysis and the development of

appropriate technologies (Manig, 1992). They carried out on-farm experimentations in different farming systems and locations and helped to adapt technologies to meet the needs of farmers (Manig, 1992). Another example, was experienced by graziers in the rangelands of New South Wales in Australia during the CARR project (Community Approaches to Rangelands Research), where they were part of the technology development process (Ison & Russell, 2000). The graziers developed confidence in the sharing of ideas and they approached research and extension staff about related issues (Ison & Russell, 2000).

The last three decades have seen the emergence of several of these approaches, in pursuit of meeting the needs of farmers, particularly the resource poor, coupled with the need to improve the research-extension system in developing countries (Black, 2000; Manig, 1992; Tripp, 1990). Generally, these approaches evolved as a result of perceived flaws in the preceding ones (Nagel, 1997) . The use of extension approaches, in the transfer of information and knowledge to farmers, is therefore important in technology adoption studies, since the approach used may influence the success of the technology transfer programme. This is because, whilst some of the approaches targ*et al*l farmers as one entity and treat them as such, others use specific criteria, in order to cater for the specific concerns of targeted farmers (Manig, 1992; Tripp, 1990). A review of some of the extension approaches, particularly those that are being used in Ghana – Training and Visit system and Farmer Field School – is provided in the subsequent sections.

Training and Visit system

The Training and Visit (T&V) system of agricultural extension was developed to enhance the dissemination of research information to farmers (Manig, 1992). It was introduced in Ghana during the1980s (Amezah & Hesse, 2003). The Training & Visit system, which was promoted by the World Bank, had a top-down course of action with designed programmes aimed at increasing agricultural production (Anderson & Feder, 2004). The extension methods were standardised, with regular training for the Village Extension Workers who worked with the farmers (Anderson & Feder, 2004; Hakiza *et al.*, 2004; Manig, 1992). This approach aimed to help improve accountability within the extension service and introduced strict measures regarding the use of contact farmers, routine

meetings and intensive supervision of the village extension workers (Gilbert, Posner, & Sumberg, 1990; Hakiza *et al.*, 2004; Manig, 1992).

The Training and Visit system proved to be more viable with simple farming systems under situations where a cropping pattern dominated and it was limited to important crops: it was termed the 'commodity approach' (Manig, 1992). It was also beneficial for local level extension service delivery, because low paid extension workers were able to contact more farmers within a particular period of time (Antholt, 1998; Hakiza *et al.*, 2004; Manig, 1992). The extension workers were involved in the transfer of information to the contact farmers, relating to agricultural technologies, which originated from the researchers but the communication of feedback from the farmers to the researchers was weak not substantial (Hakiza *et al.*, 2004). However, although the T & V system has resulted in some achievements, it has faced some institutional challenges. Inadequate collaboration between researchers and extension staff was, in some instances, due to disparities in their organisational, decision-making and management styles (Manig, 1992).

These differences, coupled with discrepancies in the orientation of researchers and the extension staff, in terms of level of education, social status and the different development strategies, affected the effectiveness of the approach (Anderson & Feder, 2004; Manig, 1992). In most cases, the research goals varied from that of the extension, although there was a great deal of interaction between the researchers and extension staff through regular meetings (Anderson & Feder, 2004). The Training and Visit approach was also estimated to cost about 25-40% more in staff training, compared to the other extension approaches it was meant to replace, such as the traditional extension system, where the main thrust is the transfer of information to farmers by extension agents (Anderson & Feder, 2004).

Farmer Field School

The Farmer Field School approach of extension service delivery is a non-formal type of education which uses participatory methods, by involving farmers in technology development and dissemination (Hakiza *et al.*, 2004; Madukwe, 2006). It was initially introduced in Asia, particularly in Indonesia and the Philippines, in the late 1970s and 1980s (Anderson & Feder, 2004; Simpson & Owens, 2002) but it later spread to Latin America and Africa (Hakiza *et al.*, 2004). In Ghana, it was introduced in 1995 (Albert,

Braun, Donkoh, Loos, & Schill, 2001). The Farmer Field School was set up to educate farmers in Integrated Pest Management programmes, in order to help improve farmers' knowledge concerning farm management practices (Anderson & Feder, 2004; Simpson & Owens, 2002). It employed the principles of adult learning and experimental activities to educate farmers about improved farm practices and ideas (Anderson & Feder, 2004; Hakiza *et al.*, 2004; Madukwe, 2006). The Farmer Field School meetings are held at regular intervals with groups of 20-25 farmers during one crop-growing season. The formation of farmer groups is based on crops grown or animals being produced, such as poultry farmers or vegetable growers (Anderson & Feder, 2004; Madukwe, 2006).

Field days are organised for the Farmer Field School groups and other farmers, to enable the participants to have the opportunity to teach others what they have learnt (Hakiza *et al.*, 2004). Some of the trained farmers in a particular season may be provided with training materials, so they can become facilitators for the subsequent season's school sections (Anderson & Feder, 2004; Madukwe, 2006).

The Farmer Field School approach theoretically enables farmers to assess their own situation with the knowledge they have acquired and the skills they have developed (Anderson & Feder, 2004; Madukwe, 2006). The participating farmers tend to increase their communication and management skills through interactions with others, whilst at the same time it enhances their decision-making and leadership abilities (Hakiza *et al.*, 2004; Madukwe, 2006). The farmers are also able to adjust to changing situations, since they tend to test and adapt technologies to suit their needs (Anderson & Feder, 2004; Madukwe, 2006). This approach helps to make the farmer-facilitators more accountable to the farmers in their communities, because these fixed programmes with a strict schedule of activities are usually supervised by a more senior staff member (Anderson & Feder, 2004; Madukwe, 2006). However, Farmer Field Schools require significant financial support for sustainability, due to more costs being incurred in the training extension agents, together with the farmers' training (Anderson & Feder, 2004; Hakiza *et al.*, 2004; Madukwe, 2006).

It must be noted that most of the perceived flaws in the application of the above approaches to extension were due to poor management and lack of resources (Nagel, 1997). For example, most of the publicly funded extension workers have problems with

mobility and other socio-economic incentives (Nagel, 1997). Consequently, an integration of some of these approaches could help harness the strengths to improve the efficiency and effectiveness of extension activities (Nagel, 1997) .

2.5.3 Characteristics of Farmer Adopters

Farmers' technology adoption decisions are the outcomes of a number of interrelated factors (Boahene *et al.*, 1999; Ersado *et al.*, 2004; Feder *et al.*, 1985; Ogunlana, 2004). In general, these factors are personal characteristics which are inherent to the individual, whilst others are external and in addition there are other situational factors which influence the farmers' decision to adopt or reject a technology (Spence, 1994).

Personal Characteristics

The influence of farmer characteristics on adoption decisions depends on the technology and the circumstances of the specific farmer. Personal characteristics, such as the age, gender, health and level of education of adopters are factors which influence farmers' technology adoption decisions (Boahene *et al.*, 1999; Ersado *et al.*, 2004; Feder *et al.*, 1985; Hossain & Crouch, 1992; Ogunlana, 2004). According to Spence (1994), farmers who are generally innovative are often younger than most of their colleagues. However, it is believed that these personal characteristics, per se, are not the only driving force for the decision to adopt or reject a new idea. For example, Doss & Morris (2001) found that gender, per se, has no obvious influence on adoption decisions regarding improved maize and chemical fertilizer use in Ghana. However, these and other factors interact together and influence the adoption decision process. It was found that there was a significant relationship between gender and access to land in Ghana, since women have less access to land and therefore gender is indirectly a factor in adoption (Doss & Morris, 2001).

The age of a farmer may not be the only factor influencing the decision to adopt a new practice (Hossain & Crouch, 1992). For example, it is believed that, in a community where a new practice of growing sweet potato on ridges to increase yield is introduced, a farmer may reject the new practice because he/she cannot afford the labour input, regardless of his/her age.

On the other hand, the farmer's attitude to farming and the prospects of the farming business, coupled with his/her perception about the technology, could be influential on the decision to adopt a technology (Guerin & Guerin, 1994). A positive attitude would increase the possibility of adopting the technology. Other predisposing factors, such as values, beliefs and goals are also influential on the decision of potential adopters (Spence, 1994). This may cause the individual to react either positively or otherwise towards the introduced technology. Depending on the person's perceptions about the technology regarding the predisposing factors, he/she may decide to adopt or reject it (Rogers, 2003). There is also the possibility of the individual holding misconceptions about the technology, in terms of the potential costs and benefits, which can also influence the adoption decisions (Doss, 2006).

Social, Economic and Situational Factors

The socio-economic and situational factors, relating to the potential adopters, influence their response to new farm practices. These factors are external to the individual farmers but they are part of the environment within which they carry out their daily activities (Spence, 1994). Membership of organisations, the level of income, market access and farm size, amongst others, have been found to influence farmers' technology adoption decisions (Feder et al., 1985; Floyd et al., 2003; Garforth & Usher, 1997; Gottret, Henry, Duque, & Cristina, 1993; Hossain, 1988; Hossain & Crouch, 1992; Ogunlana, 2004; Zeller, Diagne, & Mataya, 1998). Membership of organisations, such as farmer cooperatives and other associations, have been found to be very instrumental in changing farmers' attitudes towards new agricultural practices and thereby they enhance the adoption of such practices (Gottret *et al.*, 1993; Hossain, 1988; Hossain & Crouch, 1992; Ogunlana, 2004; Zeller *et al.*, 1998).

The sustainability of farmer groups is also important in the improvement of farmer access to information and inputs (Lyon, 2003). Due to difficulties experienced by farmers in accessing credit from the banks, particularly the smallholders, group membership may be an advantage. For example, in the case of the Grameen Bank in Bangladesh, group membership enhanced access to credit and improved loan recovery rates (Hossain, 1988). However, in Ghana, attempts by donor agencies to promote group sustainability, through the provision of monetary incentives, did not work effectively, since group members

tended to withdraw from the groups immediately the subsidy was removed (Lyon, 2003). This was because most of the farmers joined the groups to enable them to access credit, in the belief that the loans were gifts, since they came from the government. This influenced the banks' willingness not to offer credit to such groups, since they (Banks) could not trust the sustainability and hence the prompt repayments by the members (Lyon, 2003).

A farmer's sound financial situation provides security against any risk of liability, in case of failure whilst using the technology (Feder *et al.*, 1985; Guy Henry *et al.*, 1994; M. Hossain, 1988; Ogunlana, 2004). The higher the level of the farmer's income, the more he/she can afford to take financial risks as he/she can offset losses from some of the less successful experiments (Feder *et al.*, 1985; Guy Henry *et al.*, 1994; Hossain, 1988; Ogunlana, 2004). Feder *et al.* (1985), in a study on adoption of technologies in developing countries, indicated that off-farm income may also affect adoption, by providing a source of cash flow to buffer the risk associated with new agricultural practices. Smallholder farmers tend to adopt low-cost technologies and as such they may not be willing to adopt capital intensive technologies (Peterson, 1997).

Farmers who can easily access credit may be more willing to adopt introduced technology, such as the case of hybrid maize adoption in Zambia, where limited access to credit slowed down the adoption process for smallholder farmers (Boahene *et al.*, 1999; Ogunlana, 2004). Problems of low loan repayment rates and lack of collateral are some of the limiting factors relating to credit accessibility by smallholder farmers. A study revealed that financial institutions in Ghana were reluctant to grant loans to smallholder farmers, due to their records of low loan recovery and lack of collateral (Fenichel & Smith, 1992).

Farm size has a varying influence on the adoption decisions of potential adopters. Studies indicate that farmers with larger farms have a greater probability of adopting improved technology, than small scale farmers (Boahene *et al.*, 1999; Ogunlana, 2004). The larger scale farmers can enjoy the economies of scale from buying large quantities of certain inputs, which can then help reduce production costs. However, in contrast, Yaron *et al.*, (1992) discovered, in their study on technological improvements on family farms in the Nazareth region of Israel, that small land areas encouraged adoption of input-intensive technologies which have high returns.

A review of constraints to adoption of technology also indicated the possibility of small farm holdings having the tendency to adopt improved farm practices (Guerin & Guerin, 1994). For example, adopters of conservation practices in east-central Illinois were found to be relatively young farmers with small land holdings, who had fewer years of farming experience (Guerin & Guerin, 1994). It was also indicated that smallholder farmers were more willing to adopt labour-intensive technologies, than larger farmers, since smallholder farmers could use family labour which was relatively cheaper (M. Hossain, 1988). Access to labour during the peak-season is also important in the technology adoption decisions of resource poor farmers (White, Labarta, & Leguia, 2005), because high labour demand can increase labour costs. A study in Zaire indicated the failure of a cassava technology extension programme as a result of the increase in the women's workload, due to the high yields obtained from the new varieties, since the women are responsible for the processing of the cassava (Campbell & Barker, 1997).

The effect of farm size on adoption may be location specific and also depend on other factors. Smallholder farmers in a position to innovate were from developed economies, whereas those constrained by land size were found in developing economies.

Socio-Economic and Political Environment of Target Area

The social and economic development of an area, where a particular technology is introduced, also affects the adoption rates of technology. The existence of an appropriate infrastructure is likely to promote the adoption of related technologies (Feder & Umali, 1993; Peterson, 1997; Rahman, 2003; Vanclay, 1992). The level of communication and quality of the transportation system will enhance farmers' access to information and extension agents (Feder & Umali, 1993; Peterson, 1997; Rahman, 2003; Vanclay, 1992). The ease with which a farmer can access inputs for a particular technology or a reliable local supply of inputs can encourage farmers to adopt an introduced technology (Feder & Umali, 1993; Guy Henry & Gottret, 1995).

Farmers who are exposed to the mass media, notwithstanding their level of education, were found to have a higher tendency to adopt new farm practices, than others who are not exposed (Hossain & Crouch, 1992). Also, these farmers may be able to access technical information from reliable sources, which would then enhance their adoption

decisions. Therefore, if the area is not developed in terms of improving access to these facilities, it will be difficult for individuals to become aware of the existence of the technology, since access to information is one of the important stages of the adoption decision process (Peterson, 1997).

Good transportation systems can enhance extension activities, whilst marketing and storage facilities are also important to promote the continuous use of technologies, such as improved crop varieties (Peterson, 1997; Vanclay, 1992). For example, Asafo (2001) indicated, in a study on the adoption of new cassava varieties in the Tongu District of Ghana, that the marketing of produce was one of the factors that have affected adoption of new varieties. Poor road networks also affect farmer access to information and the marketing centres they need for their produce (Peterson, 1997) and this will eventually affect the adoption of improved farm practices. A study on the adoption of hybrid maize in Malawi also revealed the importance of access by farmers to agricultural markets for both inputs and outputs and this situation affected the adoption decisions (Zeller *et al.*, 1998). In addition, a study in Tanzania found that proximity to markets was one of the factors that influenced the adoption of the crossbred-cow technology (Abdulai & Huffman, 2005). The farmers there were encouraged by the ready access to markets.

Research has shown that farmers, who can easily access a processing factory for some of the introduced crop varieties, are more likely to adopt and use such crops (Johnson & Masters, 2004). Proximity to a grater or a processing facility could influence the ability of the farmers to adopt the cassava technology (Johnson & Masters, 2004). The availability of processing facilities would enable the farmers and processors to add value to their produce. This would help prolong the shelf life of the products and minimise fluctuations in the market price, which then affects production costs (Janssen & Wheatley, 1985). For example, in Colombia, the price of cassava tubers reduces drastically when there is a glut and because of poor storage quality farmers are forced to sell them at any price they can get, in order to avoid a total loss (Janssen & Wheatley, 1985).

Government policies and other institutional factors can influence the adoption decisions of farmers, with regards to improved crop varieties and other inputs (Ajayi, Franzel, Kuntashula, & Kwesiga, 2003; Doss, 2006; Peterson, 1997). Increase in input prices, as a result of government policy, can cause farmers to be reluctant to adopt or use introduced

technologies that require external inputs (Amezah & Hesse, 2003; Van den Ban & Hawkins, 1996). For example, in countries like Ghana, where structural adjustment policies led to the removal of agricultural subsidies with increased input prices, the adoption of technologies with such inputs has reduced (Amezah & Hesse, 2003). It has been found that the institutional relationships involved in the provision of credit to farmers, government policies and the financial institutions' policies regarding credit and its availability, are relevant to the success of extension programmes (Doss, 2006; Peterson, 1997).

The success of any technology extension programme may be measured, based on its impact on the livelihoods of the adopters of the technology. This impact levels may reflect the adoption rate by farmers. The contributions of technology adoption are reviewed in the next sections. This is followed by highlights of livelihood strategies, including the adoption of improved agricultural practices, usually employed by rural households, to enable them to cope with livelihood situations. The review on these livelihood strategies also covers the role of cassava in livelihood sustainability.

2.6 Contributions of Technology Adoption to Adopters Livelihoods

The adoption of improved farming practices is important for increasing agricultural productivity and to the promotion of sustainable livelihoods (Ersado *et al.*, 2004; J. N. Pretty, Morison, & Hine, 2003). An increase in agricultural production and productivity is necessary for the achievement of economic growth and to ensure food security and poverty alleviation amongst rural households (J. N. Pretty *et al.*, 2003). A general increase in per capita agricultural production appears to be the only practical way to improve the livelihoods of rural people, due to the limited opportunities for growth in the industrial sectors of developing countries. This was observed in the analysis of technology adoption by smallholder farmers in Zambia (Rauniyar & Goode, 1992). As such, technological change is considered a major driving force for agricultural development, since this will help increase output for domestic consumption, in addition to that for export (Rauniyar & Goode, 1992). Adoption of improved farm practices is therefore expected to enhance the living conditions of the people, in one way or another, particularly at the household level.

The improvement in livelihoods could, however, be either through increased income or by making more food available. For example, it was revealed by an impact evaluation study, carried out on a national agricultural extension project in Ghana that, the adoption of an agricultural technology resulted in yield increments. This led to improved livelihoods, with more children being sent to school, since the farmers were able to increase the sale of their farm produce (NAEP, 1999).

Allocating benefits from the use of improved agricultural technologies is still contentious, since some are location specific. Although, a number of rural and urban poor may benefit, in some instances, a greater percentage of the benefits are enjoyed by well-endowed farmers and people who can access lower food prices and who also have an increased per capita consumption (J. N. Pretty *et al.*, 2003; Shaw, 1987).

Effect of Technology Adoption on Household Income

Improved technologies have the potential to make a positive impact on the livelihoods of the people, by raising their income levels (NAEP, 1999; Saka *et al.*, 1998). The effect of technology adoption on income levels of households could be through the sale of farm produce and products. It may also be through services provided in the form of labour or other services, which are generated as a result of using the technology (NAEP, 1999; Ospina, Poats, & Henry, 1993; Saka *et al.*, 1998). An example is the outcome of a study conducted in Malawi, in which people engaged in producing, processing and/or selling cassava and/or its products, in order to raise household incomes (Saka *et al.*, 1998).

Evidence from Ghana indicates a substantial increase in household income for smallholder farmers, who have adopted an improved rice-based fallow system in the northern part of the country (Yiridoe, Langyintuo, & Dogbe, 2006). Also, in Bangladesh, technology adoption helped improved income levels for farm households (Mendola, 2006). It helped to increase the incomes of the poor people, who are usually without farm land, but it rarely raised them above the poverty line (Mendola, 2006). Income generating opportunities may also be created for communities with small-scale agro-based industries (Ospina *et al.*, 1993), thereby reducing poverty and enhancing the adoption of other improved farm practices.

Effect of Technology Adoption on Food Security

Empirical work has shown that technology adoption contributes significantly to increased food production and increased household food supply (Kristjanson, Place, Franzel, & Thornton, 2002; Nweke, Hahn, & Ugwu, 1994; J. N. Pretty *et al.*, 2003). Increases in maize production were achieved, as a result of the adoption of improved fallows, in western Kenya and Zambia (Kristjanson *et al.*, 2002; Nweke *et al.*, 1994; J. N. Pretty *et al.*, 2003). Also, in northern Ghana, the adoption of an alternative rice cropping system enabled farmers to cultivate a large area of rice (Yiridoe *et al.*, 2006). Cassava also contributes significantly to food security and to increased income for households in Sub-Saharan Africa (Howeler et al., 2001; Johnson & Masters, 2004; Prudencio & Alhassan, 1994; Saka et al., 1998).

An increase in the yields of crop varieties adopted may contribute to an abundance of food, as indicated in an integrated cassava research and development project in Colombia and Brazil (Ospina *et al.*, 1993). The adoption of improved varieties of crops for the export market can, however, affect availability of food for domestic consumption, thus leading to food insecurity (Conley & Udry, 2001; Shaw, 1987). This implies that, as the demand for the export crop increases, farmers may produce more of these crops, thereby reducing the production of those crops intended for the domestic markets. Similar to the case in Ghana, where the production of staple food crops – maize and cassava – was replaced with pineapple production, due to the adoption of chemical fertiliser and access to international markets (Conley & Udry, 2001).

Technology Adoption and Employment Generation

Scarcely anything has been written on the employment opportunities that have been generated through the adoption of improved technologies, particularly crop varieties. Ospina *et al.* (1993) pointed out that the establishment of small-scale agro-based industries, for the processing of agricultural produce, might create employment opportunities for people in and around the locality. This may help raise income levels and offer people an improved means of living. Cassava has the potential for agro-industrial processing (Kawano *et al.*, 1998) and therefore the establishment of a cottage industry for processing cassava may provide employment opportunities.

Enete *et al.* (2005), in assessing the hired labour use decisions of cassava producers in Sub-Saharan Africa, observed that cassava production systems responded positively to the use of hired labour. Therefore, the expansion of cassava production will generate employment opportunities for people who can provide casual labour in such areas. Also, in a survey on the adoption of agricultural technologies in developing countries, Feder *et al.* (1981) identified that a new practice may create an effective labour demand, which can then result in the development of a labour market and thus, it becomes a source of income for some individuals or households. An example is the case of Southern Israel, where nomadic Bedouins became hired farmhands as a result of agricultural intensification (Feder *et al.*, 1981).

2.7 Livelihood Strategies and Cassava's role in Livelihood Sustainability

Generally, in developing countries, individuals or households engage in activities, in order to generate means for survival under difficult living conditions (Ellis, 1998). Livelihood strategies, generally employed, include agricultural intensification and extensification, migration and diversification into off-farm and non-farm activities (Carswell, 1997; Ellis, 1998, 2000a, 2000b; Orr & Mwale, 2001; Scoones, 1998) . Households or individuals can also diversify into off-farm and non-farm activities, in order to make a living (Carswell, 1997; Ellis, 1998, 2000a, 2000b; Scoones, 1998). Some household members also migrate to a new environment, within or outside their country, as a strategy to help cope with the situation, through remittances (Carswell, 1997; Ellis, 1998, 2000a, 2000b; Orr & Mwale, 2001; Scoones, 1998).

Agricultural extensification involves the expansion of agricultural practices, rather than them being intensified. Thus, farmers tend to lease or purchase more land for cultivation. Alternatively, agricultural intensification involves increasing the levels of production from farmers' existing resources (Ellis, 2000b; Orr & Mwale, 2001; Scoones, 1998). This may require the use of more inputs on the same piece of land, or the use of higher producing varieties of crops per unit area or livestock, in order to secure their livelihoods (Carswell, 1997; Ellis, 1998, 2000a, 2000b; Orr & Mwale, 2001; Scoones, 1998).

The adoption and use of improved varieties of crops, such as cassava, as an agricultural intensification strategy, can help sustain livelihood situations for a particular period of time. This is because cassava is recognised as a famine crop (Johnson & Masters, 2004; Prudencio & Alhassan, 1994) or last resort food crop (Howeler *et al.*, 2001), since it can help ensure food security (Saka *et al.*, 1998). In addition, cassava can produce reasonable yields under adverse weather conditions and in recent years there has been also a growing interest in it as a potential industrial crop (Kawano *et al.*, 1998). In fact, there is evidence that farm households or individuals produce cassava to bridge the gap between seasons of hunger (Saka *et al.*, 1998). Others also cultivate it when there are viable marketing opportunities, in order to raise their income levels (Prudencio & Alhassan, 1994). People become dependent on cassava for survival when they deplete their stocks of other staples, such as maize, yam, rice, millet and plantain.

Farm households may also rely on cassava during adverse weather conditions, such as drought, pest infestation or a general crop failure (Prudencio & Alhassan, 1994). People also engage in cassava cultivation in order to meet the per capita starchy food requirement of their households (Prudencio & Alhassan, 1994). Studies have shown that cassava flour can be used as a complement for wheat flour in the making of bread (FAO, 1977; O'Hair, 1995). In the U.S.A., cassava flour bread is marketed to meet the needs of people who are allergic to wheat flour (O'Hair, 1995).

2.8 Summary

Agricultural extension plays an important role in the technology development and dissemination process. Extension helps to provide farmers with information regarding new ideas and it improves their practices, which then enables them to make decisions that will improve their living conditions. A number of livelihood improvement interventions and resource sustainability programmes have been carried out through agricultural extension activities. An improvement in research, extension and farmer linkages is needed, in order to promote sustainable livelihoods, through the development and extension of technologies that match farmers' situations. Infrastructure development is equally important to enhance extension service delivery.

The adoption of agricultural technologies is imperative for livelihood adaptations and sustainability. Technology adoption contributes to food security, income generation and sometimes it opens up employment opportunities. However, farmers' technology adoption decisions are influenced by a number of interrelated factors. The characteristics of the technology, the processes and approaches used in the development and the extension of the technology is also influence the adoption process. The personal attributes of individual adopters and their circumstances, ranging from household situations to the socio-economic development of their communities, also influence adoption decisions. The effects of these factors on adoption decisions are interrelated.

Chapter Three: Research Methodology

This chapter describes the methodology used for this research. The first section describes the research strategy used in the study. The case selections criteria are described in section two, including details relating to selection criteria, the units of analysis and the sampling procedure and sample size. The data collection methods and the data analysis techniques are described in section three. Ethical considerations are encompassed in the last section.

3.1 Research Design

The research question posed in this study is "How can the district level transfer and adoption of cassava technology be improved" and the type of research strategy, used for this particular research work is identified as based on certain factors (Yin, 2003). The type of research question, the degree to which the researcher has control over the research subject and the focus of the research, whether it is on historical events or contemporary issues, are the three main factors to be considered, when selecting the appropriate approach for a particular research project (Rowley, 2002; Yin, 1994, 2003). Yin (1994:1, 6; 2003:5) stated that a case study strategy is preferred for 'how' and 'why' research questions, when the focus of the research is on current issues within a real-life situation (Table 3.1).

Various research strategies exercise different levels of control over events, depending on the type of research question and the research focus. In an experiment, the researcher has control over the behaviour of the research subjects and he/she can focus on contemporary events using 'how' and 'why' types of research questions. Research strategies, involving surveys and archival analysis, do not exercise any control over the research subjects and the focus is generally on contemporary events with research questions reflecting the 'who', 'what', 'where' and 'how many' type of question. However, historical studies use the 'how' and 'why' forms of research questions that do not exercise any control over the research subjects. Nevertheless, case study strategies focus on current events and the researcher has no control over the behaviour of the research subjects (Table 3.1).

Table 3.1: Relevant Situations for Different Research Strategies (Yin 1994:6; 2003:5)

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

Blaikie (1995) also indicated that 'how' research questions are used for case studies on interventions, in terms of improving policies, implementation and benefits. 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).

Consequently, given the research question guiding this research, a case study approach was considered appropriate and was therefore used. The study was conducted in the natural setting and the researcher had no control over the respondent's behaviours or the data collection environment; and the research also focused on contemporary events (Blaikie, 2000; Rowley, 2002; Thomas, 2003; Yin, 2003).

Yin (2003) further stated that a case study could be a single case or multiple cases. A single case study can be used to test theory, in order to determine whether the theory confirms the propositions or not. In extreme cases, a single case study may also be undertaken to build theory on rare circumstances or issues (Rowley, 2002; Yin, 1994, 2003). However, multiple-case studies allow for a cross-case analysis, in addition to the

comparison that can be made with theory, for more compelling evidence. Nevertheless, the extensive resource and time requirements for multiple-case studies may be beyond the means of the researcher (Blaikie, 2000; Yin, 2003).

The single case can be holistic or embedded, depending on the intensity of the analysis (Rowley, 2002; Yin, 2003). A single holistic case study focuses on the general nature of, for example, an organisation, without any in-depth analysis of the services and staffing issues. In contrast, a single embedded case study may be a government intervention with a number of donor-assisted projects – that would then be the embedded units, which may be selected for analysis (Rowley, 2002; Yin, 2003). The single case study approach was chosen because, given the breadth of information required and the amount of time available for the data collection and analysis, a single case was deemed appropriate. The units of analysis, the technology itself, the farmers' socio economic environment and the extension processes involved, provided opportunities for an extensive analysis to be carried out, thus enhancing the insight into the whole case (Rowley, 2002).

3.2 Case Selection

This research focused on a cassava extension programme in the Hohoe District, as an example of a district level extension initiative directed at achieving the uptake of cassava technology, under the Root and Tuber Improvement Programme (RTIP). The Hohoe District is amongst a number of districts within which the Root and Tuber Improvement Programme has been implemented (MOFA, 2005b). Phase one of the RTIP has been completed. Given the objectives of this study, a completed project would be more appropriate in the assessment of factors that influenced the adoption of cassava technology, rather than a project that was still in progress. In addition, the livelihoods of the people in the district was predominantly dependent on agriculture and cassava was the second major cultivated crops in the area (MOFA, 2005b). The familiarity of the researcher with one of the widely spoken local languages in the area was also taken into consideration, when the Hohoe district was selected as the site for this case study.

Extension agents working in separate operational areas implemented the extension initiative related to the RTIP within the district. The operational areas in the district were

communities within which the various extension agents had previously worked (MOFA, 2005b). There were about 1998 farmers in each operational area with approximately 285 in each community (Personal communication with District Director of MOFA, 12/12/ 2006).

Each agricultural extension agent was allocated to a number of communities in the district. The number of communities that constituted one operational area, for each agricultural extension agent, varied from five to eight, with an average of seven communities (Personal communication with District Director of MOFA, 12/12/ 2006). These communities were allotted based on the size of their traditional area and their proximity to each other, in order to enable the extension agent to easily commute between the communities (MOFA, 2005b; Personal communication with District Director of MOFA, 12/12/ 2006).

There were originally thirty three (32) operational areas but eight have since been assigned to a private organisation – the Extension Development Fund (EDF) that also organised extension programmes in those areas. The remaining 24 operational areas was being managed by the Hohoe District Directorate of MOFA with 24 extension agents (MOFA, 2005b; Personal communication with District Director of MOFA, 15/9/06).

3.3 Site Selection and Sampling Procedure

The communities were selected with the assistance of the District Directorate of the Ministry of Food and Agriculture, where issues relating to the farmers' access to plant materials of the new cassava varieties, the relative distance to marketing centres and accessibility to the various communities, by the researcher, were taken into consideration. The identification of the farmer groups and individuals who had adopted the new cassava varieties and the key informants was undertaken with the assistance of the District Directorate of the Ministry of Food and Agriculture.

Purposive and snowball sampling methods were then used to select the participants for interviews and observations (Ruane, 2005; Scheyvens & Storey, 2003). In the purposive sampling method, the farmers, who were part of the secondary and tertiary multipliers,

were selected from some of the communities, on the basis described above. Individual farmers, in addition to groups of farmers were interviewed. One of the group interviews was conducted in the form of a group discussion (Figure 3.1) to facilitate the gathering of various ideas on a particular issue, at the same time.

Group interviews helped individual members to explicitly state their perceptions and views (Punch, 2005). On the other hand, individual members of some of the groups were interviewed individually, so that everyone had the opportunity to express their opinions relating to the issues. With regards to the snowball sampling method, farmers who were not part of the programme were identified and selected for interview, with the help of the participating farmers (Ruane, 2005; Scheyvens & Storey, 2003). The interviews were conducted with respondents in seven out of twenty four (24) of the operational areas in the district.

Figure 3.1: The researcher in discussion with a farmers' group
Photographed at Goviefe Kowu- 31/5/2006

The researcher was offered the opportunity to interview four of the agricultural extension agents, from the group of the seven allocated to the operational areas, where the farmers were interviewed. In total, fifty four (54) respondents were interviewed. This was comprised of four extension agents and 50 farmers, which included twenty three (23)

females and (27) males. Amongst the respondents were three 'opinion' leaders (a chief, an assemblyman and a tutor in one of the secondary schools in the district).

The opinion leaders in this case were the people who hold various leadership roles in the community. They are influential, in terms of their roles and they are also a source of information for the community members. These are people whose social status in a community is considered to be above average and they are given due respect, although their position may be difficult to define in any given society (Spence, 1994). The opinion leaders tend to be well-known people in their communities, particularly within the immediate environment and as such most extension agents attempt to contact other community members, to explain the new ideas or practices through them (Rogers, 2003). This helps the extension agents to get information to other members of the community.

The assemblymen/women are the immediate political leaders of the communities and they represent the local government of the area. The chiefs are the traditional leaders of the various communities. These leaders are informed of any development programme being introduced into their respective communities, by private or government institutions, since they can help the people implementing the programme to get in contact with the target groups. Primarily the extension agents work with the farmers, in order to facilitate the flow of information to these farmers and to help them apply the knowledge that have acquired, relating to the new cassava varieties.

Following identification of the farmers, a time and venue, convenient to the respective respondents, was scheduled two to three days ahead, since this was the major farming season time and the farmers were busy with farming activities.

3.4 Data Collection

The data collection was carried out between May and June 2006. Primary and secondary sources of data were used in gathering relevant information for this study. The primary data was collected through taped semi-structured interviews with farmers, extension officers and other opinion leaders. These interviews were supplemented by field observations, undertaken at the time of the interviews. The researcher used an interview

guide (Appendix 1) with a prepared list of general topics based on the literature. An interview is one of the important sources of information for case studies (Yin, 1994, 2003). In this case study, the interviews were conducted as guided conversations, in which the researcher ensured that a consistent line of enquiry was pursued, in order to avoid unnecessary diversions (Yin, 2003). This also allowed the respondents to express their diverse views on the topics (Thomas, 2003).

Farmers who have or have not adopted the cassava technology and the opinion leaders were interviewed in the local language, with which the researcher is familiar. The interviews with the agricultural extension agents were conducted in English. Field notes were taken during the various interviews, in addition to field observations. The field notes were undertaken as a back up for the taped interviews, in case of any eventuality, such as damage or failure of the tape recorder. Observation is another means of gathering information (Creswell, 1998; Thomas, 2003). This can be done by watching and/or listening to the events live or later on a recorded version. The researcher observed a number of the cassava farms and other relevant events, such as the processing of cassava dough (figures 4.2 – 4.3 and 4.6 – 4.10), in some of the communities, both in and outside the district.

The secondary information was accessed through a document analysis of files from the district and national offices of the Ministry of Food and Agriculture. The use of these documents was to substantiate and augment the evidence gathered from other sources (Creswell, 1998; Thomas, 2003). There were personal communications with the District Director of the Ministry for clarification and updates on some of the evidence in a number of the documents.

Multiple sources of information were used to ensure the research findings were more rigorous and accurate within the data triangulation process. This was intended to help address the issue of validity and thus improve the quality of the results (Yin, 2003), since any information collected from one source could be verified with information gathered from another source. The information gathered from the farmers and the key informants was compared with the documents obtained from MOFA and the sponsors of the RTIP.

3.5 Data Analysis

Qualitative data analysis was used to analyse the data collected for the study. This was based on the iterative spiral process (figure 3.2), which involves the processes of describing, classifying and connecting the data to give specific conclusions (Dey, 1993). In describing the raw data, the situation within which the study was undertaken and the expressions of the participants were taken into consideration, in addition to the whole process of interaction (Dey, 1993). The classification process involved categorising the data and identifying relationships and connections (Dey, 1993). Some of the interview tapes were transcribed, in order to provide a basis for the analysis of all the interviews, whilst the remaining tapes were listened to, in order to crosscheck and expand on information gathered from other sources.

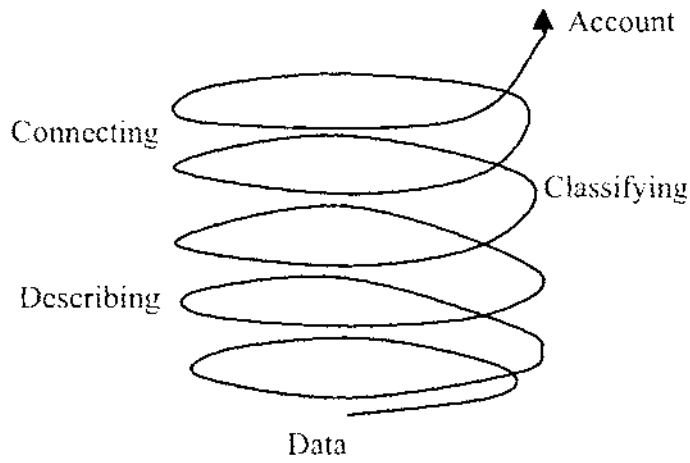

Figure 3.2: The Data Analysis Spiral (Dey, 1993:53; Creswell, 1998:143)

From the first three tapes selected, a framework was developed for analysis of the data. The categories identified were used as the basis for identifying other categories and relationships in the remaining tapes that were listened to. In the process, errors were corrected and new categories, concepts and relationships were identified, whilst each interview was summarised. Developing categories of information is an approach used to reduce the data to a manageable format for analysis (Creswell, 1998; Punch, 2005).

Table 3.2: An example of categorising data

Transcript summary	Categories of factors
What are the problems you encountered with cultivating the new cassava varieties?	
I have seen that when you plough the land before planting, it gives more yields than when the land is not ploughed. When the tractor comes to plough the yield is better. When you uproot them and you leave the stems around, without protecting them or burying them in the soil, they dry up quickly. The suitability for fufu depends on the soil types. There are some areas when the land is nearer to a mountain - when you grow them there it is good. We got a market for it but the price is not stable, we sometimes give it out on credit for a long time and even some people have not finished paying until now, that has been for two years	Soil characteristics Attributes of technology, Economic and social factors
Does it mean that it is only the new cassava you found difficult to market?	
Even the local ones. It is a general problem with the marketing aspect. There is no marketing centre in Hohoe. With regards to our farming situation here, the most important problem is that there is no marketing centre. Transport to our rural areas and the farming communities, is another problem, our road network is not good and the farms are also far from home. When you set off to the farm by the time you reach there you have travelled one mile already, you are exhausted. Secondly, hiring labour, the money for hiring labour. When you get a market you can hire labour, that's why marketing is also a problem. Some of the NGOs also promised to give us money to farm rice. Madam, we worked towards that and we had deposited some money for it but up till now, another rice farm has started again yet we've not made any headway.	Economic and situational factors Situational factors Access to input, institutional support,
How do you see the work of the extension officers?	
When I guard a rice farm, which was finished, and I was paid he came for part of the money. When they are asked to do something then they want to gain from it. He was given four hundred thousand to bring to us to work and he took a hundred thousand from it and only brought three hundred thousand cedis. So the extension officers are nothing before us.	Relationship with extension workers

The table above (Table 3.2) is an example of data categorisation. In the section highlighted, a question was posed on whether the marketing difficulty was related only to the new cassava varieties? The farmers, who were contacted, indicated that the marketing difficulty was a general problem and included the marketing of various agricultural produce, including both the new and the old cassava varieties. This was basically due to the absence of a vibrant market centre in the Hohoe township, the district's capital. Transportation difficulties were also linked to the marketing problems. These were due to the poor road network, which hampered the movement of agricultural produce from the rural communities to the nearby markets. These factors are categorised as economic and

situational factors, because they affect the source of income generation and they are also related to the environment of the respondents.

3.6 Ethical Consideration

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). A verbal consent was sought from the participants before the interviews, field observations or other information gathering methods, for example, the taking of photographs. 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). The purpose of the study was explained to the participants at the beginning of the various interviews, so that they could decide to be part of the exercise or decline. The rights of the participants were taken into consideration, regarding their anonymity and therefore they were informed of these rights and hence the researcher did not require any of them to mention his/her names before or after the interviews. The respondents were also assured of confidentiality regarding the information provided.

3.7 Summary

A single case study approach was used, with the case selected being an example of an extension initiative, which was directed towards the uptake of cassava technology, in order to improve the livelihood situations of farm households in the Hohoe District. The communities were selected, taking into consideration: farmer access to cassava stems for planting; the relative distance to marketing centres; and accessibility to the various communities by the researcher.

Data collection was undertaken using semi-structured interviews and field observations, in cognisance of ethical issues. A framework for data analysis was developed, based on the transcribed interview tapes. The data was then described through the identification of categories and relationships, after which the results were compared and contrasted with theory and conclusions were drawn, which indicated any policy implications and possibilities for further research in the area.

Chapter Four: Study Background and Case Description

This chapter provides a description of the background in the case under study. The history of agricultural extension and the emergence of various extension approaches in Ghana over the years are outlined. Agricultural practices and livelihood conditions in the study area are briefly described.

4.1 Research Background

The case under study is a district level extension initiative, directed at achieving the adoption of improved cassava varieties, under the Root and Tuber Improvement Programme. The success of the programme's implementation process, by the Ministry of Food and Agriculture, dwelt much on the effectiveness of the extension activities, in addition to the farmers' circumstances. The next section reviews the extension system in Ghana, in terms of the structural reforms that have taken place in line with the government's decentralisation policies and their possible influence on these extension approaches and the general service delivery.

4.2 Structural Reforms in Ghana's Extension System

Agricultural extension in Ghana is similar to that which exists in other developing countries. However, structural reforms in the extension system in Ghana have occurred in line with changes in the political economy of the country (Amezah & Hesse, 2003; MOFA, 2003). Agricultural extension activities before 1957, were directed towards improvement in the cultivation of cash crops, particularly cocoa and therefore crops grown for subsistence were ignored (Amezah & Hesse, 2003). However, after independence in 1957, an agricultural development strategy was adopted to help increase agricultural productivity, through rural development and the utilisation of new and existing technologies (Amezah & Hesse, 2003).

Various extension strategies were tried to improve service delivery, including a service provision under the farmers' co-operative movement and donor agencies (Amezah & Hesse, 2003; MOFA, 2003). The modernisation process of traditional farming practices was implemented in the 1960s, when the United Ghana Farmers' Co-operative Council was providing extension services (MOFA, 2005a). The Focus and Concentrate Programme, sponsored by USAID, supplemented these services (Amezah & Hesse, 2003; MOFA, 2003). The Focus and Concentrate Project and the United Ghana Farmers' Co-operative Council together sought to increase farmers' access to, and availability of, inputs and technical advice (Amezah & Hesse, 2003; MOFA, 2003).

The individual technical departments, within the then Ministry of Agriculture, were separately providing extension services to farmers in the 1970s and 1980s (Amezah & Hesse, 2003; MOFA, 2003), but the establishment of the Department of Agricultural Extension Services, in 1987, brought the extension services under one umbrella (Amezah & Hesse, 2003; MOFA, 2003). However, extension service provision to cocoa and coffee farmers still remained with the Cocoa Services Division of the Ghana Cocoa Board (Amezah & Hesse, 2003; MOFA, 2003, 2005a). The Ghana Cocoa Board (COCOBOD) is a government owned marketing board for cocoa. Under the Cocoa Services Division, extension agents provided technical advice and distributed agricultural inputs to the cocoa and coffee farmers (Amezah & Hesse, 2003; Donkoh & Amezah, 2003).

As part of efforts to encourage other related organisations to support the cocoa industry and to improve the cost-effectiveness of services, the Cocoa extension service was merged with MOFA's in 1998 (Amezah & Hesse, 2003; MOFA, 2003).

4.3 Government's Decentralisation Policy and Extension

The Ministry of Food and Agriculture (MOFA), in 1997, restructured its organisational and management operations from one central unit and established ten Regional Agricultural Development Units (RADUs) and one hundred and ten District Agricultural Development Units (DADUs) (Amezah & Hesse, 2003; MOFA, 2003). These units were to be responsible for the co-ordination, management and implementation of projects and

programmes at the regional and district levels, respectively (Amezah & Hesse, 2003). This was in line with the government's decentralisation policy, where administrative power was delegated to people at regional and district levels (Amezah & Hesse, 2003; MOFA, 2003). The decentralisation policy was adopted as a result of inefficiency in the centralised system of governance and its inability to respond to the specific needs of the people (MOFA, 2003, 2005a).

The conventional centralised system had a single line of command from the national to the local government level (Amezah & Hesse, 2003; MOFA, 2005a). Resources were allocated from the national office to the various departments at all levels. The Ministry's technical departments managed their staff and other resources, including the allocation of funds and human resources (Amezah & Hesse, 2003). MOFA also opened 45 Subject Matter Specialist Centres to provide technical support to the Agricultural Extension Agents (Amezah & Hesse, 2003).

Under the decentralisation programme, a Regional Director of Agriculture manages all agricultural programmes and activities at the regional level and the District Director controls operations at the district level (Amezah & Hesse, 2003; Ghanaweb.com, 2007b). As such, the various departments of crops, fisheries, livestock, policy planning, monitoring and evaluation, veterinary services, plant protection and regulatory services and agricultural engineering services were put together under one directorate, headed by a District Director of Agriculture at the district level (Amezah & Hesse, 2003; Ghanaweb.com, 2007b).

However, concerns regarding farmers' participation in planning, preparation of budgets and accountability have not been fully addressed in this restructuring process (Amezah & Hesse, 2003; MOFA, 2003, 2005a). The process of decentralization is identified as one of deconcentration (Amezah & Hesse, 2003). This is due to the fact that the decentralised system, although it has relayed some responsibilities to the regional and district level government authorities, still retains the public service delivery and funding features of a centralised system of extension.

4.4 Extension Approaches and Concepts in Ghana

Over the years, approaches employed by extension organisations in extension service delivery in Ghana have changed, as a result of policies and new ideas. The Training and Visit system (T & V) of extension was adopted by the MOFA in the 1980s, to provide farmers with relevant information and knowledge, through regular training programmes (Amezah & Hesse, 2003). This training and visit approach, sponsored by the World Bank and other donors, involved the regular training of extension agents and Subject Matter Specialists (Amezah & Hesse, 2003). This was done to provide regular visits to farmer groups by the extension agents, in order to improve efficacy in programme management and service delivery of MOFA (Albert et al., 2001; MOFA, 2003). The extension message and the advisory service delivery focused on production technology, with an emphasis on the major food crops (Albert et al., 2001). This was the basis upon which the system was termed the 'commodity approach' as indicated earlier in Chapter Two.

The extension agents encouraged and enhanced information delivery and knowledge to the farmers, relating to basic agricultural technologies (Amezah & Hesse, 2003; Ntifo-Siaw & Agunga, 1994). The agricultural extension agents interacted with the farmers, through farm demonstrations, training and discussions with farmer groups (MOFA, 2003).

The T & V system was modified into a Unified Extension System in 1992 (Amezah & Hesse, 2003; Donkoh & Amezah, 2003; MOFA, 2003) so that extension agents could increase the scope of their work to cover other aspects, such as helping farmers form groups to enhance access to information. The focus was on farmer group activities, rather than on individual farmers and there was a reduction in the regular training activities to once a month or in some cases once in two months (Amezah & Hesse, 2003; Donkoh & Amezah, 2003; MOFA, 2003). The modification of the T & V system was facilitated by the World Bank and sponsored National Agricultural Extension Project (NAEP) and this was implemented from 1992 to 1999. The NAEP aimed to improve efficiency in the extension service delivery, whilst also strengthening MOFA's technical departments (MOFA, 2003). Under the Unified Extension System, information regarding improved agricultural practices and other relevant issues were extended to the farmers by the extension agents, with technical support from the Subject Matter Specialists (Amezah & Hesse, 2003; Donkoh & Amezah, 2003; MOFA, 2003).

The Subject Matter Specialists, agricultural extension agents and the farmers worked closely with the Research Extension Liaison Committees, formed in 1991, to assess technology adoption by farmers and examine research and extension programmes, in terms of their importance to agricultural development (Amezah & Hesse, 2003; MOFA, 2003, 2005a). A Research Extension Liaison Committee, which operated over a number of regions, consisted of researchers, a Regional Director of Agriculture, Subject Matter Specialists, a Regional Development Officer, representatives of the farmers and Non-Governmental Organisations and input suppliers (MOFA, 2003, 2005a). However, the committees were unable to respond to the specific needs of the various regions and districts under their jurisdiction (Amezah & Hesse, 2003; MOFA, 2003, 2005a).

The Unified Extension System was administratively structured such that a senior technical officer co-ordinated the activities of the technical staff and then reported to the regional director, for onward submission to the national director (MOFA, 2003, 2005a). Prior to 1987, there was a duplication of services when the various technical departments of MOFA were providing separate extension services to farmers (Amezah & Hesse, 2003; Donkoh & Amezah, 2003).

The Unified Extension System helped to eliminate the duplication of extension activities, by improving the extension service provision under the Department of Agricultural Extension Services (MOFA, 2003, 2005a). However, a review of programmes with this approach revealed a lower adoption rate of introduced technologies, particularly for technologies requiring external inputs, although there was a high level of awareness (Amezah & Hesse, 2003). This was in part attributed to the government's trade liberalisation policy, which had led to the removal of agricultural subsidies and a resultant increase in the price of inputs (Amezah & Hesse, 2003).

The Farmer Field School approach to extension was introduced in Ghana in 1995, with the help of the FAO Global IPM Facility (Albert et al., 2001). It involved a participatory type of extension and focused on the facilitation of learning by farmers. The agricultural extension agents were trained to facilitate the farmers in learning or acquiring knowledge, relating to the integrated production and pest management practices of different crops (Albert et al., 2001). This approach helped to train almost 6,000 farmers and 400 extension agents (Albert et al., 2001). The focus was on one crop at a time, within a

particular season. In addition to MOFA, there were other private organisations and institutions, such as UNDP, FAO and the Savannah Agricultural Research Institute, that undertook agricultural extension projects with the Farmer Field School approach (Albert et al., 2001; MOFA, 2003, 2005a; Simpson & Owens, 2002).

MOFA also encouraged private sector participation in extension services, in order to make the extension activities more competitive and thereby improve the farmers' access to the extension agents. This was a result of the low extension agent-farmer ratio. In 1998, According to Fiadjoe (1998 cited in (Amezah & Hesse, 2003), the ratio was found to be 1:1500. Whilst, the ratio was supposed to be reduced, in order to enhance efficiency in service delivery, the IMF (2004), on the contrary, indicated that it had in fact tripled to 1: 4500 in 2003.

Currently in Ghana, there has been increased private sector participation in the provision of extension services. Private organisations, such as cotton companies, pineapple exporters, NGOs e.g. TechnoServe, Sasakawa Global 2000 and farmer cooperatives and associations e.g. GNAFF, are involved in extension services delivery throughout the country (Albert et al., 2001). Some other extension approaches are being implemented on a pilot basis. For instance, the Participatory Technology Development and Extension and the Integrated Pest Management programmes, together with the Farmer Field Schools are the subject of an experiment within the rural communities, by the MOFA, in collaboration with FAO and GTZ (Albert et al., 2001; MOFA, 2003). The Farmer Field School concept was used under the IFAD sponsored Root and Tuber Improvement Programme (IFAD, 2005b; MOFA, 2002c). The next section describes the case under study.

4.5 Case Description

The data was collected in the Hohoe District of the Volta Region of Ghana (Figure 4.1). The Hohoe District is one of 15 administrative districts in the region. It covers an area of 1172 square kilometres (117,200 hectares), which represents 5.6% of the regional land area and 0.5% of the national land area (Ghanaweb.com, 2007c; MOFA, 2005b). This district shares common borders with the Republic of Togo on the east, the Ho District on the southeast and the Kpando District on the southwest. The Jasikan District occupies the

northern side (Ghanaweb.com, 2007c). The Hohoe District had an estimated population of 144,502 in 2000, with a 1.9% annual population growth rate (MOFA, 2005b), , which is also the average for the region (Ghanaweb.com, 2007c).

Figure 4.1: Ghana map showing the study area

The district has the highest mountain in the country, Afadjato, which is 885 metres high and other highlands including the Akwapin-Togo range, that stretches across the eastern part of the country to Togo and beyond (MOFA, 2005b). It has a perennial water source from the river Danyi and other streams (Ghanaweb.com, 2007c). Ghanaian agriculture is rain fed and hence weather dependent. The district experiences two distinct rainy seasons, of which the major one starts in April, and going through to July and the minor season falling between September and November. The annual rainfall ranges between 1100mm and 1500mm (MOFA, 2005b). Occasionally, the rainfall pattern changes and there is continuous rain from April through to November.

The table below (Table 4.1) shows variations in the rainfall pattern, between 1996 and 2005. Although, the annual rainfall for 1997 was 1639mm, the district experienced the least number of wet days, which was 70 days in that year. The highest number of wet days, 104 days, was recorded in the year 2005.

Table 4.1: Annual rainfall figures of wet days from 2005 back to 1996

Year	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996
Annual rainfall (mm)	1,224	1,394	1,424	1,557	1,108	1,635	1,566	897	1,639	1,234
Wet days	104	95	95	101	99	77	90	71	70	75

Adapted from the Hohoe District Profile (MOFA, 2005b)

The district falls within the forest-savannah transitional agro-ecological zone of Ghana (Ghanaweb.com, 2007c). Parts of the southern and eastern sides, in addition to a stretch of land in the middle of the district, are covered with forest, which is gradually diminishing as a result of human activities (MOFA, 2005b).

The soils are normally sandy with iron pans beneath, which cause poor drainage and extreme soil moisture variations. The soil groups ranged from the forest zone ochrosols with oxysols intergrades to savannah types. Both savannah and forest crops do well in the district but soil fertility is gradually becoming an issue (MOFA, 2005b). Some of these crops are cocoa, coffee, oil palm, banana, plantains, rice, cassava, yam, maize, groundnut and mango (Ghanaweb.com, 2007c). There is a high level of soil nutrient depletion, due to the annual destruction of the vegetation cover by bush fires and the conventional slash and burn method of land preparation (MOFA, 2005b).

The district is comprised of eight major ethnic groups (Table 4.2). The Ewes are the predominant ethnic group (MOFA, 2005b). Some other tribes in the district also speak the Ewe language. The population of some ethnic groups had increased, within the five year period from which the statistics were taken (MOFA, 2005b) The populations of the Ewe and the Logba ethnic groups have decreased within the period between 1995 and 2000. However, the Santrokofi and Tafi ethnic groups gained some increments within the same period. The smallest ethnic group in the district is the Nyagbos (MOFA, 2005b).

Table 4.2: Ethnic Groups within the Hohoe District

Ethnic Group	Language spoken	1995		2000	
		Population	%	Population	%
Ewe	Ewe	95,497	66.47	104,664	66.04
Akpafu (Kawu)	Siwu	8,158	5.67	8,964	5.65
Lolobi	Siwu	7,100	4.94	7,815	4.93
Santrokofi	Sele	4,687	3.26	5,851	3.69
Likpe (Bakpele)	Sekpele	14,286	9.94	15,699	9.9
Logba	Ikpana	6,727	4.68	7,334	4.62
Tafi	Tegbor	3,629	2.52	4,212	2.65
Nyagbo	Tetrugbu	3,582	2.49	3,938	2.48

Adapted from the Hohoe District Profile (MOFA, 2005b).

Farming is the predominant occupation of the people in this district. Approximately 70% of the population are engaged in agricultural activities (Ghanaweb.com, 2007c; MOFA, 2004b). The farming activities are carried out mostly by smallholder farmers, with land holdings of approximately 0.5ha (MOFA, 2005b). Nearly every farm household cultivates cassava, for both domestic consumption and for the markets (MOFA, 2004b). The estimated number of cassava farmers in the district, as of 2003, was 21,000 (MOFA, 2005b).

The main avenue for the sale of agricultural produce, by farmers in the district, is through the local markets, which are located in some of the communities. There are different market days for the various communities in the district. Whilst some communities have fixed days within the week for marketing, others rotate the days (MOFA, 2005b). The fixed days can be every Friday, whereas for those who rotate, it can be either every other fourth or fifth day. For instance, if the market day falls on a Tuesday, the next one will come on Saturday. Generally the mode of sale in the market is by price bargaining and the products are sold by size, quality and appearance, but not by weight (MOFA, 2005b). Grains are normally sold with specific measuring units, such as olonka, margarine tins or bowls (MOFA, 2005b). Women generally carry the agricultural products to the market place.

Traditional hand tools, plant materials and livestock breeds, which do not produce high yields, are mostly used by the smallholder farmers. Only a few of the smallholder farmers use non-traditional farming practices (MOFA, 2005b). Whilst cash crops are grown as sole crops, food crops such as maize, cassava, cocoyam, plantain and legumes are often grown as intercrops (Figures 4.2a & b). Livestock is generally integrated into the farming system, particularly the smaller farm animals (MOFA, 2002a).

Figure 4.2a: A cassava farm intercropped with cocoyam and oil palm
Photographed by the researcher at Gbi Kledzo – 17/5/2006

Figure 4.2b: A cassava farm intercropped with plantain
Photographed by the researcher at Gbi Kledzo – 17/5/2006

The Ministry of Food and Agriculture main role is the formulation of appropriate agricultural policies, planning and co-ordination and the monitoring and evaluation of agricultural programmes, for Ghana's economic development (Ghanaweb.com, 2007b). The ministry aims to improve agriculture productivity and increase in household incomes and employment opportunities for Ghanaians. It also sees to the establishment of an effective linkage between agriculture and industry (Ghanaweb.com, 2007b). MOFA is structured in accordance with the government's decentralisation policy and the national secretariat is in charge of finance and administration, policy planning, monitoring and evaluation at the national level, together with human resource development and management, statistics, information and public relations and research activities (Ghanaweb.com, 2007b).

The regional and district directors of agriculture (DDAs) oversee the administration and management of the regional and district agricultural development units, respectively (Ghanaweb.com, 2007b; MOFA, 2003). The DDAs also implement district level agricultural development programmes and they establish and update district profiles (MOFA, 2003). Staff development programmes are designed and implemented in collaboration with the Regional Directors of Agriculture (RDAs), whilst ensuring that the

training and technical support for agricultural extension agents are carried out effectively (MOFA, 2003). In addition, DDAs also liaise with related organisations, in the implementation of agricultural programmes at the district level.

At the administrative level below the DDA, is the District Development Officer (DDO), who works to ensure the timely implementation of planned activities. The DDOs monitor and evaluate the programme of work for the extension agents (MOFA, 2003). They also help with the establishment of the district profiles and assist the extension agents to develop work calendars and programmes: they are also involved in data collection (MOFA, 2003).

In addition to RTIP, a number of other extension and rural development projects are underway in the district. Some of these projects include NERICA (New Rice for Africa), PSI (President Special Initiative), FBO/EDFP, GATSBY (Rice Project), the Cocoa Hi-Tech Project, the Cocoa Pest and Disease Control Project and the Livestock Development Project. Generally, these projects are being organised and financed by non-governmental organisations and international donors, for example, the African Development Bank (MOFA, 2005b). The RTIP was introduced into the district in the year 2000 by the Ministry of Food and Agriculture (Ghanaweb.com, 2007c; MOFA, 2004a). Phase one of the Root and Tuber Improvement Programme has just been completed and plans are under way for the second phase to begin (IFAD, 2005b) IFAD, 2007).

4.6 The Root and Tuber Improvement Programme

The Root and Tuber Improvement Programme (RTIP) was designed and implemented to improve agricultural productivity for sustainable livelihoods, by assisting farm households to grow new crop varieties, that produce yields which can be sold and thereby generate income for those households (Ghanaweb.com, 2000b; IFAD, 2005a, 2007; MOFA, 2002c). This also was part of efforts to use the agricultural sector as a catalyst for rural development and the improvement of rural livelihoods. The programme was introduced in the Hohoe district in the year 2000. The main aim was to ensure food security and to provide income generation and employment opportunities for the poor, rural farmers in the district (Ghanaweb.com, 2007c). The entire programme was

scheduled to be completed by 31st December, 2004, but it was extended to 30th September, 2005, with approval from IFAD (IFAD, 2005b).

The MOFA implemented the programme and the extension services division was entrusted with the dissemination of the new cassava varieties. Other government departments and research institutes, such as the International Institute for Tropical Agriculture (IITA), the Savannah Agricultural Research Institute, the Crops Research Institute, the Crops Services Division, the Grains and Legumes Development Board and the public universities were also involved in organising and providing technical support for the programme (IFAD, 2004, 2007; MOFA, 2002c).

4.6.1 Plant Material Multiplication and Distribution

The multiplication and distribution of cassava plant materials was one of the components of the RTIP. This was carried out in three stages and each stage is described below.

Primary multiplication stage

At the national level, the various research institutes and the Grains and Legumes Development Board worked collaboratively to make plant materials more accessible to the farmers, in the districts in which the programme was to be implemented. The new cassava plant materials were multiplied at agricultural research stations and distributed to the farmers (IFAD, 2005b, 2007; MOFA, 2002c).

Secondary multiplication stage

At this stage, some individual farmers, in addition to farmer groups were selected as secondary multipliers in the various districts, in order to grow the cassava for onward distribution to the farming communities (IFAD, 2005b). A number of the secondary sites in the Hohoe district were at Have, Ve-Koloenu, Fodome, Santrokofi and Likpe. The MOFA explained to the secondary multipliers that the cassava stems would be coppiced for two consecutive years for further distribution to other farmers. Two-thirds of the cassava stems were coppiced and distributed to the tertiary multipliers. The secondary

multipliers were to either keep the remaining one-third or sell it back to the RTIP (IFAD, 2005b). The MOFA also agreed to assist these farmers financially in their land preparation and the weeding of the farms (IFAD, 2004).

Tertiary multiplication stage

The third stage involved the multiplication of the new cassava varieties by interested farmer groups and their distribution for cultivation, to the members of the group and other community members (IFAD, 2004; MOFA, 2002c). Some conditions were used in the selection of the tertiary farmers. One of the conditions was that a tertiary multiplier should be a resource poor farmer and he/she should belong to a group of about 5-15 farmers, with 0.4 -1.2 ha of cassava farm each. However, the criteria used to identify and select the resource poor farmers, by the extension organisation, were not defined. Another condition was that the farmers should also be people who did not own their own land but instead they rented or practised sharecropping and also that, they resided within 20 kilometres of the secondary sites. In addition, the farmers involved should be those who have had difficulty in accessing credit from formal sources (IFAD, 2004).

The conditions were in recognition of the rationale underlying the cassava technology dissemination programme. This was to help increase the household incomes and to ensure food security and sustained livelihoods for the people, particularly, the resource poor ones (Ghanaweb.com, 2007c; IFAD, 2005b, 2007; MOFA, 2002c).

In the Hohoe District, in 2000, eight individual farmers cultivated 9ha of the new cassava varieties, which had been distributed, in 2001, to 45 farmer groups, who had planted 14ha of tertiary multiplication sites (Ghanaweb.com, 2007c). Nine farmers cultivated approximately 13.1ha of the cassava at secondary multiplication sites in 2001, whilst, 91 farmer groups planted 40.4ha of it at the tertiary level in 2002 (Ghanaweb.com, 2007c). A total of 21 secondary multipliers developed 30.52 ha of plant materials in 2002, for distribution to interested farmer groups in 2003 (Ghanaweb.com, 2007c). In 2003, a total of 11.85ha were developed as secondary multiplication sites, against a target of 10ha, but MOFA accepted and paid for only 6.18ha of plots. This number of plots was for four individuals and one farmer group (MOFA, 2004d).

5.67ha of plots were rejected, due to poor maintenance. With regards to the tertiary multiplication sites, the district targeted 100ha of plots, with an expectation of covering 3000 farmers. The number of farmers involved was in fact only 1,138 and the majority of them were individuals, although the total area of plots developed exceeded the target by 20ha (MOFA, 2004d). This would suggest that non-resource poor farmers were involved at the tertiary sites, since the total land size exceeded the target, despite the fact that the number of farmers was far less than half of the set target.

Training programmes were organised by the MOFA, for the extension agents to enhance their knowledge in participatory methods and group dynamics (MOFA, 2002c). The intention was to equip the extension agents in community mobilisation and to give them knowledge of awareness creation activities. This was to ensure efficient and effective dissemination of the developed technologies, and an enhanced awareness creation amongst the farmers, concerning the improved crop varieties (MOFA, 2002c; Owusu-Ansah et al., 2005). Albert et al., (2001), defined effectiveness as being how relevant the extension message is, in terms of meeting the goals, objectives and the needs of the farmers, whilst efficiency relates to how the goals are met in terms of their cost effectiveness.

The Ministry of Food and Agriculture also engaged in in-service training programmes, so that the extension agents could enhance their knowledge and competence in disseminating the cassava technology (MOFA, 2002). The extension agents contacted in this research were educated about the new varieties and given information on the expected benefits (MOFA, 2002). The MOFA also organised training workshops for the farmers to help them acquire knowledge in book-keeping and other improved farm practices, including row planting and pests control methods.

Further research on the improvement of the shelf life of the plant materials was encouraged by the project partners, during the implementation of the programme, in order that plant material could be preserved in root and tuber producing areas, where rainfall was erratic (MOFA, 2002c). The three-stage multiplication and dissemination process, of the new cassava varieties, was designed to ensure a gradual but effective distribution of the improved crop varieties to the farming communities and also to promote adoption (MOFA, 2002c).

As part of the awareness creation exercise, the Hohoe District Directorate ensured that radio announcements were made on the regional FM station, Volta Star Radio, concerning the availability of plant materials in the district (MOFA, 2004d). In the Hohoe District in 1994, a number of workshops, relating to the processing of cassava into cassava flour, were organised for some of the farmer groups, as part of efforts to promote the industrial use of the crop (MOFA, 2004a).

4.7 Cassava

4.7.1 Origin and Propagation

Cassava (*Manihot esculenta* Crantz) originated in Brazil and Paraguay and was introduced to the western coast of Africa by slave merchants, around the sixteenth century (FAO, 1977). It is the second most important starchy root crop in the tropics, after the sweet potato (FAO, 1977). Cassava (Figure 4.3) according to Asafo (2001), was brought to Ghana by the Portuguese in the 1750s. It was steadily accepted and became one of the staple crops across the country, particularly in the southern part of the country (Asafo, 2001). It is vegetatively propagated, by the use of stem cuttings, although some of the varieties produce seeds (O'Hair, 1995). These seeds are generally used by research institutions as genetic material for the development of improved varieties (O'Hair, 1995).

Figure 4.3: A cassava farm in Ghana (mono-cropped)
Photographed by the researcher at Goviefe Kowu – 31/5/2006

4.7.2 Environmental Requirements

Cassava thrives well under marginal conditions. It requires at least eight months of warm weather to produce a crop, although under adverse conditions, such as cool or dry weather, it takes about 18 months to produce a reasonable yield (O'Hair, 1995). It is drought tolerant and requires few production skills and inputs into its cultivation (Polson & Spencer, 1991; Prudencio & Alhassan, 1994). It can also produce reasonable yields in less fertile soils (Howeler et al., 2001; Polson & Spencer, 1991; Prudencio & Alhassan, 1994). Cassava can be grown as a sole crop but it is usually intercropped with other crops. This is to minimise or eliminate the risk of complete or partial crop failure associated with a monoculture system (Polson & Spencer, 1991). Intercropping with other crops also helps to maximise land and labour use, whilst providing a source of a more balanced diet for the farm household (Polson & Spencer, 1991).

Cassava thrives in almost every part of the country and it is one of the staple foods for Ghanaians. In Ghana, cassava is cultivated as a sole crop or intercropped with maize and or other crops during the major or minor farming seasons. Subsistence or smallholder farmers mainly carry out its cultivation. It is estimated that about 1.55 million farm

households cultivate cassava in Ghana, covering about 726,000 hectares, with yields of 11.8 tonnes per hectare (MOFA, 2002b, 2002c). It is estimated that there is the potential to increase these yields to 28 tonnes per hectare (MOFA, 2002b, 2002c).

4.7.3 Uses of cassava

Cassava is consumed fresh or in processed forms, such as gari- cassava granules (Figure 4.4), chips (kokonte – peeled dried tubers), dough (pulp), flour, salad cream, confectioneries, pastries, tapioca (Figure 4.5) and some other staples (Ghanaweb.com, 2000a; MOFA, 2002b).

Figure 4.4: Gari (processed from grated cassava tubers)

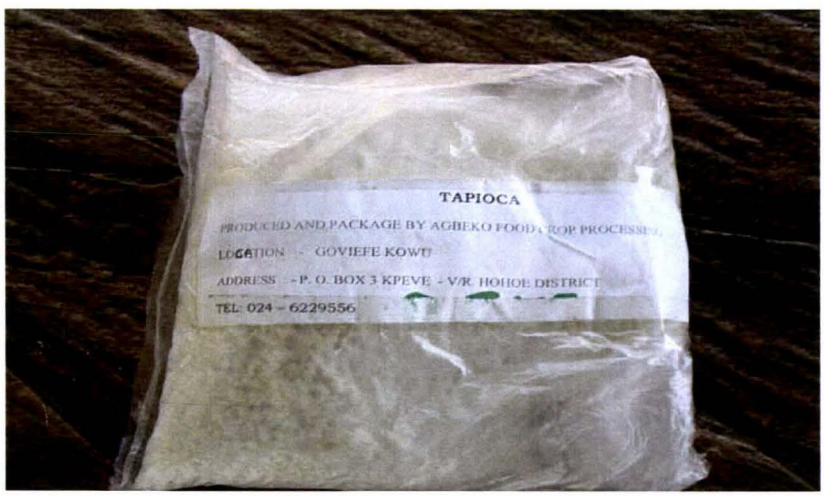

Figure 4.5: Tapioca (processed from cassava starch)

Figures 4.6 through to figure 4.10 show how the farmers process cassava dough using conventional methods. The photographs were taken at Juapong in the North Tongu district, since the researcher could not witness any of such events in the case study area during the interview period and it is a fact that the process is the same throughout the country. The cassava tubers are first peeled and washed (Figures 4.6 & 4.7 respectively). These tubers are then sent to the mills where they are grated into paste (Figures 4.8) and then put into fertilizer bags under a heavy weight, normally big stones (Figures 4.9a & b), in order to squeeze out the sap. This sometimes takes three to four days, depending on the weight of the stones. They are then re-bagged for the market (Figure 4.10).

Figure 4.6: Women peeling the Cassava Tubers
Photographed by the researcher – 6/6/2006

Figure 4.7: Children helping with washing of the Peeled Cassava Tubers
Photographed by the researcher – 6/6/2006

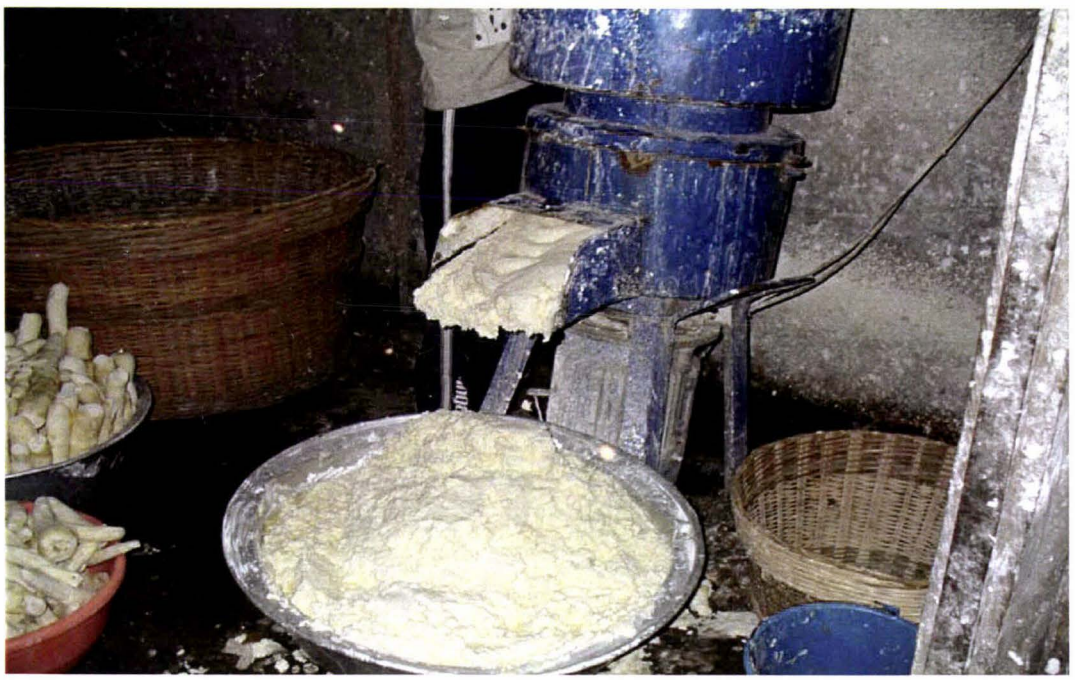

Figure 4.8: Milling of Cassava Tubers for Dough or Gari
Photographed by the researcher -6/6/2006

Figure 4.9a: Women packing the bagged cassava paste for pressing
Photographed by the researcher –6/6/2006

Figure 4.9b: Pressing the grated cassava (traditional and laborious)
Photographed by the researcher –6/6/2006

Figure 4.10: Bagged Cassava Dough ready for the market
Photographed by the researcher –6/6/2006

4.8 The New Cassava Varieties

The new varieties of cassava, introduced under the Root and Tuber Improvement Programme in the Hohoe District, include Abasa fitaa, Afisiafi and Tekbankye. All these varieties can be cultivated as sole crops or intercropped with other crops, during either the major or minor rainy seasons (Asafo, 2001). The southern part of Ghana experiences two rainy periods in the year.

The morphological characteristics of the three cassava varieties introduced are summarised in Table 4.3. The Abasa fitaa variety has yellow petioles with a brownish white outer skin of both the mature stem and the tubers (Asafo, 2001). It is a low branching type and more resistant to other cassava pests and diseases, except the cassava mosaic virus. Abasa fitaa is also high yielding, with about 26 to 31 tonnes/ha of fresh tubers coming from a one year old cassava plant (Asafo, 2001).

The variety called Afisiafi has a brownish grey mature stem with light green petioles (Asafo, 2001). This cassava plant branches a great deal, thereby helping to control weed

growth as the canopy closes over the ground (MOFA, 2004c). Afisiafi is more tolerant to major pests and cassava diseases. It is also high yielding, producing about 27 to 30 tonnes/ha of fresh tubers from a 12 month old plant (Asafo, 2001).

The Tekbankye has red petioles with a grey mature stem. It does not produce branches in the same way as the other varieties. But it is resistant to major cassava pests and diseases (Asafo, 2001). The tubers produce a large amount of water when grated. This may be the reason for the low dry matter content, despite the high yields of 26 to 31 tonnes/ha of fresh tubers (Asafo, 2001).

Table 4.3: Varietal characteristics of the new cassava varieties

Cassava Variety	Morphological characteristics	Potential yield (tonnes/ha) @ 12 months maturity	
		Fresh tubers	Dry tubers
Abasa fitaa	- Petiole is yellow - Mature stem brownish white - Tubers with brownish white outer skin - Short and low branching variety - More resistant to other cassava pests and diseases - Moderately tolerant to the African cassava mosaic virus disease	26 - 31	8 - 10
Afisiafi	- Petiole is light green - Mature stem is brownish grey - Light brown outer skin tubers - Branches a great deal - More resistant to major pests and diseases of cassava	27 - 30	9 -10
Tekbankye	- Petiole is red - Mature stem is grey - Does not form branches - Pale brown outer skin tubers - Moderately resistant to major cassava pests and diseases e.g. African cassava mosaic virus disease	26 -31	8

Adapted from Asafo (2001:12-15)

The level of cyanide (hydrocyanic acid) content in the tubers (Table 4.4) determines how poisonous the cassava is should it should be consumed when fresh. The cyanide content

of the cassava varieties affects the taste of the tubers. The fresh tubers, from the variety with high cyanide content, usually taste very bitter. The processed products have less cyanide content, since this is reduced through the processing stages. This means the cyanide content reduces in the process of converting the tubers into finished products, such as gari, tapioca, etc. All the new cassava varieties can be processed into cassava dough, gari and cassava chips (Asafo, 2001).

Table 4.4: Cyanide levels and some uses of the new cassava varieties

Cassava variety	Cyanide content		Uses
	Peeled fresh tubers (%)	Unpeeled tubers (%)	
Abasa fitaa	17.5	8.4 -24.0	-Cassava dough - Gari - Cassava chips - Fufu & boiled tubers
Afisiafi	15.0	13.0 - 25.5	- Cassava chips - Cassava dough - Gari
Tekbankye	-	44.22	- Cassava dough - Gari - Cassava chips - Fufu & boiled tubers

Adapted from Asafo (2001:12-15)

4.9 Summary

Agriculture's role in the economy of Ghana is very important. Agricultural extension in Ghana has gone through a number of reforms, in line with changes in ideas and policies over the years. Various approaches were adopted by the extension organisations, in pursuit of improving service delivery and increasing farmer access to information, as part of efforts to use the agricultural sector as a catalyst for rural and agricultural development. Private participation in extension service delivery is currently being encouraged, with some donor-assisted programmes being organised on a pilot basis.

The Hohoe district was amongst the first districts that implemented the root and tuber improvement programme. Agriculture is the predominant occupation in this district and cassava is one of the major staple foods. Although, there are several ethnic groups, with different languages and cultures, the people share a common issue of their dependence on agriculture as their main source of livelihood. The new cassava varieties, developed under the Root and Tuber Improvement Programme, were introduced into the district in the year 2000. This was to help farm households to increase their income levels and food security through the new, high yielding and early maturing cassava varieties. The community support and mobilisation component of the programme has helped created awareness about the improved cassava varieties and enhanced the farmers' access to plant materials.

Cassava was brought to Ghana by the Portuguese and became one of the staple foods in the country. It is cultivated in most parts of the country mainly by subsistence farmers. Cassava makes a significant contribution to the agricultural GDP of the Ghanaian economy. It is used fresh or in processed forms, such as gari, cassava chips, cassava dough, flour, and tapioca and also in confectioneries. The new varieties developed under the RTIP include Afisiafi, Abasa fitaa and Tekbankye. The new varieties are also tolerant to the major cassava diseases.

Chapter Five: Factors Influencing the Adoption of the New Cassava Varieties

As outlined in the literature review, the adoption of a technology is likely to be influenced by multiple factors. The factors will be related to: the technology itself; the circumstances of the farmer and the farm situation; and the extension organisation's initiatives to implement and support the adoption of the technology. The chapter that introduced the results firstly presented those factors identified as important, in relation to the new cassava varieties themselves. Analysis of the data highlighted the fact that, in this case, the factors that influenced the initial adoption of the new cassava varieties were different to those that influenced the farmers' decision to continue to grow those varieties. These differences are highlighted throughout this chapter. The factors, that initially influenced the adoption decision of the farmers and also affected the sustained use of the new varieties, were related to the sourcing of plant material, cultivation, processing and the marketing of the new cassava varieties.

5.1 Characteristics of the Cassava varieties

Yield and Time of Maturity

Characteristics of the cassava technology, which were identified as having initially influenced the farmers' decision to adopt the new varieties, were based on information the farmers received from the MOFA. The farmers' perception of high yields and the early maturity of the new varieties, with the subsequent increase in their household food stock and income, influenced the farmers, who were interviewed, to adopt the cassava technology. The number of cassava tubers per plant was expected to be more than that of the local varieties. The tubers were expected to be bigger in size, meaning that the number of tubers, which would be used for a particular quantity of cassava dough at a specific time, would be less, in comparison to that of the local ones. One farmers' group mentioned that 110 bags of cassava dough were obtained from one acre of the new varieties, whilst the same farm size of the local variety produced only 50 bags.

The local varieties normally have fewer and smaller tubers, so therefore the increase in yield was one of the factors that convinced the farmers to use the new varieties.

> *When they uprooted one it had about 19 tubers under it, but the scale they used to weigh it I could not get the weight in pounds, but it had long, long tubers about 19 of them. The cassava on my own farm has one tuber, which was as long as 5 feet 10 inches [and a width of about 8 inches].*

This variety may be the Tekbankye one because, in a report on the project by the District Director of MOFA in July 2004 (MOFA, 2004a), the Tekbankye was identified as being able to produce as many as 19 tubers per plant. The farmers also realised that cassava tubers, which were not harvested could stay longer in the soil without rotting and they could then serve as a reserve for times of food scarcity.

The message given by the extension staff to the farmers indicated that the new cassava varieties were early maturing. The early maturity characteristic of these cassava varieties enhanced the adoption of the varieties, since it was expected to help with early harvesting of the crop, which could help alleviate a food shortage. Some of the farmers interviewed indicated *"when you cultivate the new ones, they begin to develop tubers within three months and you can harvest at about nine months"*. In the case of the local types, they take a longer time to mature and as one farmer put it *"...the duration that the new varieties take to mature is not as long as the ordinary ones like Ankrah and others"*. There were some local varieties that could be harvested, even after nine months, but they still do not have any sizeable tubers.

The farmers interviewed identified some variations between the new and local cassava varieties (Table 5.1), which affected their decision to discontinue growing the new varieties. The new cassava varieties were found to produce more and larger tubers, compared to the local varieties. The new varieties were also earlier maturing and two of them reduced weed growth with the many branches they had formed, thereby reducing the cost of weed control and helping to restore soil fertility with the leaves. On the other hand, the local varieties took a longer time to produce sizeable tubers and they rarely formed branches of more than two stems per stalk and hence they could not replenish soil fertility with only a small number of leaves. In addition, one farmer indicated that the Abasa fitaa variety tasted bitter and this might have been due to its hydrocyanic acid

content. The local varieties, that were good for fufu, did not normally taste bitter (Table 5.1).

Table 5.1: Differences between the new and local cassava varieties, as identified by the farmers contacted

New cassava varieties	Local (old) cassava varieties
* High yielding (more and larger tubers per plant)	* Low yielding (less and smaller tubers per plant)
* Early maturing (tubers develop early e.g. three months after planting)	* Late maturing (take a longer time to produce tubers)
*Two of the new varieties form branches (weeding of the soil reduces as the canopy closes and stems can be coppiced)	* Have one or two stems per stalk (weeding becomes difficult resulting ion a wastage of labour, particularly if other crops are harvested earlier, and it is difficult to coppice the stems because their cooking ability would be affected)
* The additional branches formed also produce more leaves to fertilise the soil	* Less leaves due to the single stems produced
* Abasa fitaa was found to taste bitter	*Generally the local ones, which are good for fufu, do not taste bitter

Cassava products and Processing Characteristics

The farmers' sustained use of the new cassava varieties was influenced by a number of factors related to the cassava itself. The soil type, in which the cassava was planted, affected the yield and the suitability of the harvested crop for local dishes. Some of the farmers interviewed indicated that the yield was not as high as they were told, across different soil types and fertility levels. The yield, according to the respondents, was affected by the land preparation method used before planting. Yields for those who ploughed their farmlands with tractors before planting were found to be higher, than those who prepared their land manually.

The fact that the new varieties were not the type that could be used for local dishes also made it difficult for some of the farmers in the district to sell the fresh tubers in the local market, or anywhere else unless they were first processed into cassava dough, gari or other products. This discouraged some of the farmers interviewed from cultivating the new varieties. They indicated that they would not grow the new varieties of cassava again, unless they were given an assurance from the MOFA that people (traders) would be brought in to buy their produce.

It was indicated by some of the farmers interviewed that they were able to cook one of the varieties introduced to them, although this was not indicated by the initial extension information. This was found to be the Afisiafi cassava. However, the suitability of this variety to use in the cooking of fufu was affected by the variation in soil types. In an interview with one of the farmers, relating to the suitability of this variety for local dishes, he said *"well some people said it is good when you cook it but mine is not good, I don't know whether it depends on the soil type. Some of them said it contains so much starch and they are not able to use it so much"*. In another community, one of the farmers interviewed stated emphatically *"the suitability for fufu depends on the soil type. There are some areas where the land is near a mountain, when you grow them there it is good when you cook it"*.

Some other farmers mentioned the Tekbankye as another variety that can be cooked but the suitability of the Tekbankye also depended on the age of the cassava and the type of soil. The younger cassava tubers were suitable for cooking but not when they were fully matured. This was confirmed by one of the quarterly reports, prepared by the District Director of the Ministry concerning the project in July 2004 (MOFA, 2004a), which was after the RTIP implementation.

Storage Characteristics

Although, storage of fresh cassava tubers was a general issue and not peculiar to only the new varieties, the farmers interviewed felt that the ability of the new varieties to be stored for some days after harvest, for example, one week, would help reduce loss through the rotting of unprocessed tubers, but nevertheless long term storage remained an issue.

Ready Access to Plant Material

The Ministry of Food and Agriculture freely supplied the plant materials (stem cuttings) for the new varieties of cassava to the prospective adopters. This encouraged farmers to adopt the new cassava varieties. The farmers were also encouraged by the presence of more secondary multiplication sites in the district. One farmer said after making contact with the MOFA, they just scheduled a day and we went to a farm in another community to collect the plant materials. This meant that the farmers did not need to worry about where and how to get the plant materials and hence their decision to use the new varieties, as they could get the plant materials free of charge. The fact that plant material could be accessed from fellow farmers, particularly by the tertiary multipliers also encouraged farmers to adopt. This was because tertiary multipliers were allowed to distribute the cassava stems to other interested farmers in their communities. Some of the farmers indicated that they had arranged to bring the plant material to their farms themselves and this would have incurred some cost to them.

Generally, farmers relied on other farmers for plant material and seed, so therefore collecting plant material for the new cassava varieties from fellow farmers was not very different to what they would have done to source the local varieties.

5.2 Non-farm Factors

Production cost rebate

One factor, that encouraged some farmers to adopt the new cassava varieties, was the fact that the MOFA paid for the cost of land preparation and the weeding of the farm. This was one of the factors that influenced their adoption decision, since they had received a rebate on these expenses, as promised by the MOFA This money was given to some of the farmers, in order to motivate them to initially adopt the cassava technology. However, this was not the case for all the farmers. One farmer said that he was waiting for the MOFA to give him the go ahead, before he would grow the new varieties again and he assumed that his expenditure would again be reimbursed. He stated that the initial rebate helped him to send two of his sons to technical school, therefore if the MOFA asked him to again plant the new cassava; it would mean that some money would also be given to him.

Farmer Access to Credit

With regards to credit, the farmers interviewed stated that they needed money to hire a tractor for ploughing, when preparing the land for planting the cassava. According to them, when the land is ploughed before planting, the yield was found to be generally better, than when manual land preparation is used. The farmers contacted also indicated that they needed money to be able to rent/lease extra farm land, hire labour for weed control in the cassava farm and for transporting the harvested produce home for processing. One group specified that they have acquired approximately ten to thirty acres (4.05 - 12.14ha) of land for the cultivation of the new cassava varieties, but they could not plant any crop at that time because they didn't have enough money to hire a tractor for the ploughing.

The respondents indicated that it was difficult for them to access credit from the banks for any agricultural project. The farmers interviewed expressed an interest in acquiring their own processing machines. This, according to the farmers, would enable them to add value to the new cassava and prolong its shelf life for a better market price, but the difficulties in accessing loans was deterring them. In answer to a question, concerned with going to the bank for a loan, some of the respondents stated that they would not encourage anyone to go to the bank for a loan. According to these farmers, the bank officials in charge of the loans are liars because they keep on deceiving the farmers, when they (farmers) applied for financial assistance. The farmers indicated that in the Hohoe district, there were always difficulties when they applied to any bank for credit, even as a group.

Some of the farmers, who wanted to access the loan facilities as a group, found it difficult, due to the high commitment fees being charged by the banks. The banks demanded that farmers should deposit 10% of any amount to be received as a guarantee and to ensure the farmers were committed to the loan agreement. This was due to the farmers' lack of collateral and a history of low loan recovery rates amongst farmers in the district. One farmer said:

> *We don't have money yet they asked us to maintain a ten percent deposit before they will give us something. We take it as collateral, but they should come and have a look at the work we are doing. When they see it, they should make an estimate to find out whether it is worth investing in, before giving us the money.*

Where are we going to get the ten percent? Even that 10% we should have invested it into the project.

The problems regarding credit accessibility do not apply only to crop production projects, like cassava, but also to livestock. The farmers, in one particular group, gave an example of how they had started working towards gaining access to financial assistance for a livestock project, but they did not succeed. The group indicated that they also sought financial assistance from the Community Based Rural Development Programme (CBRDP), which was meant to support community based farmer groups, but to no avail. In addition, the group also applied for credit under a special programme being offered by one of the rural banks for women and yet they could not get anything. Consequently, the group became discouraged about sourcing financial assistance from these institutions.

The farmers interviewed expressed frustration at the time they had wasted trying to source credit from the financial institutions, in order to enable them to carry out farming activities. Some farmers stated that, more often than not, by the time the loan was granted, if at all, the farming season was almost over, thereby causing them to use the money for a use not originally intended. According to one of the farmer groups contacted, that had been granted a loan; it was difficult for them to repay the loan because they could not get good yields from the crops they had cultivated, since the season was almost over before the money was given to them. One farmer categorically stated that:

It is not advisable to go to the bank at all for money. They will not give it to you. If you would be given any money at all you'll have to send a lot of money to them first. Even ADB (Agricultural Development Bank) will require that you should bring your land receipt. We realised that they wanted us to be sending money to them and the benefit that you will get from what they will give, you would have given it to them (Bank officials) already. The officials will gain more than what you will get, so we don't know where else to go, unless God sends manna from heaven.

Other farmers, who had been given credit by the financial institutions, had failed to repay the loans. Both individuals and group members found it difficult to access credit because of the 'system of give and take'. They found the attitude of the financial institutions to be discouraging, with regards to accessing credit facilities.

The bank officials came and said they'll give money to women as a group so we wrote our names and did everything, yet they did not give us anything. When we made a follow up they did not give us any concrete answer. Finally, what we realised was that the one in charge wanted us to give him some thing before he would process the loan. He wanted to be given money. So we now had to squeeze ourselves despite everything, while the loan is with interest. When that happens with the person who collects the loan and then you cannot pay, whose fault is it?

Cassava Processing Requirements

The processing machines are required to enable the farmers to add value to the produce and to obtain a better price for it. Aside from processing cassava into gari and cassava dough, it can also be made into chips and flour, which can be used for other things. The starch can also be extracted for both pharmaceutical and industrial purposes. The majority of the farmers contacted had no choice, other than to depend on the conventional processing methods (highlighted in chapter four), which made the farming and processing activities more laborious. The work is time consuming, labour intensive and produces a low output.

Only one of the farmer groups contacted was able to process the cassava into flour, gari and tapioca for export and they supplied a nearby biscuit factory with flour. The conventional processing method was being used because they could not afford an improved one. A food company in Tema called Endless Love Exports exported the gari, flour and tapioca. The group had tried to improve the nutritional value of the gari by adding protein rich crops - soybeans or Mucuna. They won some awards, during a district level Farmers' Day celebration in 2004, with the Mucuna flour (Figure 5.1) and the Mucuna gari (Figure 5.2). They were, however, unable to meet the demands of the customers because they only have the use of basic equipment. They were expecting a better set of processing machines promised by the AgSSIP (Agricultural Services Sub-sector Investment Programme).

AgSSIP was one of the agricultural sector programmes, which supported interventions under FASDEP. It supported RTIP because it was in line with the technology development and dissemination objectives of the FASDEP. Another group was also promised a set of processing machines, so therefore both groups had started work on sites for these projects. Other groups contacted expressed their disappointment with the concerted efforts they had made to acquire the processing machines, with the help of the Ministry of Food and Agriculture and other organisations both public and private, but to no avail.

Figure 5.1: Mucuna Flour (processed from the new cassava and Mucuna)
Photographed by the researcher at Goviefe Kwawu – 31/5/2006

Figure 5.2: Mucuna Gari (Processed from the new cassava and Mucuna)
Photograph by the researcher at Goviefe Kwawu – 31/5/2006

Generally, the gari lasts longer than the cassava dough and requires more labour, time and other equipment and inputs to process it. The dough is bulky and difficult to preserve, hence the need to sell it at prevailing market prices, due to its short shelf life, which also means farmers had to take the price of the day and they could not store the dough until such time as the prices increased. The local varieties did not have a long shelf life, but because they were harvested as required, in order to provide for the farm household or for sale and they could be harvested in smaller amounts so there was very little wastage.

The new varieties were intended for the markets, since they were not suitable for direct use in local dishes and therefore large quantities had to be harvested for processing at one specific time. Moreover, because the tubers could not be sold raw but needed to be processed for the markets, the farmers had to harvest a large enough quantity at any one time for further processing, in order to enjoy economies of scale, although only one group was processing beyond the dough and gari.

The farmers interviewed expressed the importance of having a processing machine of their own. *"If we get the gari processing machines, we can process the cassava and package it as well. When we get our own machines we'll appreciate it so much because, when we process it, the shelf life will be longer, so another year would be added, so if it is scarce in some places we can go and sell it there and we can also store it for some time".*

Product Price and Market Access

Marketing of the cassava is another factor that influenced the farmers' adoption decision, particularly in regard to the sustained use of the technology. The price paid for cassava and cassava products varied over the season, in response to availability. When fresh cassava and cassava products were not readily available, the prices paid were much higher, than those around harvest time when more cassava was available. The normal harvesting regime for cassava was that the local varieties were planted and once they had matured enough for harvest they were harvested as required for home consumption. The tubers could remain in the ground without rotting for about two to three years, depending on the farm household food needs and the rainfall pattern and soil type. Large households with small farms could not afford to leave the matured cassava unharvested for such a long time. Soils with poor drainage became easily flooded and thus caused the cassava

tubers to rot. However, the new varieties were harvested in large quantities once they were ready and then processed into cassava dough, gari or other products.

Normally, prices for agricultural produce were high during the dry season, which was generally between December and March. Prices for cassava also went up during this period, because it was usually difficult to harvest the tubers, since the ground had become too hard to dig. One of the key informants gave an example of the effect of a glut on the price of cassava dough. He stated that the price of a bag of cassava dough was being sold at ¢60,000.00 (Sixty thousand cedis) but when the new varieties were introduced and there was a glut the same quantity of dough was sold at ¢15,000.00 (Fifteen thousand cedis).

The difficulties with storing the harvested produce, together with the preservation of the cassava dough, were also contributing factors to the poor marketing system. The farmers were forced to dispose of their products at the prevailing price, since they did not have a means to preserve and store the products. If the cassava tubers were able to be stored for a number of days, the loss through rotting would be reduced and farmers would be saved from the hassle of selling at low prices.

The processed products also faced problems of market access and storage. Generally, there was no ready market for the goods, so the farmers had to keep the products for sometime, whilst they waited for a better price and market for their produce. In some of the communities within the district there was no large market place nearby, where large quantities of cassava products (dough or gari) could be sold. Therefore, farmers with large quantities of such goods, in these communities, had to travel to nearby towns or cities with larger market places, to be able to sell their cassava. As mentioned previously, there were different market days for the various communities in the district.

Some of the farmers interviewed, further indicated that they were waiting for a better price, considering the cost of transportation and the low market price at the time. This was also costing them as the cassava tubers were rotting in the ground before they could harvest them.

Transport and Storage Facilities

The lack of storage facilities influenced the farmers' decision to continue cultivating the new cassava varieties. Lack of storage made it difficult for the farmers to keep the processed dough, until the time they could sell it for a better market price. Transporting the produce from the farm to the house was also difficult for the adopters interviewed. Most of the farms were located some distance from their homes, so the cassava tubers were transported by using trucks or by head carriage, which was usually tedious with such large quantities. Some had to hire trucks to transport the produce to their house and then to the mills. One farmers' group, that was contacted, stated that they had to rely on school pupils to help them convey the cassava tubers from the farms, because there was so much to carry home.

Another group indicated that the mills or the cassava grater, belonging to their community had unfortunately broken down at the time they were harvesting the cassava. These farmers had to hire trucks to convey the cassava tubers from their farms to the next community for grating. This process, according to the group members, was tedious and expensive and thereby it affected their profit margin.

The cassava stems dried out quickly during the dry season, making it difficult for some farmers to keep plant material for planting during the subsequent rainy season. Some of the farmers indicated that they had devised a way of storing the cassava stems, when they harvested during the dry season. They cut the stems into segments about 12 inches long and buried them on the farm until the rains set in for planting. This helped them to get plant materials for cultivation the following season.

5.3 Farmer Characteristics

Personal characteristics such as age, gender and level of education had no obvious influence on the adoption decision of the respondents. The youngest adopter of the new cassava varieties, amongst the farmers interviewed, was 24 years old and there were people who were around60 years old amongst the farmers who have adopted. There were some farmers who had a technical school level of education amongst those interviewed.

One of the respondents had a university education and she was a tutor in one of the high schools in the district.

5.4 On-farm Factors

Labour Requirement

Farmers' access to other inputs, such as labour and agro-chemicals, was one of the factors that the farmers, who were contacted, felt would have been made it easier for them to access credit. The farmers interviewed indicated that regular weeding of the farm was required to obtain the higher expected yields, so therefore extra labour was needed to keep the farm clean of weeds and to assist in the conveyance of the produce to their home during harvest time. In areas where access to labour proved difficult, there was the need to use herbicides to control the weeds, which was an additional cost to the farmer. Hired labour could be scarce, particularly during the peak of the production period, as there was a high demand for extra hands in carrying out farming activities.

Farm Size and Location

The farms of the farmers contacted were actually located some distance from their homes. The scattered nature of the land was due to the difficulty in securing large farmland in one location. In Ghana, although everyone has an equal right to land ownership, it is, in reality, not easy to gain access to large plots of land at any one location, due to the subsistence nature of the farming system. Land can be acquired through inheritance or it can be eased. It can also be an outright purchase from individuals, families or community/traditional leaders. Farmer groups normally rent/lease a parcel of land for their farming business, but it is not usually easy to acquire such a large plot of land in anyone place and also close to town.

In the study area, one of the farmer groups contacted decided to farm at more than one place. They stated "*as for the group farm, because of the land acquisition problem, we decided that we should cultivate it at separate places, anywhere we could get a piece of land and then we'd plant some of the cassava there for a number of group members to manage*". This farmer group, in fact, had a case pending in the court with one landowner,

over the sharing of benefits that had accrued from running a rice project on his plot of land. The group had cultivated rice on the plot of land but the crop failed, due to the erratic rainfall that year and so their harvest of rice from the farm was small. The landowner then sued the group because he did not get a larger share of the harvest.

In Ghana, land tenancy agreements are available for renting or leasing farmland. The tenant farmer can go into a sharecrop system or otherwise rent the land for cultivation, depending on the relationship between the landowner and the potential tenant farmer. The sharecrop system involves sharing the farm produce between the tenant farmer and the landowner at the end of the cropping season. The ratio of the shared crop can be either 1:1 or 2:1 and thus the farm can be divided into two or three parts, depending on the agreement. If the produce is divided into two, then one part is for the farmer and the other half for the landowner. If it is divided into three parts, two parts are for the tenant farmer and the remaining part for the landowner.

The location of the farms away from the farmers' homes affected the amount of time spent and the quantity of produce they were able to bring home at any time. There was limited head-load-carriage of produce to the house, because of the distance and the large number of tubers. According to the farmers, they spent a long time and a great deal of labour in the transportation of the produce. *"Our road network is not good and the farms are also far from home"* [so] *"when you set off to the farm by the time you reach there you have travelled one mile already and you are exhausted"*. One elderly farmer said she had to walk to and from the farm, which was a distance of about 2.4 kilometres, three times in one day, to be able to convey all the tubers harvested that day. Her children went to school so she had to do it on her own. It must be noted that the transportation problem is not peculiar to the new cassava varieties alone but, because of the higher yield and harvesting of more tubers at a time, it required more labour and time to convey them home.

The scattered nature of the farmlands also made it difficult for the farmers to expand their farms. The farm land is generally cultivated in small plots so one farmer may not have been able to extend his/her farm boundaries because the farm might have been surrounded by other people's own plots, so expansion into neighbouring land may not have been possible. This has led to the situation where farmland is widely scattered. When these

farmers tried to expand the farms, by farming at different locations, they tended to have more work to do, which then made it difficult to manage the farm effectively.

Soil Type and Fertility

The difference in soil types and fertility in the district also influenced the yield and suitability of the new cassava varieties, as indicated earlier. In some areas, the level of soil fertility affected the higher yields of the new varieties of cassava. The yield was extremely high in fertile soils and farms located near mountains had at least two of the new varieties being suitable for fufu. One farmer even stated, "*for our farm, all the three varieties are good for fufu*". The soil types in the district varied from forest zone ochrosols with oxysols intergrades to savannah ground water laterite type.

5.5 Community and Group Characteristics

Group membership and community-wide information delivery helped the farmers to access detailed information relating to the technology and thus enabled them to make a decision on adoption. Most of the farmers interviewed indicated that they accessed the extension message about the new cassava variety from the MOFA, as members of one farmer group or another. Some of the groups contacted were formed before the introduction of the RTIP in the district, so the information on the new cassava varieties was delivered to the group members through the extension agents in the various communities.

New farmer groups were also formed by the MOFA, in areas where there were no existing ones. However, some of the members of most of the groups have terminated their membership for various reasons. One major factor, that affected the sustainability of the groups, was the inability of members to access credit from the banks. Another factor was inadequate institutional support from other local agencies and NGOs. Some of the groups received assistance from CRAN (Christian Rural Aid Network) and the French Embassy with credit and inputs, but others had no support. How these groups were able to get this assistance was not clearly defined.

Chieftaincy problem was mentioned by one extension officer, as one of the factors that limited effective extension information dissemination, in some of the communities within his operational area. In communities where two factions are fighting for the leadership position, when one faction summons the community to a gathering, the subjects of the other party may not respond to the call. This makes it difficult for the extension agents to get information delivered to the people, since their personal safety could be put at risk from the other community faction.

5.6 Extension Related Factors

This section outlined the issues identified in the results in relation to extension activities, including the method of service delivery and working conditions. The importance of farmer groups in extension message delivery, access to resources by the extension agents and their relationship with farmers are highlighted.

Use of Groups

The MOFA's dissemination of information, relating to the new cassava varieties, was varied and depended on the presence of farmers' groups and the community networks. The agricultural extension agents usually got in touch with farmers, through contact with existing farmer groups in the various communities. Where such groups did not exist then a community wide delivery of information would be undertaken by contacting the chief farmer and the traditional head (chief) of the community. The chief would then summon the people in the community to a gathering and the extension agents would deliver the information to them. One extension agent described how they normally go about their first entry into a community.

So you will get to the chief farmer and then you'll tell him your mission and then together with the community leaders, one or two community leaders, you will go to the chief. So, then after that they'll beat "gong gong" for you to meet the people in the community and tell them your mission.

Although individual farmers were also contacted, the use of groups was more prominent. The use of farmer groups, as opposed to working with individual farmers, meant that the extension officer was able to access more farmers in a shorter period of time. Nevertheless, the extension agents sometimes visited individual members of a group, depending on the farmer's situation and the service to be provided. For instance, when a farmer required advice on a particular disease on his/her farm, other farmers might not have been involved.

One of the extension agents contacted indicated that the group method was becoming less effective in some of the communities, due to a lack of trust amongst group members. It was realised that some of the group members, particularly those who were literate, tried to take advantage of the illiterate members and misused group funds. It was further stated that female groups and those with female leaders were found to be more vibrant and effective than male dominated ones.

Resourcing and Motivation of Extension Agents

Most of the agricultural extension agents could not effectively and efficiently carry out their duties, due to inadequate transport and hence their lack of motivation for the work. There was also inadequate financial support for the extension agents. The insufficient and irregular allowance for the maintenance of the few motorbikes and their per diem was discouraging. One extension agent had this to say:

> *A lot of people do not have motorbikes and then for those of us who do have one, there was no maintenance allowance so we always use our salary for doing maintenance work. It was only recently that we started receiving it. I had my motorbike for four years with no maintenance allowance. Meanwhile, it is the very bike I was using to convey the cassava stems to the field.*

Another extension agent also expressed concern about the irregularity and inadequacy of the allowances they received and how this influenced their service delivery. He said:

> *In fact, the allowances that are supposed to come do not come regularly, they are not enough, is not enough so it becomes difficult for you to get to all the farmers that you are supposed to work with, and you cannot do any effective work. The*

motorbikes that are given to us, some of us the motorbikes are very old. The maintenance allowance too is not regular, it scarcely comes to fifty thousand cedis (¢50,000.00) a month, it doesn't even come often, and so is actually a setback.

Farmer - Extension Agent Relationship

The farmers interviewed had mixed reactions to the extension agents. Most of them indicated that they had regular contact with the agricultural extension agents. The regular visits of the extension agents had a positive influence on the decision of the farmers to adopt the new cassava varieties, since it enabled them to access detailed information on the technology. *"We have a cordial relationship with the extension agents, they visit us often"* one group stated.

However, some of the farmers interviewed, in one of the operational areas, questioned the integrity of the extension agent in the area, based on her past experiences. This farmer expressed disappointment about the way the extension agent handled certain financial issues with her. One farmer specified *"when I finished guarding the farm and was paid he came for some money from it. He wanted a share in the farm guarding money. When I went guarding the rice farm, he wanted a share from it"*. Another one also reported, *"when the extension agents are asked to do something then they want to gain from it. He was given four hundred thousand cedis (¢400,000.00) to bring to us to work with; he took a hundred thousand from it and brought three hundred thousand cedis. So the extension agent is nothing to us"*.

Some of the project officials, in addition to some of the extension agents, had lost credibility with some farmers, as a result of promises made to the farmers, which were not fulfilled. Some of the farmers were given the assurance that they would be helped with the marketing aspect of the project. Some other farmers interviewed also had the impression that they would be assisted to market their produce. However, when it came to the post-production stage of the new cassava, they were left to find their own markets for their produce/products. This was not easy for most of them, so therefore these farmers were discouraged from cultivating the new varieties again. This misconception, according to the farmers, was due to the way the information was delivered to them. In an interview with the extension agents, some of them confirmed the fact that they promised farmers to

bring in traders to buy the produce from them. Other extension agents, however, denied making any such promises, but said the farmers might have developed that impression because of the way the message was delivered to them.

According to some of the farmers interviewed, they informed the extension agents when the cassava had matured, so that traders could to be brought in when the cassava was to be harvested. These farmers kept waiting until they realised that the cassava tubers had started to rot in the ground. The farmers then decided to harvest and process the cassava for sale by themselves. Some of the farmers felt they had no market option and therefore the cassava was left on the farm to rot. For example, this was what one group experienced, "*the cassava tubers, when we harvested them, most of them were rotten so the little we got we sold and shared the money. I would say it was on the farm for four years before we harvested*".

Some of the farmers felt they had little support and they were unable to achieve their aims, so growing a different crop or looking for an alternative opportunity, that would help achieve their goals, was a better way to go. They lamented the fact that they had intended establishing an agro-based cottage industry, to help open up employment opportunities for the youth in their community, through the production and the processing of the new cassava varieties and this had not happened. However, they realised that the marketing of the cassava produce and products was not as easy as they expected and hence less financial gains were made. They would rather cultivate crops, for which marketing would be easier and it would have a higher profit margin. This was because some of the officials, organising the project with the extension agents, did not fulfil some of the promises they had made to the farmers. Most of the promises were about the marketing of the produce and the provision of processing machines.

Chapter Six: Discussion

This chapter discusses the research results, by comparing and contrasting the research findings (Chapter 5) with the literature review (Chapter 2) and identifying the main findings from the research. The main categories of factors, identified as influencing the adoption of the cassava technology, are first outlined and then followed by a discussion relating to each category. The next section discusses agricultural extension, as part of rural development efforts to improve livelihoods. The subsequent sections discuss the various factors, which have been identified as having influenced the cassava technology extension and its adoption. The final section summarises the chapter.

6.1 Agricultural Extension, Rural Development and Livelihood Improvements

Agricultural development programmes, geared towards livelihood improvements and resource sustainability, have been promoted in many developing countries through agricultural extension activities (Anderson & Feder, 2004; Fenichel & Smith, 1992; Von Blanckenburg, 1982). The Root and Tuber Improvement Programme is an example of an intervention directed at improving the livelihood of farmers' households. However, not a great deal has been achieved with the development interventions directed at livelihood improvements, through agricultural modernisation, such as the extension and adoption of improved agricultural practices to increase production and enhance productivity, since the programmes generally face organisational challenges and resource constraints (Anderson & Feder, 2004; Fenichel & Smith, 1992; Von Blanckenburg, 1982). The RTIP, in this case, did not achieve the anticipated benefits of raising household incomes to secure livelihoods.

Agricultural extension is being used to enforce livelihood improvement in rural development programmes in many developing countries (Ersado et al., 2004; Fenichel & Smith, 1992; Ison & Russell, 2000; Rauniyar & Goode, 1992; Von Blanckenburg, 1982). The potential of agricultural extension activities in livelihood improvements cannot be overemphasised, since it improves the farmers' access to information and knowledge relating to improved agricultural practices (Anderson & Feder, 2004; Marsh et al., 2004;

Rauniyar & Goode, 1992), which are intended to ensure livelihood security for farm households. Agriculture extension in Ghana is also directed at livelihood improvement for farmers' households and agricultural extension also played an important role in the RTIP project.

In difficult life situations, rural households employ livelihood strategies that will enable them to survive. The livelihood strategies of agricultural intensification and extensification, in addition to diversification and migration, are generally adopted to cope with and/or adapt to difficult livelihood situations and if possible to reduce vulnerability (Carswell, 1997; Ellis, 1998, 2000a, 2000b; Ellis & Mdoe, 2003; Madukwe, 2006; Scoones, 1998).

Farmers' households in the Hohoe district faced life situations that were difficult and the farmers were interested in any opportunities that would enhance their livelihoods. This is evident from the fact that households sought to adopt similar strategies to that highlighted by Ellis (2000), which were offered by the RTIP project. In this case, the livelihood strategies that the farmers adopted can be described as agricultural extensification and, in some cases, agricultural intensification, in addition to diversification into off-farm activities as defined by Ellis (1998; 2000), Carswell (2000) and Scoones (1998). Although, Ellis (1998; 2000), Carswell (2000) and Scoones (1998), identified these different strategies, they did not highlight, as it was in found in this case, that farm households could in fact adopt a number of strategies at any point in time, in order to enhance their livelihood security. For any of these strategies, as supported by this research, access by the individuals or households to both fixed and or variable inputs - land, labour and credit (capital), was very important in assisting them to secure their livelihoods (Ellis, 1998; 2000a & 2000b; Carswell, 2000; Scoones, 1998).

This study did not identify any significant increase in household incomes, through the sale of produce and products from the new cassava varieties. The new cassava varieties had the potential to improve livelihood security through income generation, if farmers had been able to access credit, processing and reliable markets. The higher yields obtained from the new cassava cultivation and the fact that it matured earlier could have reduced the intensity of the hunger season, which has been reported in the literature (Howeler et al., 2001; Johnson & Masters, 2004; Prudencio & Alhassan, 1994). There has, however,

not been any lucrative employment opportunity for these farmers through the adoption of the cassava technology, since processing factories were not established in any of the communities in this particular district.

6.2 Factors that Influenced the Adoption of the Cassava Technology

The majority of factors identified in this research, as being influential on the adoption of the cassava technology, are consistent with those factors found in the literature. These include the characteristics of the cassava technology (Ogunlana, 2004; Rogers, 1995, 2003), personal attributes and the socio-economic environment of the farmer adopters and also situational factors (Boahene et al., 1999; Doss & Morris, 2001; Ersado et al., 2004; Feder et al., 1981; Feder et al., 1985; Hossain & Crouch, 1992; Spence, 1994). In addition, to the infrastructural development of the community, policy issues in the community and the role of the extension agents were also influencing factors (Ajayi et al., 2003; Ajayi & Kwesiga, 2003; Asafo, 2001; Johnson & Masters, 2004; Peterson, 1997; Spence, 1994).

The factors, that have been identified as having influenced the adoption of the cassava technology, are many and complex and consistent with the literature (Boahene et al., 1999; Ersado et al., 2004; Feder et al., 1985; Ogunlana, 2004). These factors were interrelated and influenced not only the initial adoption process but also the sustained use of the new cassava varieties by the farmers. Some factors were initially influential on the decision of potential adopters, regarding the new cassava varieties, whilst others were influential during the adoption process and after the adopters had started growing the crop. Also, some others factors influenced the continuous cultivation of the new cassava varieties by these farmers.

6.2.1 Characteristics of the Cassava Technology

Rogers' 'classic' technology adoption model is helpful in terms of identifying attributes of the new cassava technology, that influenced its initial adoption and the fact that the adoption decision was a process (Rogers, 1995, 2003). Rogers' (1995; 2003) attributes are often identified as factors that influence the adoption of a technology. However, this

research has shown that these attributes can also be relevant to factors that influence the sustained used of a technology. This case highlights that the complexity of the 'technology package' influenced the sustained use of the new varieties by the farmers.

In addition, Rogers' (1995; 2003) work did not capture the interrelated and complex nature of the factors in the technology transfer and adoption process in Ghana. Rogers' (1995; 2003) work identifies the attributes as being discrete characteristics and it does not address the interrelated nature of these attributes within the adoption decision process. Although useful, Rogers' (1995; 2003) attributes are somewhat simplistic and they do not adequately capture the complexity of the factors that contributed to the farmers' decisions to adopt and/or continue to grow the new cassava varieties in Ghana. The variations in farmers' situation that also affected the farmers' adoption decision were not reported by Rogers (1995; 2003). However, Guerin & Guerin (1994) noted the importance of researchers recognising the socio-economic settings of farmers, in order to make the developed technologies fit into the farmers' situations and this fact is supported by this research.

Relative advantage

The farmers were initially encouraged to adopt the new cassava varieties because of the perceived benefits of the new varieties, relative to the traditionally grown local varieties, in terms of yield and time of maturity. The overall anticipated advantages came from the opportunity to generate income from the sale of products from the new varieties. Although this corresponds with Rogers' (1995; 2003) relative advantage attribute, the new varieties did not replace the traditional varieties. Farmers' households continued to cultivate the traditional varieties, in order to provide a staple supply of food for their households. In accordance with Guerin & Guerin (1994), farmers' households in the district discontinued the use of the technology because the anticipated monetary gains, from the higher yields of the new varieties, were not realised.

Compatibility

The cassava technology can be classified according to Rogers' (1995; 2003) attributes as being compatible with existing farming systems of the people in the Hohoe District and hence its adoption. Cassava is in fact the second major staple food for the people in this district and it is cultivated by most households (MOFA, 2005b). However, because the new varieties did not replace the old varieties as a source of food for the farm households, the farmers were required to expand their operations. This then imposed new requirements on them, including access to credit and accessing land, both aspects making the technology, as a whole, far less compatible. This corresponds to the literature on the influence of compatibility, in terms of the easy integration of the introduced technology into the existing farming system and access to relevant inputs on adoption (Floyd et al., 2003; Ogunlana, 2004).

Complexity

The farmers' understanding, when they adopted the new varieties, was that the processing and marketing elements would be supported and implemented by the MOFA. For this reason, the technology would have seemed to be much less complex, than was eventually realised when the support for processing and marketing did not eventuate. The post-production components of processing and marketing were absolutely necessary in order to achieve the intended benefits. The cassava varieties themselves are simple, and the prospective adopters did not require any improved skills or new understanding about its cultivation (Ogunlana, 2004; Rogers, 1995, 2003). However, the farmers did require processing machines, transportation and storage facilities notwithstanding access to credit and reliable markets, to enable them to realise the overall advantage of income generation from the adoption of the new varieties. In this case, considering the cassava technology as a 'package,' it could be seen as complex and this influenced the sustained use of the new varieties, in contrast to the influence of complexity on the initial adoption decision of farmers, as indicated by Ogunlana (2004) and Rogers (1995; 2003).

Trialability and Observability

The MOFA played an extensive role in the raising of the farmers' awareness relating to the new cassava varieties and they convinced the farmer adopters to adopt, through the information provided by the extension agents. The extension agents played an important role in the early stages of the technology adoption decision process, as a source of information to the farmers (CORAF, 2001; Feder et al., 1985; Feder & Umali, 1993; Yaron et al., 1992). These stages, identified by Rogers (1995; 2003), are known as the knowledge, persuasion and decision stages: and Spence (1994) referred to them as the awareness and interest stages. Given this situation, the farmers did not trial or observe the technology, in order to assess the potential benefits and any associated problems with the new varieties.

Although, it would have been easy to try out the new varieties, to a limited extent and the improved yields and early maturity could have been observed within the first growing season. the 'technology package' included elements, which were a great deal less trialable or observable. The processing and marketing components of the technology meant that farmers had to act with some degree of 'faith' in initially growing the new varieties. Farmers had a limited ability to trial these components and the benefits of income generation were not easily observed because of the scope of the 'technology' package. The literature reviewed does not address these issues, in relation to initial adoption and continued use of a technology.

The farmers generally focussed on the information provided by the extension agents concerning the technology and then they decided to adopt or not to adopt. This may be due to the level of trust the farmers had in the extension agents, but it may also reflect the complexity and scope of the technology. The characteristics of technology, identified by Rogers (1995; 2003), Spence (1994) and Leeuwis & Van den Ban (2004), may not apply in all adoption decision processes, particularly in cases where the technology is introduced as part of a project in developing economies, unlike the case in developed countries where technologies are generally not part of a project package.

In relation to the confirmation stage of the technology adoption decision process (Rogers, 1995, 2003), the farmers who adopted the new cassava varieties faced a conflicting situation after the partial implementation of the technology (Rogers, 1995, 2003; Van den

Ban & Hawkins, 1996), regarding the original message given to them and their inability to get assistance from the extension organisation, for the marketing of their cassava produce and products. Therefore, the farmers discontinued cultivating the new cassava, since they could not market the products and there was no indication of the extension organisation coming in to help. The discontinuance of adoption, in this case, was as a result of the complexity of the 'technology package' and the conflicting situation faced by the farmers, in relation to credit accessibility, processing and the marketing of their cassava products. This differs to Rogers (2003), who states that farmers will discontinue use of a technology when a better replacement technology is available.

It is worth noting that smallholder farmers in Ghana are used to a culture of development programmes that provide inputs. This is very different to the situation in developed countries, where it is much more demand-led and farmers generally pay for technologies and do not get subsidies to adopt technologies. Given what has happened with this project, it would be interesting to see whether the farmers in the Hohoe district would have the same confidence in adopting a technology the next time a similar project is offered to them.

6.2.2 Farmer Characteristics

Personal characteristics of Adopters

The influence of personal attributes, such as age, health, gender and level of education, identified in the literature (Boahene et al., 1999; Doss & Morris, 2001; Ersado et al., 2004; Feder et al., 1981; Feder et al., 1985; Hossain & Crouch, 1992; Ogunlana, 2004), has not been obvious in this case. The age of the farmer adopters ranged between 23 and 60 plus. Also, the levels of education and gender were not identified in this research as a limiting factor to the farmers' adoption decision. There was almost equal numbers of both male and female farmers amongst the adopters.

Although, this research did not specifically explore the influence of attitude and perceptions, beliefs, traditional values and goals relating to adoption decisions regarding the new varieties, as noted by Rogers (2003) and Spence (1994), the fact that the farmers

adopted the technology reflects their goal of achieving increased income to improve their livelihood security.

Farm Related Factors

Farm size and location

Farm size, although found to have a varying influence on the farmers adoption decision (Boahene et al., 1999; Guerin & Guerin, 1994; Ogunlana, 2004; Yaron et al., 1992) had no obvious influence on the initial adoption of the new cassava varieties by the farmers in the Hohoe district. Given that the project policy stated that the target group of beneficiaries should be resource poor with small land holdings (IFAD, 2004; MOFA, 2002c), the market oriented nature of the cassava technology required large scale production, and hence the need for extensification of the farming systems by the farmers. However, the farm expansion required by the technology had been limited by the subsistence nature of Ghanaian agriculture, since the farms were small and scattered.

Generally, the farmer groups who adopted the cassava technology wanted a large plot of land at one location for their farming activities. The location of the farms, far from their homes, was due to the inability of the farmers to acquire large plots of land in one location and near to town. This was not one of the major reasons for the discontinuance of the adoption, since one of the groups had acquired a large plot of land, but they could not proceed with the cultivation due to financial constraints. Accessing credit in order to prepare the land for planting was a much more significant constraint.

Soil Type and Fertility

Different soil types and fertility levels were influential on the yield of the new cassava varieties. Some of the characteristics of the cassava, indicated in the extension message to the farmers, were confirmed as the farmers cultivated the cassava, whilst others were found by the farmers to be influenced by other external factors, such as the method of land preparation before planting and soil types across the district. This confirms the findings that farmers circumstances often differ from those on research stations (Anderson & Feder, 2004; Guerin & Guerin, 1994; Swanson, 1997).

Also, the new cassava varieties were generally understood by the extension agents to be not very good for local dishes, for example fufu. However, in some areas, the Afisiafi variety was found to be suitable for fufu, whilst the extension agents indicated that it was only good for processing into other cassava products. The other varieties, the Abasa fitaa and the Tekbankye, were also good for fufu according to some people, whilst not for others, even in the same community. Some other farmers also indicated that younger tubers of the Tekbankye were suitable for fufu but not when they were fully matured. This supports the fact that the conditions, under which research station trials are carried out, are often different from the situations of the users, particularly farmers (Anderson & Feder, 2004; Guerin & Guerin, 1994; Swanson, 1997).

Social, Economic and Situational Factors

The social, economic, and situational factors that influenced the adoption of the new cassava varieties included the group membership of adopters, access to labour and other complementary inputs (Feder et al., 1981; Feder et al., 1985; Floyd et al., 2003; Garforth & Usher, 1997; Gottret et al., 1993; Hossain, 1988; Hossain & Crouch, 1992; Ogunlana, 2004; Spence, 1994). However, these factors did not influence the initial adoption decision of the adopters but they did influence the sustained use of the cassava technology.

Group membership

Farmer groups were used, by the extension agents, to improve their efficiency in the number of farmers they were able to access and work with and also to enhance the farmers' access to information (Gottret et al., 1993; Hossain & Crouch, 1992; Ogunlana, 2004). Von Blanckenberg (1982) advocated the use of farmer groups, as a means of ensuring that smallholder and resource poor farmers were not alienated when the ratio of extension agents to farmers was low. In contrast, in this case study, the use of farmer groups did not ensure the involvement of the resource poor farmers and in fact those involved were not resource poor, since their land holdings were larger than what was outlined in the project policy (IFAD, 2004, 2005b). The reason for this is not clear but it appeared to be linked to the poor resources of the extension agents in the district and their

level of motivation and commitment to the project, in addition to the small number of extension agents for the large number of farmers in the district and other factors highlighted in the literature (Amezah & Hesse, 2003; Anderson & Feder, 2004; Nagel, 1997; Swanson, 1997).

The farmers' group membership was expected to provide them with the opportunity to access credit, so most of the groups contacted in the Hohoe District had tended to decrease in size, as members were not able to access credit and other inputs. Lyon (2003) also found in Ghana that difficulties, in accessing credit by members, affected farmer group sustainability in some other regions of the country. In this case, group sustainability was also influenced by the exploitation of the less educated and illiterate group members by the more educated members, to their advantage. This caused members to withdraw, due to mistrust towards each other. Group sustainability, in effect, influenced their chances of getting loans from the banks, in terms of prompt repayment by members (Lyon, 2003). This may be an issue for the farmers in the Hohoe district and it is compounded by their history of low loan recovery rates.

Access to plant material

The plant materials were obtained virtually free of charge and hence the decision by the potential adopters to use the new cassava varieties. The free access to the plant materials of the cassava technology contributed to its adoption, since it provided a relative advantage in terms of cost of accessing the principal inputs (Floyd *et al.*, 2003; Rogers, 1995, 2003). This case further supports the literature, which reports that access to inputs for any introduced technology is important for its adoption (Feder & Umali, 1993; Guy Henry & Gottret, 1995; Ogunlana, 2004).

Access to Credit by Farmers

Access to credit was a major factor that influenced the sustained use of the cassava technology by farmers and this is identified by Peterson (1997), as an issue for many smallholder farm households in developing countries. The difficulty with access to credit facilities, by farmers in the Hohoe District, was influenced by their lack of collateral and a history of low loan recovery rates in the district. Lyon (2003) also reported that low loan

repayment rates affected the willingness of the banks to grant loans. The inability of the farmers contacted to access credit facilities easily, from formal financial sources, therefore discouraged them from sustaining the adoption of the cassava technology. This is in contrast to the literature which states that access to credit influences initial adoption decisions (Boahene et al., 1999; Feder et al., 1985; Ogunlana, 2004) but it is consistent with Fenichel and Smith's (1992) findings that it does in fact slow down the adoption process.

The extension organisation and project partners could explore other options for helping the farmers to secure credit, as in the case of the Grameen Bank (Hossain, 1988). Redesigning the RTIP programme to cater for credit accessibility, since the technology in this case is not just the new cassava varieties, but it also includes the processing and marketing of the cassava products is likely to improve the continued use of the varieties.

Income levels of Farmers

The level of income had no prominent influence on the farmers' initial adoption decision relating to the cassava technology. The expectation of improvement to their income did, however, influence their decision to adopt the technology. Also, considering the difficulty of access to credit by the farmers in the district and had their income levels been higher, this may have enabled them to offset the financial risks and uncertainties associated with the introduced technology (Feder et al., 1981; Feder et al., 1985; Guy Henry et al., 1994; Ogunlana, 2004) and therefore the impact of the difficulties involved in credit accessibility would have been different. Nevertheless, although the majority of farmer adopters contacted in the district were not actually the resource poorest, their difficulties with accessing credit and marketing their cassava produce discouraged them from continuous cultivation of the new varieties.

Access to other Complementary Input

The yields of the new cassava varieties, obtained from the farms ploughed by a tractor before planting, were observed to be higher than those from land prepared with the traditional farm tools. Therefore, access to a tractor for ploughing is necessary, in order to enhance the higher yields. This indicates the importance of access to complementary

inputs to enhance adoption, as noted in the literature (Floyd et al., 2003; Garforth & Usher, 1997; Ogunlana, 2004).

The large scale production of the new cassava varieties had implications for farm land expansion, with its labour and financial needs in land preparation or planting, weeds control and the harvesting of the produce, notwithstanding the transportation of tubers to their homes. Labour availability during the peak-season affected adoption decisions (White et al., 2005), but this was not evident at the initial stage of the adoption decision process of these farmers, regarding the new cassava varieties. Labour became an issue when the farmers required extra labour for the harvesting and post-harvest handling of the produce. This corresponds to Campbell & Baker's (1997) finding that the introduction of new cassava varieties in Zaire, with their high yields, increased the workload of women, since women generally bear the responsibility of processing and marketing agricultural produce in Ghana and this may also be the case in Zaire.

Infrastructural Development and Political Environment of the Hohoe District

The infrastructural development of the district was another factor, which was identified as having influenced the adoption of the new cassava varieties. Difficulties with transportation and storage and the processing and marketing of the cassava products influenced the sustained adoption of the new cassava varieties. This illustrates the fact that the socio-economic development of an area, where a technology is introduced, influences the adoption of the technology (Feder & Umali, 1993; Peterson, 1997; Rahman, 2003; Vanclay, 1992). Access to reliable markets and processing machinery was important for sustaining the use of the cassava technology and promoting its industrial potential. This was also reported by other studies (Asafo, 2001; Johnson & Masters, 2004; Kawano et al., 1998; Nweke, 1994; Zeller et al., 1998).

Transportation Facilities

The transporting of harvested cassava tubers from the farm to the mills and the products to the market was another factor that influenced the continuous cultivation of the new varieties. The high yields of the new cassava made it difficult for some farmers to convey the harvested tubers home. This was more cumbersome for farmers whose farms were

located a long way from their homes. A good transportation system enhances the activities of farmers and the processors of the agricultural produce and thus it sustains the adoption of the technology, as noted by Peterson (1997) and Vanclay (1992).

Processing of Cassava Produce

The lack of processing machinery was a contributing factor to the processing problems and it influenced the continuous use of the new varieties. This is consistent with a number of studies, which stated that access to processing and marketing of the new cassava and its products is influential to its adoption (Asafo, 2001; Johnson & Masters, 2004; Nweke, 1994; Zeller et al., 1998).

As highlighted by Janssen and Wheatley (1985), the processing of cassava, in this case, would have improved the shelf life and the market price, since it could have been stored for periods of scarcity. Processing the cassava would enhance its industrial potential and contribute to household incomes and food security, as noted by Kawano et al., (1998), Nweke (1994) and Saka et al., (1998). However, unlike Ospina et al.'s (1993) study, the processing of the cassava did not generate employment opportunities for the people in the communities, in this case, since processing factories had not yet been established, although the potential exists for this to occur.

Market Access by Farmers

Marketing of the cassava and its products influenced its continuous cultivation by farmers in the Hohoe district. The farmers found it difficult to sell their cassava products, in order to achieve the intended benefits through income generation. Asafo (2001) also found this problem in the Tongu district in Ghana. This case supports the findings that the farmers' ability to get better prices for their produce would have helped to maintain the adoption of new crop varieties (Conley & Udry, 2001; Guerin & Guerin, 1994; Shaw, 1987). The low prices of the cassava and its products discouraged the majority of farmers and the adopters from any continuous cultivation of the new varieties. Although the new varieties were high yielding, the farmer adopters did not maintain its cultivation, since they could not easily market the products. This corresponds to Abdulai & Huffman's (2005)

findings, where market access enhanced the adoption of crossbred cow technology in Tanzania.

The marketing difficulty was further compounded by the unsuitability of the new varieties for fufu (in most cases) and the high yields, since the local markets could not absorb the produce. The absence of a vibrant marketing centre in Hohoe town itself was a contributing factor to the marketing problems in the district.

Project Policy

The project's policy, to provide cassava plant material freely to farmers, played an important role in its adoption, as reported in information regarding government policies and input prices (Amezah & Hesse, 2003). The rebate provided also encouraged its beneficiaries, but its suspension influenced the lack of sustained use of the technology.

6.2.3 Role of Extension Agents

Resource availability and service delivery

Another factor, that influenced the extension and adoption of the cassava technology, was the poor resources of the extension agents, which hampered their service delivery. This has been commented upon by other authors, who stated that lack of resources also affected their morale and their level of commitment to work (Anderson & Feder, 2004; Nagel, 1997). The extension agents, in this case, were poorly resourced, so therefore it was difficult for them to effectively carry out their activities.

The mobility of the extension agents was hampered by financial constraints and inadequate transport. Poor transportation and communication systems, according to Peterson (1997) and Vanclay (1992), influence extension service delivery, thereby affecting the farmers' access to relevant information.

The financial sustainability of the RTIP was important, in influencing adoption decisions of prospective project beneficiaries. This fact was obvious, due to the suspension of the

rebate being given to some of the farmers. There were also reports of a late release of funds for RTIP activities, which made it difficult for the extension organisation to meet the demands of farmers for more plant materials (MOFA, 2005c). These financial constraints influenced the adoption of the cassava technology, in terms of the prompt supply of plant materials to farmers and the working conditions of the extension staff. This research also indicated the effect of the extension agents' poor working conditions on their credibility with the farmers, due to the way credit issues were handled with some of the farmers. Guerin and Guerin (1994) stressed the need for extension agents to build good credibility with farmers, in order to incur their trust and the importance of this is supported by this case.

The sustainability of the RTIP also hinged upon the willingness of the donors to maintain their financial support. The importance of continuous external financial support for extension programmes has been indicated by Anderson & Feder (2004). The timely release of funds and other resources for the RTIP would have helped meet the demands by farmers for plant materials and more importantly it would have improved the working conditions of the extension staff.

Given that the project supposedly targeted resource poor farmers, who in terms of access to credit are the least likely in the community to be able to access credit, arrangements could have been made with the local financial institutions to enable these farmers to access credit facilities. A strong collaboration between the extension organisation and the local institutions would also have been important in this case, since it would have encouraged institutional support for the farmers and thereby provided them with opportunities to source credit and other inputs from the local organisations, thereby contributing to the success of the programme as reported by Fenichel & Smith (1992). The success of such extension programmes, according to Deshler (1997), also depends partly on the level of participation of the project beneficiaries in the monitoring and evaluation of activities.

Extension Agents – Farmer Contacts

The extension agents' contact with farmers was possible through membership of farmer organisations and community networks, as reported in the literature (Gottret et al., 1993; Hossain & Crouch, 1992; Ogunlana, 2004). The farmers relied solely on the extension agents' information before adopting the cassava technology, and this gives a clear indication of the fact that the extension agents tended to work with the farmers they already had previously contacted, which initially gave these farmers the confidence to adopt the new cassava. Von Blackenberg (1982) criticised the contact farmer approach as it isolated the resource poor farmers. This also confirms the apparent fact that the supposed target group of the project, the resource poor farmers were not actually involved in the project.

Given that resource poor farmers were not the beneficiaries, even though the policy stated they were the target group, it must be stated that, due to what has occurred, this study highlights how the intended project beneficiaries have been miss-targeted.

This research supports the need for a strong relationship between the farmers and the extension workers, in addition to that between farmers and researchers, in order to help eliminate the problems of developing technologies, which may be inappropriate to the farmers' situations (Garforth & Usher, 1997; Guerin & Guerin, 1994). It also highlights the need to ensure the proper targeting of project beneficiaries in development interventions.

6.2.4 Appropriateness of the Cassava Technology

This research supports the importance of ensuring the relevance and appropriateness of not only the technology to the farmers' circumstances, but also the appropriateness, relevance and likely implications for the processing and marketing on the desired outcomes of an introduced technology, as commented on by other authors (Campbell & Barker, 1997; CORAF, 2001; Hall et al., 2001; Johnson & Masters, 2004). A number of reasons highlighted in this research, which have led to farmers' non-adoption and discontinued use of the new cassava varieties, suggest that the process by which the

technology and project were developed reflects more the conventional transfer of a technology model, rather than one driven by an understanding of the farmers' circumstances and needs.

The findings of this research revealed an apparent poor linkage between the users (farmers) of the technology and those who developed and extended it. This was influenced by the limited involvement of the farmers, in the development and dissemination of the cassava technology that was intended to meet the farmers' needs. This was obvious at the stage when the farmers were involved in the multiplication of the cassava plant materials and their subsequent discontinued use of the new varieties by these adopters. This supports the literature on the importance of the farmers' feedback in the research, in order to help meet their needs (Guerin & Guerin, 1994; Röling & Pretty, 1997; Swanson, 1997) and also the importance of ensuring that developed technologies are appropriate to the farmers' situations (Eponou, 1998; Garforth & Usher, 1997).

There seemed to be inconsistency in this project design, given that the focus was on the resource poor farmers, and the requirement for credit and additional land would have been an important constraint in their ability to adopt. Yet, there appears to have been limited efforts put into assessing their requirements and the likely implications for processing and marketing of their produce. This situation has discouraged the majority of the farmers contacted from continuous cultivation of the new cassava varieties. This may not have occurred had the links between the extension agents and the farmers been better, in addition to the links between researchers, programme designers and farmers. This study also supports Peterson's (1997) call for development interventions to focus on socio-cultural practices and the affordability of introduced technologies, in order to make them more appropriate to smallholder farmers, since they tend to adopt low-cost technologies.

The poor linkage further influenced the extension message delivered to the farmer by the extension agents. Farmers had misconceptions about the information received, relating to the post-production aspect of the project. This situation, according to Doss (2006), is possible when technology is introduced, in terms of the benefits and costs which can influence the farmers' adoption decisions about a particular technology. However, in this case the misconception was particularly about the marketing aspect of the cassava

technology (not the initial adoption decision), which then influenced the sustained use of the technology. This supports Nagel's (1997) report on the need for extension agents to be careful with their extension message delivery.

6.3 Summary

This chapter compares and contrasts the research results with the literature reviewed. The factors identified are consistent with what have already been stated in the literature. This research identified many interrelated factors that influenced the initial adoption and the sustained use of the new cassava varieties under the Root and Tuber Improvement Programme. These factors include: the characteristics of the technology; the socio-economic environment of the farmers; the infrastructural development of the Hohoe district; and the extension contacts. The characteristics of the cassava technology influenced the initial adoption decisions, whilst the farming situation and the social and economic circumstances of farmers, coupled with the situational factors of the district, notwithstanding the extension agents' activities, have influenced the continued use of the new varieties.

The attributes of the cassava technology, in terms of the relative advantage regarding the perceived high yields and early maturity and their compatibility with the existing farming systems and also in terms of its cultivation as a major staple food, have influenced the initial adoption decision of the farmers. However, the complexity of the cassava technology as a package, in terms of it being composed of both the production and the post-production components, has limited its sustained use.

The farmers' circumstances, in relation to their access to credit and other complementary inputs and other social issues also influenced the achievement of the anticipated objectives of increased income for farm households and subsequent livelihood security. The infrastructural development of the district was influential on the farmers' access to means of transportation and the processing and marketing of their cassava products. The farmers contacted were discouraged from the continuous growing of the new cassava,

since they could not process and market their produce and products, in order to obtain the intended benefit of livelihood improvements from the technology.

Extension service delivery was hampered by inadequate institutional support with resources. Poor resourcing of extension agents did not only affect their service delivery but it also influenced the farmers' access to information and relevant inputs, thereby influencing the sustained use of the new cassava varieties by the farmers.

This technology package appears to be inappropriate to the farmers' situation and this is likely to be as a result of the limited farmer input in its development and also the subsequent inability of the farmers to achieve the anticipated advantages.

The next chapter provides a summary of the research findings and concludes the thesis.

Chapter Seven: Summary and Conclusions

This chapter concludes this thesis by outlining the main research findings and their implications and the conclusions of the study. The remaining sections assess the research methods used and identify further research that will build on the findings of this research.

7.1 Main Research findings

The objectives of this research work were to identify the factors that influenced the adoption and non-adoption of the new cassava varieties in the Hohoe District of the Volta Region of Ghana and to investigate how a district level extension initiative can be improved. A single case study approach was used to achieve these objectives. The main issue identified, regarding the adoption of the cassava technology, is the sustainability of its adoption levels. The new cassava varieties have a proven potential to improve livelihood security through income generation, provided farmers have access to credit, processing and reliable markets. The factors identified to have influenced the adoption and non-adoption of the new cassava varieties in the Hohoe District were many, varied and interrelated. One key finding of this research is that there were factors that initially influenced the decision of prospective adopters of the cassava technology, whilst other factors also influenced the sustained use of the cassava varieties.

Some of the factors, that were influential at the initial stages of the adoption decision process for the new cassava varieties, include the attributes of the cassava technology and some of the external factors were access to the principal inputs of the technology and extension contacts. Other factors were influential, after the farmers had adopted and started cultivating the new varieties and these included access to credit and post-harvest handling of the produce, such as processing, storage, transportation and marketing of the cassava and its products.

The many and complex circumstances of the adopters made it difficult for them to actually process and market the new varieties, in order to improve their livelihood situations. Although, the plant materials were readily available for planting, access to

credit, labour and to some extent land had influenced the continuous growing of the new varieties. The majority of the farmers discontinued the cultivation of the new cassava varieties, since the overall advantage of generating income for farmers' households did not materialise.

A summary of the factors identified to have influenced the adoption and sustained use of the new cassava varieties is provided in Table 7.1 below.

Table 7.1: Factors that Influenced the Adoption of the New Cassava Varieties

Main factors	Areas of influence on adoption	
Cassava technology	Initial factors	* High yielding ability * Early maturity * Ready access to plant material
Farmer and farm characteristics	Factors related to sustainability of adoption	* Access to credit * Processing of produce * Marketing of produce * Transport & storage facilities * Access to other inputs (labour, land) * Farmer access to information (membership of organisation and extension contacts) * Farm size and location * Soil types and fertility * Soil factor on yield and suitability for fufu * Storage of harvested raw tubers
Extension organisation (MOFA)	Organisational factors (logistics)	* Message delivery (approaches, methods) * Relationship with farmers * Mobility *Resource availability and Financial support

The extension agents were poorly resourced and as such the effectiveness and efficiency of their activities were affected. The inadequate institutional support for farmers and the

low level of collaboration between the extension organisation and other institutions influenced the farmers' access to farm inputs. These farmers found it difficult to access credit from formal financial sources, to enable them to acquire other inputs such as labour, agro-chemicals and it probably reduced their ability to lease large plots of land for the cultivation of the new cassava varieties.

7.2 Conclusions

The findings, that there were initial factors that influenced the adoption of the cassava technology and other on-farm and non-farm related factors that affected the sustained adoption of the technology, have not been indicated in the literature in relation to similar technologies. This case indicated that, in difficult life situations, farmers' households could adopt a number of livelihood strategies as coping mechanisms to reduce their vulnerability. It also indicated that some of the stages in the adoption decision process of the farmer adopters might remain dormant if the introduced technology forms part of a broader intervention.

The complexity of the cassava technology as a package, in terms of it being composed of both the production and the post-production components, has been brought to light in this case. This research highlights the inappropriateness of the technology package to the farmers' situation, which is most likely due to limited farmer input in its development and the farmers' inability to achieve the anticipated advantages. The farmers contacted were discouraged in relation to the continuous growing of the new cassava, since they could not process and market the produce and products, in order to obtain from the technology the intended benefits of livelihood improvement.

The influence of farmer group sustainability on members' access to credit has also been indicated. The study underscores the mis-targeting of intended project beneficiaries, in this case the resource poor. It further suggests the need for livelihood improvement interventions to have a clearly defined scope and capacity, so that responses from the beneficiaries can be used to make relevant amendments that will eventually ensure that the projects are more beneficial to the target group.

If district level agricultural extension organisations are to fulfil a role in extending and supporting the implementation of a technology, such as the cultivation, processing and marketing of new cassava varieties, they require adequate resources, capacity and the support of other agencies and entities, crucial to the successful long-term implementation of the technology. Effective service delivery, by extension field staff, is also dependent on their level of resources at the district land project level. The credibility of extension staff is affected by the degree to which the initial expectations of the farmers are matched by subsequent actions of extension staff.

The research supports the research findings reported in the literature. Access to inputs, the social and situational environment of farmers and the socio-economic development of a community, within which an improved crop variety has been introduced, influences the rates of adoption and the sustained use of a technology by farmers.

It is important that livelihood interventions are structured to help beneficiaries with opportunities that will increase their access to credit and other inputs, such as linking them to various institutions that provide those services. For example, farmers can be helped to access alternative marketing channels or processing machineries, to enable them to obtain a good market value for their produce.

The findings also call for a better support for extension agents and a strong collaboration between organisations, in order to make extension and rural development projects successful, in terms of meeting the needs of the target groups. A focus on farmers' circumstances would help facilitate a more targeted approach to technology transfer and adoption by farmers, in order to reap the intended benefits of such programmes. There is the need for donor organisations and policy makers to devise better strategies, when targeting the poor with poverty alleviation interventions at any level, in order to reach the intended beneficiaries.

7.3 Assessment of Research Methodology

A case study strategy was used for this research, due to the need to explore the in-depth experiences of the farmers who have been part of the Root and Tuber Improvement

Programme. The interviews were conducted between May and June 2006, which was a period when farmers were busy with farming activities. The number of farmers contacted who were adopters was far more than that of non-adopters, because the adopters could not easily point out those who were not part of the group. The inability to find more of the non-adopters might be due to the fact that the RTIP project was completed the previous year and the adopter farmers were still growing the old varieties, which made it difficult for them to remember group members and non-members, in relation to the new cassava technology. Also, because it was a busy period for the farmers, they often leave their homes to travel to their farm in the early morning. This made it difficult for the researcher to find them at home to schedule a time for an interview.

Ghanaian farmers, in the southern part of the country in particular, are generally less busy with farming activities during the first quarter of the year which is the dry season, so it would have helped to access more of the farmers who did not adopt the cassava technology, if the data collection had been undertaken around this period.

This case is an example of a district level extension initiative, directed at achieving the adoption of cassava technology by farmers' households for livelihood improvement under the RTIP. The case was selected, since phase one of the programmes had been completed and in view of the objectives of the study a completed programme was more appropriate for assessing the factors that have influenced the uptake of the cassava technology. The fact that the livelihood of the people is predominantly agriculture dependent and cassava being a major food crop was also taken into consideration, in addition to the familiarity of the researcher with one of the local languages. This case revealed many factors that were not indicated in the documents gathered from the extension organisation.

The purposive and snowball sampling methods used allowed the researcher to access information from farmers who had or had not adopted the cassava technology. The purposive method helped obtained information from adopters of the technology, since most of them were selected with the assistance of the District Directorate of MOFA. However, only a few of the non-adopters were accessed with the snowball method, since they were individuals who did not belong to any farmer group, which might be one of the reasons for non-adoption, as it was indicated that they were aware of the introduction of the cassava technology in the district.

The semi-structured interviews allowed for a guided conservation between the participants and the researcher. The semi-structured interview was also an effective tool for collecting the data, as it allowed the respondents to express their views and perceptions explicitly. Field observation and secondary data from document analysis also confirmed some of the primary information, thereby substantiating the findings.

The qualitative data analysis procedure used helped to identify and categorise important concepts and relationships. It allowed for a systematic and rigorous analysis of the data. The transcribed tapes formed the basis for the data analysis, with the repeated listening to the remaining interview tapes helping to provide a more accurate summary of the data.

7.4 Further Research

The case study strategy used in this study was helpful in achieving the set objectives. Considering the fact that the situation in other parts of the country, where the RTIP programmes have been implemented, may be different from what pertains to the Hohoe district, there may be the need for further research into the level of impact of adoption of the cassava technology on the livelihoods of farmers' households. Further research into the specific impact of increased income levels and food security, on the nutritional needs of the households, may help assess the actual improvement in household nutrition, since some of the adopters diversified into other activities, in order to sustain their livelihoods. Research is also needed into ways in which a model could be developed to help better target the project's beneficiaries.

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Appendix 1: Interview Guide

Interview Guide for Farmer Participants

Understand household situation and history on:

Personal and family life

Occupation

Household decisions

Role in the community

Relationship with AEA in the community

Understand their farming systems and history

Crops cultivated on farm

Constraints and opportunities

Knowledge about RTIP (how did you get the information)

Knowledge about the new cassava varieties

Differences in the local and the new varieties

Information sources influencing

Innovation-adoption decisions in general

New cassava varieties adoption decisions

Factors influencing the decision to adopt the new varieties

Constraints (major concerns and problems -what are the reasons for adoption / non-adoption) why?

Motivation (credit, access to information)

Opportunities (family labour, social network)

New Cassava varieties – benefits

Food security (describe the importance of the new varieties with regards to food availability)

Household income (how the new varieties contributed to income levels)

Employment opportunities created (in what ways has the technology help create job for people)

Production level (identify the effects on the level of production)

Productivity

New cassava varieties - costs

Factors affecting use of the varieties with regards to

- Access to plant material
- Availability
- Distance to marketing centres
- Problems with the plant material (affordability, storage, quantity, means of transport

Relationship/association with AEA and MOFA

- Regular contacts
- Working relationship
- Source of information

Post-harvest handling of produce - Cassava

- Home consumption
- Marketing
- Processing (local, starch factory)

Document analysis

Country profile (location, population, economy, livelihood situation)

Agriculture (farming systems)

RTIP- purpose, strategies and achievements

Cassava - production, importance (information on trends in cassava production)

Distribution of the plant material

Extension activities and approaches

Possible questions to farmers and objectives of the question

Question	Objective
Which crops are on your farm? And why?	Understand the cropping system
For how long have you been cultivating these crops?	Trends in the crops cultivated within a particular period of time
How do these crops contribute to your livelihood situation?	The various contribution the crops cultivated have made to livelihood situation
Which of these crops do you depend on throughout the year? In what way?	The roles of the crops throughout the year
How did you get to know of RTIP and new cassava varieties?	Access to information and knowledge about the technology in the community
What is the difference between the local and the new varieties?	Farmers ability to differentiate between the varieties
Where do you normally get the plant material?	Plant material availability and accessibility in the community
What do you do to your produce?	The disposal of produce
What are the problems with the local varieties?	Main problems with local varieties
What are the problems with the new varieties?	Main problems with the new varieties
How do you relate to the extension agents in the community?	The relationship between the farmers and AEAs in the community
How often do the AEAs visit you the farmers in this community?	Frequency of extension contacts with farmers in the community
How many of the AEAs are in this community?	The ratio of AEAs to farmers in the community
What other things do you want to add?	

Interview Guide for Key Informants – AEA/ MOFA

Personal history

Personal and family life

- History and involvement in MOFA, RTIP
- Role in the community and in MOFA

Extension activities

- Methods and approaches used (to develop and extend new Cassava varieties) and why?

Factors influencing effectiveness of extension programme

- Logistic
- Funds
- Institutional support

Factors affecting adoption from the perspective of the AEAs

Who adopted the new varieties and why?

Who did not adopt the new cassava varieties and why?

The relationship between the AEA and the farmers; and the community at large

- Involvement in community activities and working with community leaders

Evaluation of extension activities

How is the adoption process from the farm level to district level from the AEA's perspective?

Directors see the adoption process from farm level through community to the district level

Can any improvement be made?

Appendix 2: Ethics Approval Letter

Massey University

OFFICE OF THE ASSISTANT
TO THE VICE-CHANCELLOR
(ETHICS & EQUITY)
Private Bag 11 222
Palmerston North
New Zealand
T 64 6 350 5573
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humanethics@massey.ac.nz
www.massey.ac.nz

15 March 2006

Mary Azilah
[redacted]

Dear Mary

Re: Adoption of Agricultural Technology for Sustainable Livelihood

Thank you for your Low Risk Notification which was received on 14 March 2006.

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

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 a campus human ethics committee.

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 Sylvia Rumball, Assistant to the Vice-Chancellor (Ethics & Equity), telephone 06 350 5249, e-mail humanethicspn@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 a Campus Human Ethics Committee. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

Sylvia Rumball

Sylvia V Rumball (Professor)
Chair, Human Ethics Chairs' Committee and
Assistant to the Vice-Chancellor (Ethics & Equity)

cc Ms Janet Reid
Institute of Natural Resources
PN433

Prof Russ Tillman, HoI
Institute of Natural Resources
PN433