Factors Influencing the Discontinuance in Adoption of Tissue Culture Banana Technology: A Study of Smallholder Farmers in Maragwa District

By

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This is my original work and has not been submitted for any degree in any other university

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Abstract

Smallholder farmers in Kenya have been cultivating bananas among other crops such as coffee since the pre-colonial times. Bananas before the 1980s were grown to provide rural households with food. Unlike in other countries where banana is considered a typical export crop, in Kenya banana is grown by peasant farmers for home consumption and for domestic market. The Kenya Agricultural Research Institute (KARI) launched a tissue culture project in 1996/97. Since there was a lack of clean planting materials, the main objective of this project was to supply smallholder farmers with pathogen free materials, notably tc-plantlets. Despite the earlier adoption, in 2008, a study by Mbaka *et al.* (2008) revealed that farmers were discontinuing the technology and reverting to the old practice of obtaining suckers from own orchard or neighbour field. In this regard, it was important to carry out a study and establish why these farmers were discontinuing the technology and reverting to the use of suckers despite the challenges that suckers hold. The specific objectives include: First, to establish the characteristics of the discontinuing farmer; Second, to establish farmers' reasons for discontinuing the technology; Third, to find out from farmers the advantages of suckers over tissue cultured plantlets and; Lastly, to analyse and establish the most important factors which influence farmers' discontinuance decision of tc-banana technology.

In terms of methodology, this study adopted a case study approach. Case study approach is useful in investigating a contemporary phenomenon in its natural setting (Yin, 2003). This approach was used in order to investigate the phenomenon of discontinuance amongst smallholder banana farmers in Kenya. The main unit of analysis was the smallholder banana farmer. This study was informed by both primary and secondary data. The research started by reviewing relevant documents such as books, newspaper articles, web resources, brochures, reports from various sources. Then, proceeded to collect primary data through the following methods, namely: in-depth interviews, key-informant interviews and personal observation. Two main sampling techniques were used namely: purposive and snowballing sampling. Data was analysed both qualitatively and quantitatively. Whereas quantitative data collected through interviews was cleaned, coded and analysed using the Statistical Package for Social Sciences (SPSS), qualitative data was analysed through thematic analysis.

The study found that discontinuance decision is pegged on several factors. This study however categorized the factors into two broad categories, namely: technical and socio-economic factors. On the one hand, technical factors include factors such as pests and

diseases, labour requirements of the cultivation of tc-bananas and costs of plantlets. On the other hand, the socio-economic factors include factors such as access to credit and information, poor infrastructure and access to markets. The study recommends that farmers be educated to understand and appreciate the benefits of tissue culture technology as a tool for crop propagation. It is also imperative that the potential risks or disadvantages associated with this technology be communicated and carefully explained to the farmers. In this case, the possibility of encountering problems should always be made clear. Without proper communication and transparency, the potential of the technology to improve the lives of the rural poor can be easily be lost.

Abbreviations

AIDS	Acquired Immunodeficiency Syndrome
ACF	Action Against Hunger International
ADB	Asian Development Bank
DAEO	Divisional Agricultural Extensional Officer
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
HIV	Human Immunodeficiency Virus
ISAAA	The International Service for Acquisition of Agri-biotech Applications
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KARI	Kenya Agricultural Research Institute
MDG	Millennium Development Goal
MoA	Ministry of Agriculture
NGO	Non-Governmental Organization
SPSS	Statistical Package for Social Sciences
Tc	Tissue Culture
Tc-project	Tissue Culture Project

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Chapter One

1.0 Introduction

Historically, agricultural technologies have played a key role in increasing agricultural production. One past example in literature of such contribution in agriculture was the rise of the "green revolution" technologies in the 1970s and 1980s which led to increased crop productivity thus leading to doubling of yields in much of Asia and Latin America (Brink *et al.*, 1998). Increased production also entailed improved food availability in the region leading to reduced food prices. Asia's "green revolution" technologies brought about remarkable increases in crop productivity which translated to increased food supply. Availability of food due to increased food supply led to reduced food prices thus the poor in parts of Asia were able to access it with ease. Due to the increased availability and accessibility of food in the region, it was observed that the proportion of the population suffering from chronic hunger had reduced from 40 percent to 20 percent (Brink *et al.*, 1998). This development was made possible only through remarkable technological progress in agriculture, which involved introduction of new high yielding varieties of major food grains like maize, wheat and rice, combined with intense use of inputs such as agrochemicals as well as improved farm management practices. Even though the green revolution technologies of the 1980s achieved great gains in much of Asia in terms of improving food production, it cannot hide the fact that the issue of hunger and poverty in this twenty-first century is still a challenge in the developing countries. According to the ACF[1] report (2009), the number of people suffering from hunger had grown to around 963 million in 2009 from 800 million in 1999. According to Brink *et al.* (1998), there are still few examples of "green revolution" technologies transforming the lives of rural population in sub-Saharan Africa. Ogoro (2007) argues that Africa was by-passed by the green revolution. Yet, millions of people, majority of who reside in Africa suffer from chronic hunger (Food Agriculture Organization (FAO), 1999).

[1] Action Contre la Faim(ACF) International Network

The adoption of modern biotechnology among smallholder farmers is expected to contribute significantly towards meeting the challenge of food production in developing countries. According to the Asian Development Bank (ADB) report of 2001, biotechnology is increasingly being applied in Asia to develop new strains of improved crops and livestock. Karembu (2007) adds that it has the potential to provide rapid solutions in a more precise and cost effective manner. Both Wambugu (1999) and Ogoro (2007) acknowledge its potential and assert that Africa, more than any other continent in the world, urgently needed it to improve her food status. But the benefits of biotechnology among smallholder famers can only accrue as long as the technology is in use. In most diffusion-adoption research, there has been a general concern with process of initial adoption decision (Miller and Mariola, 2009). Few studies have focused on understanding discontinuance[2] decision of innovation. The objective of this study is to investigate why some farmers discontinue previously adopted technology. This chapter provides the background of the research topic; presents the problem statement; states the study objectives and research questions and; discusses the significance of the study.

1.1 Background

Agricultural technologies are vital tools for improving food production. In the global debate about the role of agricultural technologies in production, the human population issue has been at the centre of attention. Cockburn (2002) indicated that the world population was less than 2 billion at the beginning of 19th century. But, by the year 2000, the number had tripled to 6 billion (Cockburn, 2002). Kenya's population on the other hand has more than tripled from 10.9 million in 1969 to 38.6 million in 2009 (Kenya National Bureau of Statistics (KNBS)[3], 2013). Given the high number of births per woman (an average of 4.6 children per woman), the population will continue steadily. Because more people in the developing world are malnourished (ACF, 2009), it will be necessary to increase current levels of food production more than proportional to population growth, so as to provide them with an adequate diet. This implies that, in future, developing countries such as Kenya that have a high population growth rate will be unable to meet their food demand as opposed to the developed countries, unless a solution is obtained.

[2] Discontinuance by definition refers to the decision to discard an innovation (technology) after previously accepting it (Rogers, 2003).

[3] Kenya National Bureau of Statistics (2013) report

Indeed, the gap between food production and food demand in developing countries will worsen the existing problems of hunger, malnutrition and poverty. According to scholars, it is quite unfortunate that technologies widely used during the green revolution, no longer provide the needed breakthroughs in yield potentials nor gives solution to complex problems of pests, diseases and drought stress (ADB, 2001; Karembu *et al.*, 2010). Karembu *et al.*, (2010) asserts that the current state of agricultural technologies will not be able to meet the production challenge ahead. Therefore, new approaches will be required in order to expand food production.

It is against this background that biotechnology has been developed. The developments in biotechnology have sought to provide the needed breakthrough in increasing agricultural yields. Biotechnology has two dimensions, modern biotechnology and traditional biotechnology. On the one hand, traditional biotechnology such as the use of yeast to make bread or wine has been applied for thousands of years in the food industry. On the other hand, the application of modern biotechnology with a view of increasing agricultural yields dates back about 50 years ago (Amalu, 2004). Modern biotechnology has three known applications. These are genetic engineering, tissue culture and molecular marker[4]. Of these three, the application of genetic engineering (ge) on food production has often generated a heated public debate (ADB, 2001). This debate, within the scientific community, has focused on the safety of consumption of genetic engineered foods on human health. On the one hand are the proponents of biotechnology, who present the technology as the magic bullet and panacea to the multitude of problems facing African countries. On the other hand are the anti-biotechnology groups who front concerns for human health and environmental concerns as reasons to stop the technology. Consequently, numerous studies have been done to demonstrate its actual and potential role in sustainable agricultural production (Fernandez-Cornejo *et al.*, 2006; FAO, 2009). Such studies, as a result, have excluded other applications such as tissue culture (tc) whose present role and potential for

[4] Tissue culture refers to the cultivation of plant cells, tissues, or organs on specially formulated nutrient media. The objective is to regenerate, multiply and conserve plants with desirable traits (Molina, 2002). Genetically Engineering on the other hand permits the transfer of genes between organisms that are not normally able to cross breed. For example, a gene from bacterium can be inserted into a plant cell to provide resistance to insect. In conventional breeding half of an individual's genes come from each parent whereas in genetic engineering one or several specially selected genes are added to the genetic material (FAO, 2009; Amalu, 2004). Molecular Marker is one of the newest applications of biotechnology. This technology makes it possible to map the location of economic importance precisely, enabling breeders to select desirable individuals in plant breeding programmes (Amalu, 2004).

improvement of agriculture production in developing countries such as Kenya are widespread (FAO, 2009).

In Kenya, tissue culture has been applied on banana crop with a view of improving household food insecurity in banana growing regions. Its adoption has been widespread among the Kenyan smallholder banana farmers. Banana is among the important crops such as coffee, maize and tea grown in Kenya[5]. According to Qaim (1999) report, banana covered around 1.7 percent of Kenya's total arable land, an area equivalent to 74,000 hectares (Qaim, 1999). A report by the Ministry of Agriculture (MoA) of 2006 however indicates that the area has increased to 83, 687 hectares (MoA[6], 2006). The crop is grown in areas of high rainfall. The four main banana producing regions are Nyanza, Central, Eastern and Western Provinces. Among the four, Nyanza is the largest producer (56.1%) followed by Central (16.5%), Eastern (9.5%) and Western (8.5%). Banana has a wide range of varieties. These varieties can be categorised into two. On the one hand, the cooking varieties (plantain) are considered as a staple crop alongside maize. While on the other hand, the ripening varieties are a popular fruit for majority of urban dwellers. Banana is an attractive crop for smallholder farmers because it provides for their food, and the surplus production is a reliable source of their income. Indeed, it is a good source of carbohydrates, vitamins and minerals. The crop is also suitable crop for intercropping (the practice of growing two or more crops on a given piece of land), a trait which appeals to most smallholder farmers who own small plots, an average of about 0.3 hectare (Qaim,1999). Intercropping gives additional yield income per unit area than sole cropping (Wambugu and Kiome, 2001).

For the last two decades, however, banana production has been on the decline. This decline, according to Qaim (1999), was as a result of infestation of banana orchards with pests and diseases. Environmental degradation, particularly declining soil fertility also played a part. The common farmer practice of using infected suckers further aggravated the problem. This practice was observed to be familiar among smallholder farmers as opposed to large-scale producers. It was noted that smallholder famers' seldom buy new planting materials but instead obtain suckers

[5] Kenya is the leading producer of tea and coffee. Maize is a principal staple food of Kenya, averaging over 80 percent of total cereals (rice, wheat, millet and sorghum). The popularity of maize can also be derived from the proportion of the Kenyan agricultural land devoted to its production (MoA, 2006).
[6] Ministry of Agriculture (MoA) report of 2006

from possibly diseased stems from their old orchards. According to Qaim (1999), the practice persists due to the lack of availability of clean planting material and lack of knowledge among the farmers of the need to use clean planting materials. He noted that the practice had perpetuated the spread of pests and diseases from one farm to another leading to further reduction in yields (Qaim, 1999). In 2000, Wambugu *et al.* (2000) observed that the use of infected suckers had reduced banana yields by up to 90 percent among the smallholder famers. The resulting yield loss reduced the potential of the crop to contribute to food security in the rural areas and also affected peoples' incomes.

In response to the rapid decline in banana production, the Kenya Government through the Kenya Agricultural Research Institute (KARI)[7] in 1996 introduced a tc-banana project. The aim of the project was to develop and disseminate clean planting materials to smallholder farmers through tissue culture technology[8]. Its adoption among smallholder farmers promised to improve banana production and thus reduce household food insecurity and poverty in banana growing regions i.e. in Nyanza, Central, Eastern, and Western Provinces. However, a study by Mbaka *et al.* (2008) in 2008 revealed that farmers were discontinuing the technology and reverting to the old practice of obtaining suckers from own orchard or neighbour field. In this regard, it was important to carry out a study and establish why these farmers were discontinuing the technology and reverting to the use of suckers despite the challenges that suckers hold. The findings of this study will provide basic information on the challenges of tissue culture production and explain the discontinuance phenomenon in greater detail.

The present study was carried out in Makuyu division, one of the four divisions of larger Maragwa district in Central province. Besides Makuyu division, other divisions within the district are Kigumo, Kandara, and Maragua (see figure 1 below). Maragwa district was one of the focal areas where the technology was adopted in large-scale and is also one of the areas where tc discontinuance was observed (Mbaka *et al.*, 2008). According to the Welfare Monitoring Survey of 1997, the number of people living below the poverty belt in the district

[7] Kenya Agricultural Research Institute is a Government institution charged with conducting agricultural research in the country

[8] Tissue culture is a relatively simple technique that allows for quick en mass multiplication of adequate clean planting materials known as tissue cultured plantlets. Whereas conventional suckers may take up to 18 months to produce a crop and tend to mature at different times, tc-plants produce a crop within a shorter period of time and all can be harvested at the same time thus providing a substantial sum of money to the farmer.

was about 33.3 percent of the total district population (Kenya, 2005). Those hardest hit were women and children. According to the Maragwa District Strategic Plan 2005-2010, the district population in 2002 was estimated to be around 409,302 million with a growth rate of 1.8 percent per annum (Kenya, 2005). It was projected to increase to 453,647 in 2008. Clearly, the population growth has an effect on demand on agricultural land as well as social and economic development. The district lies between the altitude of 1100 and 2950m above sea level. It receives bi-modal rainfall patterns with an average of 1200mm during the long rains (March to May) and 1000mm during the short rains (October to December), thus the climate is appropriate for large-scale farming.

Figure 1: Map showing the location of Maragwa district

1.2 Problem Statement

Smallholder farmers in Kenya have been cultivating bananas among other crops such as coffee[9] since the pre-colonial times. Bananas, before the 1980s, were grown to provide rural households with food. The cooking varieties (plantain) were considered as a staple food, while the ripening

[9] Kenya coffee has been grown for over a century now, since 1983 when it was first introduced in Kenya. (www.kenyarep-jp.com/business/industry/coffee_coffee_e.html)

varieties were eaten as a fruit. Coffee on the other hand, was grown for sale and was a reliable source of income for the farmers. However, the collapse of the coffee sector in mid-eighties (Nguthi, 2007) due to the drop of coffee prices saw to the rise of banana to the level of a cash crop. Smallholder famers who depended on proceeds from coffee for their livelihood had to look for other sources of income thus diversified and commercialised banana. Between 1980 and 1996 (the year tissue culture was introduced), farmers were growing bananas but with lots of difficulties such as the incidence of pests and diseases which affected yields. The incidence of pests and diseases greatly reduced yields by up to 90 percent leading to a general decline in banana production. Countrywide, households were affected in terms of food supply. According to Wambugu and Kiome (2001), the resulting shortfall in banana had affected up to 12 million people. Even though this figure has since changed, it represented a quarter of the Kenyan population at that time.

The increasing concern over banana general production led to the introduction of tissue cultured (tc) bananas among banana smallholder farmers in 1996. The main objective of the tc-project introduced by the Kenya Government was to provide smallholder farmers with disease-free planting materials, with the ultimate purpose of alleviating hunger and poverty in banana growing regions. To reap maximum benefits, farmers had to switch from the use of conventional suckers to the new tissue cultured materials. On the one hand, acquisition of suckers was previously cheap and generally free. While on the other hand, the new materials were relatively higher in terms of cost than that of suckers. In addition, farmers were also required to use farm inputs such as fertilisers and employ labour during planting. This practice was new to some of the adopting farmers. To encourage adoption of the new tc-banana technology, the tc-project provided farmers with enough credit to purchase the tc-plantlets, farm inputs and pay for the labour. As a result, it was observed that a majority of farmers had nevertheless adopted the technology despite the challenges of adoption. The adoption of the tc-materials among the smallholder famers led to increased yields and incomes as had been predicted by Qaim (1999) in 1999. Indeed, Qaim (1999) had predicted that the adoption of tissue cultured banana would result to an increase of yields amongst smallholder farmers by as high as 150 percent and incomes by as high as 156 percent. Mbogoh and his colleagues (2002) confirmed this predicament in 2002. Their study showed that the adoption of the tc-materials had offered huge financial returns than that of suckers. Wambugu and Kiome (2001) indicated that farmers' were enthusiastic about the new technology and had received a bumper harvest. Among the factors that contributed to their positive reaction include: fast growth of the plants, high yields and uniform production. Thus, within a span of eight years, Wambugu (2004) recorded that over 500,000 farmers had adopted the technology and were reaping its benefits.

After twelve (12) years since the technology was introduced and adopted, a study by Mbaka *et al.* (2008) uncovered some shocking findings, contrary to expectation. These authors observed that farmers who had adopted the technology were discontinuing it and reverting to the old practice of acquiring suckers from own orchard or neighbour field. Considering that the use of conventional suckers has been shown to perpetuate the spread of pests and diseases leading to yield losses, it is not yet clear why the farmers were discontinuing the technology. This study seeks to establish, why. Why would a technology that promises to improve livelihood as has been discussed above be abandoned? What are the reasons for farmers' discontinuance? What are the characteristics of these conventional suckers that make farmers choose suckers over tc-plantlets?

Smallholder farmers have since in the past used conventional suckers obtained from possibly diseased stems obtained from own orchard when planting. An adoption study by Qaim (1999) had established in 1999 that the reasons for the practice were the lack of availability of clean planting material and the lack of knowledge among farmers of the need to use clean planting materials. Therefore, the tc-project had to educate the farmers on the importance of using clean planting materials and the general production of tc-banana before adoption. Yet, the practice of using conventional suckers has persisted among smallholder farmers (Mbaka *et al.,* 2008). It was thus important to find out if the farmers had access to clean planting materials promoted by the tc-project.

The cultivation of tc-banana introduced other elements that were new to the adopting farmers. Farmers were required to use farm inputs such as fertilisers and employ labour when cultivating tc-banana. Previously, banana stems were left to grow by themselves and less attention was given to the growing bananas. However, tc-plantlets required much attention from farmers; a practice that was not necessary with cultivation of suckers. In addition, the price of the planting material itself added to the cost of production. Although during adoption the tc-project had established a micro-credit scheme to provide farmers with enough credit to purchase the new tc-plantlets, farm inputs and pay for the labour, it is still unclear what caused discontinuance of tc-banana technology in 2008. This study sought to find out if cost of the plantlet, labour and farm inputs contributed to discontinuance of tc-bananas among the smallholder farmers.

Review of literature shows that little attention has been paid on the topic of discontinuance. A number of the studies have shown considerable interest in adoption (Qaim, 1999, Nguthi, 2007, Mbogoh *et al.*, 2002). Although there are few studies that have focused on this topic of discontinuance, several studies have alluded to it. Black (1983) as cited by Miller and Mariola (2009) showed that continued use of an innovation was influenced by the characteristics within the innovation. Another study by Nnadi and Akwiwu (2007) found that discontinuance behaviour was related to personal characteristics (age and education) and the social environment (access to credit and market). While a study by Miller and Mariola (2009) found that discontinuance was the result of those characteristics within technology itself and the large socio-economic context in which adoption takes place. The aforementioned studies have highlighted a number of factors which can be used to explain discontinuance decision. Discontinuance decision is related to personal characteristics, characteristics within the technology itself, access to market and credit and visit by extension staff. In this regard, it was important to conduct a field study and find out (1) whether the farmers had access to market for their goods considering that they could have received a bumper harvest as a result of adoption; (2) whether farmers receive visits from the extension staff in case of problem with the technology; (3) whether farmers experienced problems with tc-banana technology itself which could have led to its discontinuance and; (4), whether they had access to credit to purchase the new planting materials and farm inputs and pay for labour.

1.3 Objectives and Research Questions

The broad objective of this study is to provide the reasons for smallholder farmers' discontinuance in use of tissue culture banana technology in Maragwa Division.

The specific objectives are:

- To establish the characteristics of the discontinuing farmer
- To establish farmers reasons for discontinuance of the technology

- To find out from farmers the advantages of suckers over tissue cultured plantlets
- To analyse and establish the most important factors which influence farmers' discontinuance decision of tc-banana technology

The general research question for this study is: **"**Why are smallholder farmers discontinuing the use of tissue culture banana technology?**"**

Specific research questions include:

a. What are the characteristics of the discontinuing farmer?
b. What do farmers report as the reasons for discontinuance?
c. What are the advantages of suckers over tissue cultured plantlets?
d. What are the most important factors influencing farmers' discontinuance decision of tc-banana technology

1.4 Justification for the Study

Internationally, biotechnology is perceived as a panacea for achieving the agreed Millennium Development Goal of reducing poverty and hunger by 2015 (Glover, 2009). Scholars believe that biotechnology will contribute to the reduction of food shortages faced in developing countries hence boosting their economies (ADB, 2001). But according to FAO (2009), majority of developing countries are unlikely to meet the goal of reducing poverty and hunger by 2015 without a clear political commitment to making biotechnology a top priority in the development agenda. The Kenya Government recognises that biotechnology holds a great potential in solving her food problem thus is clear of her intention to apply modern biotechnologies to enhance food production as a long term strategy (Karembu *et al.*, 2010).

It is instructive to note that developments in agricultural technology are crucial to Kenya's economic and social transformation. Indeed, agriculture is a sub-economic pillar of the Kenyan ***Vision 2030***. Its growth and development is important as it directly contributes to 26 per cent of the nation's Gross Domestic Product (GDP) and generates 60 percent of total foreign exchange earnings (Kenya, 2008). This is partly the reason why the Government has invested heavily on agricultural research and in this case tissue culture research. Knowledge on tissue culture is expected to improve banana small scale farming in Kenya which since the mid 1980s has been declining (Kameri-Mbote, 2009). But the benefits of the technology can only accrue as long as the technology is in use. Therefore, it is important that farmers continue to use the technology and not axbandon it. Clearly, discontinuance of a once adopted technology would be a waste of time and resources not only for the Government but also to the farmer as well. It takes a great deal of time, energy and money to develop a technology that suits the needs of a farmer. Farmers' also have invested their time, money and energy on this technology and expect returns from adoption.

One objective of the tc banana project was to create a model project that will show the successful application of biotechnology for bananas and other commodity crops in Kenya (Karembu, 2007). Of course, if the model is to be a basis for diffusion of future technologies in the field of biotechnology i.e. genetic engineering currently under field trials, it is necessary to understand the existing technology and learn from its challenges. In this case, the findings of this study are intended to provide useful information on tc technology and inform policy makers and other development agencies on the challenges of tc production.

Chapter Two-Literature Review

2.0. Introduction

This chapter presents review of literature focusing on the adoption of tissue culture technology among the smallholder banana farmers in Kenya. The chapter is divided into four main parts. The first part presents the empirical literature on adoption of tissue culture bananas; it presents past studies, their findings and methodologies used. The second part presents the theoretical literature on the subject of discontinuance highlighting some of the factors that influence farmer discontinuance decision. The third section discusses the innovation diffusion theory and shows how it relates to the study. The last part of this chapter explains the conceptual framework designed for the study.

2.1 Empirical Literature

Qaim (1999) in his study sought to demonstrate that tissue culture (tc) banana technology holds great potentialities for the poor. This study adopted the *ex-ante*[10] impact model. Qaim categorized Kenyan farmers into three main groups, according to farm size. The small-scale farmers had less than 0.5 acres; the medium-scale farmers, as the name suggests, had farms of between 0.5 and 2 acres, while the large-scale farmers had farms bigger than 2 acres. His analysis shows that small-scale farmers had greater potential in terms of average growth in yields and incomes compared to the two. He predicted that the adoption of tc-banana technology would significantly increase average yields by up to 150 percent in small-scale farms, whereas for large and medium scale farms, average yields would increase by up to 93 and 132 percent respectively. On incomes, adoption would result in a rise of incomes by 156, 145 and 106 percent for the small, medium and large-scale farms respectively. Although beneficial, he underscores the fact that adoption entailed a considerable increase in cost of production. Farmers were required to use farm inputs such as fertilisers and employ labour when planting; something that was not required with cultivation of suckers. Another additional cost component was the planting material itself. The price of a plantlet was relatively higher than that of conventional

[10] Ex-ante studies on one hand are more concerned about estimating the potential impact of the adoption and diffusion of a technology. *Ex-post* studies on the other hand try to evaluate the effects that occur after adoption and diffusion (FAO, 2009).

suckers. The study also shows that banana is predominantly a woman's crop. To bolster adoption up, he advocated for the establishment of a micro-credit scheme which could be used to provide farmers with enough credit to purchase the plantlets as well as farm inputs and pay for the labour. He further advocated for provision of extension service for the removal of market imperfections.

Although Qaim's study has demonstrated that adoption of tissue culture technology holds great potentialities for the poor, his study does not measure the effects after adoption. His study only tried to estimate the potential effects of adoption. Therefore, there is need to find out from farmers how the technology is fairing after fourteen (14) years of adoption. This study seeks to fill this gap.

A report of a study by Wambugu *et al.* (2000) gave a detailed background of how tissue culture banana project was conceived in Kenya. The idea behind the project, as mentioned in the report, was to respond to farmers' adoption problems. Although the author undertook a 'diffusion' study to understand adoption of Tc-banana technology, the study was not very different from that of Qaim (1999). One significant finding of the study is that, it showed that the tissue culture varieties were less preferred by farmers. The new varieties were nonetheless compatible with the existing practices. However, the gender factor found to be insignificant in determining adoption. The authors note that famers were willing to acquire the new planting materials but were unable to because of financial constraints. To safeguard against poor adoption, the authors indicate that a micro-credit scheme was established to provide resource constraint farmers with money to buy the plantlets and farm inputs.

A study by Wambugu and Kiome (2001) tried to demonstrate the benefits of biotechnology for smallholder producers in Kenya, with particular emphasis on tissue culture technology. The two authors, in their report, stated that biotechnology has great potential in terms of increasing food production and incomes, creating jobs, protecting our environment and conserving our biodiversity. The study findings affirmed that the adoption of tc-banana technology offered substantial benefits to farmers. These benefits include: higher yields, fast growth of plants, uniform production and resistance of plants to pests and diseases. Adoption was found to stimulate good orchard management practices leading to further increases in production. In general, farmers were observed to have adopted the tc-banana technology. To boost adoption, these authors indicate that several approaches were used which were inclusive, participatory and interactive. But the main methodological approaches used were Farmer Field Schools (FFS) and training. However, several potential constraint to adoption were noted and these include: high cost of plantlets, the need for a wide choice of varieties, gender issues, higher requirement of labour and inputs, limited availability of clean land and limited established marketing and distribution systems. In spite of these challenges, these authors concluded in their report that the adoption of tc-technology would open the way to a more rapid dissemination of future biotechnology innovations such as genetic modified organisms (gmo), currently under field trials in Kenya.

The two above studies (Wambugu *et al.*, 2000 and Wambugu and Kiome, 2001) also adopted the same model (*Ex-ante* model) used by Qaim. This study differs from the two in its approach. It has employed a case study design.

In literature, continued use of a technology has been related to visit by the extension staff. Therefore, there is also the need to find out whether we have extension staff visiting farmers to monitor adoption. This study seeks to find out from farmers if they ever receive visits from extension to offer guidance on technology use.

Mbogo *et al.* (2002) study examined the socio-economic impact of introducing and adopting tissue culture technology in banana production in Kenya. This study, unlike Qaim's (1999) study, adopted an ex-post analytical framework and tried to show the potential effect after adoption of tc-banana technology. The study showed that the adoption of tc-banana technology among smallholder farmers had higher financial returns than that of conventional suckers. The production of bananas in Kenya is largely small-scale. According to Mbogo *et al.* (2002), smallholder farmers have farms averaging 0.32 ha of banana per farm. Amid the challenges of adoption such as cost of inputs, labour and plantlets, these authors indicate that small-scale farmers aspiring for credit needed at least have 80 stems in a 0.25 ha of piece of land so as to break even, that is, produce beyond subsistence. They established that, although tc-banana production was more capital intensive, it had higher financial returns than its counterpart-suckers. The authors observed that some households from Maragwa/ Muranga region of Central Kenya (which is the main tc-banana project area in Kenya) were not growing tc-bananas while others were growing tc-banana alongside non-tc-banana varieties. They concluded that adoption of biotechnology would make a great difference in uplifting the living standard of people, not only in Kenya but in the third world countries.

Although Mbogo *et al.* (2002) study differs from the other mentioned studies, it differs from this study in one major way; its methodological approach. Mbogo *et al.* (2002) study used the *Ex-post* model as a methodological approach. Ex-post, unlike *Ex ante*, tries to evaluate the effects that occur after adoption. This study is a qualitative study, that is, it is more qualitative than quantitative. Qualitative approach is mainly used to understand a rare phenomenon such as is the case with discontinuance. Interviewing will be the main method for data collection.

A study by Nguthi (2007) sought to establish the factors which determine adoption of tc-bananas among smallholder famers in the context of HIV/AIDS in rural Kenya. Nguthi (2007) study was based in rural Kenya, Maragwa district, Central Province. The study adopted a livelihood approach methodology which incorporated both quantitative and qualitative methods of data collection. The unit of analysis was the household. Surprisingly, the study results showed that the percentage of household growing tc-banana in the total sample was relatively low, only 26 percent. Some households because of HIV/AIDS disease were observed to have abandoned their banana plots. Nguthi (2007) study further revealed that continued use of tc-banana technology among smallholder famers was attributed to age of the household head, family size, off-farm livelihood activities and contact with extension agents. The study concludes that regardless of the HIV/AIDS status of the individual farmer, initial adoption decision was related to financial capital (savings), physical capital (farm equipment) and natural capital (security of land tenure).

Although Nguthi (2007) study has been carried out in Kenyan soil, it has focused on adoption. The present study focuses on the topic of discontinuance. It seeks to find out the factors which lead to discontinuance after adoption has taken place.

Another study by Mbaka *et al.* (2008) assessed the potential impact of Banana *Xanthomoinas* wilt (BXW) spread to key production it n Central and Eastern provinces of Kenya. This was a survey which covered three (3) districts namely: Kirinyaga, Maragwa and Meru Central districts. From the study, data on banana production practices and market was captured. Surprisingly, the study found that many farmers who had adopted the technology in the beginning had reverted to obtaining suckers from their own or neighbours' farms for planting. To forestall reversion, the authors recommend that the low uptake of tc-planting be investigated so as to discourage the use of low quality and potentially infected planting materials from existing plantations or other traditional sources. It is in this regard that this study was conceptualized; it seeks to understand technology discontinuance among smallholder farmers in Kenya and from the findings offer recommendations.

A study by Muyanga (2009) sought to determine whether cultivation of tc-bananas was actually improving households in Kenya. He carried out a survey and interviewed households in five districts. These are Embu, South Imenti, Murang'a, Maragwa and Kirinyaga. The results of this study showed that about 48 percent of farmers had adopted tc-banana technology but only seven percent had specialized in its use. Those growing tc-bananas were growing them alongside non-tc-bananas but in separate plots. Two interpretations are likely: one, either these farmers are risk averse and thus are not willing to do away with their local varieties in favour of tissue tc-bananas or two, they are yet to be fully convinced of the superiority of the technology. He also found that tc-farmers had lesser incomes than their counterparts who were growing non-tc-bananas. In much surprise, he remarked that tc-banana production was less production even though earlier studies i.e. Mbogo *et al.* (2002) had revealed that it to be 'economically' worthwhile. These findings are quite interesting when considered against the backdrop of increasing literature in support of biotechnology adoption among smallholder farmers in developing countries.

The above study by Muyanga (2009) generally shows that there is a problem with adoption of tc-bananas. It is one of those rare studies challenging adoption. However, Muyanga (2009) study differs from this study from its methodological approach. The unit of analysis is households, while the unit of this study is the individual farmer.

Although all studies discussed above have all focused on the adoption, the next three (3) studies have focused on discontinuance.

A study by Nnadi and Akwiwu (2007) in Imo state of Nigeria sought to investigate farmers' discontinuance decision behaviour of yam minisett technology. In this study, a sample of 330 famers was selected. Study results showed that showed that 63 percent of the total sample had discontinued the technology. The reasons for farmers' discontinuance are as follows. First, farmers indicated that yam minisett technology does not yield consumptive yam sizes. Second, they indicated that the production of yams was expensive and laborious. The third and final reason was the lack of access to credit and the lack of extension or information back up. The authors found that discontinuance decision was as a result of several factors. These include: age of the farmer, level of education, farm size, farming experience, marital status and access to credit.

A study by Zibaei and Bakshoodeh (2008) investigated the factors which predisposes farmers in Iran to discontinue the adoption of sprinkler irrigation technology. The study adopted two approaches, logit regression analysis and linear discriminate analysis. The findings of both models revealed that the main factors which encourage farmers to keep their systems are economic aspects of adoption and recognition of sprinkler irrigation as appropriate technology. The authors noted that when there was no enough economic motivation to use modern irrigation systems is present, farmers were more likely to discontinue the systems. They observed that the systems were costly and therefore farmers needed to be supported by cheap credit. Otherwise without support, famers were likely to return to the conventional method of irrigation. These authors also indicated that adoption behavior was highly affected by relevancy of the innovation.

This above two studies however differs from this study in view of the technology in question. One study has focused on discontinuance of sprinkler irrigation technology among farmers in Iran, while the other study has focused on discontinuance of yam minisett technology in Nigreria. The present study will be carried out in Kenya and will focus on smallholder farmers. It will seek to investigate the discontinuance phenomenon of tc technology among the farmers.

In Costa Rica, a study by Miller and Mariola (2009) sought to examine why smallholder famers had discontinued the previously adopted environmental technologies while other small smallholder farmers had continued with their use. In terms of approach, their study was a basically qualitative study. The study findings revealed that discontinuance was a result of two broad factors. First, discontinuance decision was a result of those characteristics within the technology itself. This includes the labour demands of the technology that irritates the farmers. The authors observed that when only a single person of the family carries the burden of maintaining the technology discontinuance was the likely result. Age factor was also the contributor to this kind of discontinuance. Individuals who were too old to maintain the technology were found to have discontinued the technology because of the demand of maintaining the technology. The second contributing factor towards discontinuance decision was related to the context in which adoption took place. The socio-economic context (i.e. access to market and extension service) was found to have contributed to discontinuance decision of environmental technologies among smallholder farmers in Costa Rica. Farmers who did not receive assistance or help from technology providers i.e. extension workers were observed to have discontinued the adopted technologies. These authors highlighted that discontinuance may be entirely reasonable and even reasonable choice on the part of the farmer in some cases.

The present study differs from the above studies in several ways. First, in terms of its methodological approach, the present study used a case study strategy. A case study is an empirical investigation of a contemporary phenomenon in its natural setting (Yin, 2003). In this particular case, this study investigated the discontinuance phenomenon among smallholder farmers in Maragwa District. Very few studies have focused on discontinuance as a research topic and a number of them have concentrated on the subject of adoption. Secondly, although some of the studies have discussed discontinuance as a variable, the study sites are quite different from the present study. None of the studies that have discussed discontinuance have been carried out on the Kenyan soil. The present study will be carried out in Central province, Kenya in a district known as Maragwa. This is where the phenomenon of discontinuance was first observed. Finally, the unit of analysis; the present study unit of analysis is the farmer.

2.2 Theoretical Literature

Numerous studies have shown considerable interest in the determinants of adoption of innovations (technologies). As a result, comparatively little attention has been paid on discontinuance. Nevertheless, there is no significant difference between the two. Whereas adoption refers to the initial uptake of an innovation, discontinuance refers to the decision to reject an innovation (Rogers, 2003). In literature, some authors have tried to bring out this difference. Finkelstein and Gilbert (1983), for instance, saw adoption as the exact opposite of discontinuance, arguing that one was the reverse process of the other. Others like Miller and Mariola (2009) saw the two as conceptually different. These authors argued that adoption was more concerned with the initial decision, while discontinuance decision depended on the ongoing commitment and availability of resources necessary to sustain use. Even though the two concepts are closely linked to each other, it is quite clear that both in terms of decision making as a result of a series of actions and thought but not the result of a single decision. Therefore, regardless of the said difference, it is likely that the same factors which influence adoption might or might not be able to account for the decision to discontinue (Gokhale and Narayanaswamy, 2006).

Adoption studies have been very insightful and informative in determining initial use of an innovation. Typical constraints to adoption include lack of financial resources, low education level, lack of credit, limited access to information, insufficient human capital, insufficient human capital, inadequate farm size and inappropriate transportation infrastructure (Mbaka *et al*, 2008, Muyanga, 2009). Although such studies have added to our knowledge about the factors which determine the initial uptake of innovation, little has been done to understand post –adoption behavior. A study by Gokhale and Narayanaswamy (2006) argued that the knowledge from post adoption process might actually explain discontinuance. Even though few studies have focused on discontinuance, there are studies that refer to it indirectly. Black (1983) was cited by Miller and Mariola (2009) to have found that innovation distinctiveness facilitated its adoption. It also contributed to its continued use. Complex technologies tended to be readily adopted than those which were less complex (Miller and Mariola, 2009). Less complex technologies had a higher level of continuance. On the contrary, technologies which do not address the needs of adopters or could be easily substituted for other ones, such technologies were likely to be abandoned for being obsolete.

While several definitions have been raised in literature in an attempt to explain discontinuance, this study favours Rogers (2003) definition. This is because: first, it is widely acceptable and second, it denotes the phenomenon in its right context, that of farmers. According to Rogers, there are only two categories of discontinuance, namely: replacement and disenchantment. On the one hand, replacement discontinuance is the decision to reject an innovation in order to adopt a better one. On the other hand, disenchantment discontinuance is the decision to abandon an innovation as a result of dissatisfaction with its performance. Of the two, Rogers' second category is of greater concern for this study because, in most cases, decisions to discontinue arise from dissatisfaction rather than replacement. An individual may become disenchanted with an innovation because the innovation has a flaw, turns out to be inappropriate for its original purpose or does not have a perceived relative advantage over its counterpart. The decision to reject an innovation may also be as a result of misuse of the innovation by the adopter.

Science and technologies stands at the centre of many critical issues facing societal development. Although the term ‘technology’ has all kinds of meanings depending on the context used, in this particular context, it refers to the information or knowledge gained about the physical world and how that information can be manipulated for human purpose (Rogers, 2003). This information has to be put to use for to accomplish some particular task or to provide for some solution. It is important to note however that technologies only provide for technical solutions but cannot provide for social alternatives. It is also important to note that although tc-technology is often referred to as a ‘technology’, it is not a technology *per se* but a method of propagation.

It is somewhat assumed that adopters will have to continue with the use of technologies because of the benefits that come with adoption. This is not always the case. There are cases where previously adopted technologies have been abandoned altogether. A good case is a study by Zibaei and Bakshodeh (2008) which found that adopters would discontinue the adopted technology because no enough economic motivation existed. Adopters perceived economic gains in monetary terms.

It is well acknowledged that no technology is without limitation. In this case, technologies which pose technical challenges to adopters and the challenges not addressed in time by the technology providers are more likely to be rejected.

Like other technologies, the adoption of tc-banana technology among smallholder farmers has been marred with technical challenges. Wambugu and Kiome (2001) indicated that although tc-plantlets were free from pathogens, they were not resistant to pests and diseases. In addition, viruses such as bunchy top and banana streak could also be transmitted through the plantlets (Wambugu and Kiome, 2001); unless necessary precaution procedures (e.g. virus indexing[11]) were undertaken to prevent transmission of viruses to the plantlets. The other challenge with tc-plantlets is that they require extra attention and care compared to conventional suckers. Tc-plantlets require extra resources and high level techno-management practices especially in

[11] Virus indexing is a laboratory technique which involves growing plant cells under adverse condition to select resistant cells before growing the full plant (Molina, 2002).

preparing holes, de-suckering, watering, applying manure and to some extent, fertiliser (Karembu, 2007). In addition, these have a high affinity for water and can therefore be affected by moisture stress. In this regard, water shortage is a risk factor.

The other challenge which affects continued use of technologies relates to the large socio-economic environment in which adoption takes place. It is premised that adopters who do not receive assistance or help from technology providers or extension workers are likely to discontinue adopted technologies whenever faced by challenges (Miller and Mariola, 2009).

In summary, the above discussion highlights a number of factors which are likely to influence discontinuance decision. These factors can be categorized as follows: technical factors, personal factors (i.e. age, education) and socio-economic factors (i.e. availability and access to extension and market).

2.3 Theoretical Framework: Innovation-Diffusion Theory

This research is guided by Rogers' theory of diffusion (2003) which offers a comprehensive philosophy regarding post adoption process, acceptance or discontinuance of innovations. The theory highlights five key attributes which form a basis for judging technologies and these include: relative economic and social advantage, compatibility, complexity, trialability and observability. This section discusses each of the five attributes.

The first attribute is ***Relative advantage.*** This relates to the characteristics of the technology itself. It examines the relative advantage offered with the continued use of an innovation over its discontinuance. Relative advantage is an excellent predictor of post-adoption behaviour (Miller and Mariola, 2009). According to this theory, adopters who are able to see clear economic benefits of adopting a technology are likely to continue with the use of the technology despite the challenges that it may hold. On the contrary, adopters who experience problems with the adopted technologies are likely to discontinue them for a better alternative.

The second attribute is compatibility. This is the degree to which an innovation is perceived as consistent with the needs of the adopter. According to Roger's (2003), a technology must be seen to incorporate farmers' views or practices otherwise it will not be effectively utilised. This implies that technologies which interfere with the mode of living of farmers will most likely be discontinued. It was thus important to find out in this study whether the changes introduced by adoption of tc-banana technology might have contributed to its discontinuance.

The third attribute is complexity. This is the degree to which an innovation is perceived as relatively difficult to understand and use (Rogers, 2003). According to Rogers, some technologies are easy to understand, while others are not. Since not all technologies are that simple, it is important that adopters understand and learn them. According to Rogers, the diffusion of a technology that is too complex to communicate and to apply is often slow. This implies that farmers who perceive technologies as complex were likely to discontinue them.

The fourth attribute is observability, which refers to the degree to which the results of an innovation are visible/ observable, demonstrable and communicable to farmers (Rogers, 2003). Whereas the results of some technologies can be easily observed and communicated, some are difficult to describe. Therefore, those technologies which are difficult to describe or promise little results to adopters are more likely to be abandoned.

The last attribute is trialability, also known as divisibility. ***Trialability*** is the degree to which an innovation may be experimented with on a limited basis before deciding to adopt. Technologies which can be tried on small scale will generally be adopted more rapidly than technologies that are not divisible (Rogers, 2003). When a technology is tried out in small scale, the feeling of insecurity associated with the adoption of something new can be removed thus farmers are able to use it. In summary, the above mentioned attributes form the basis for understanding technology discontinuance in retrospect to this study.

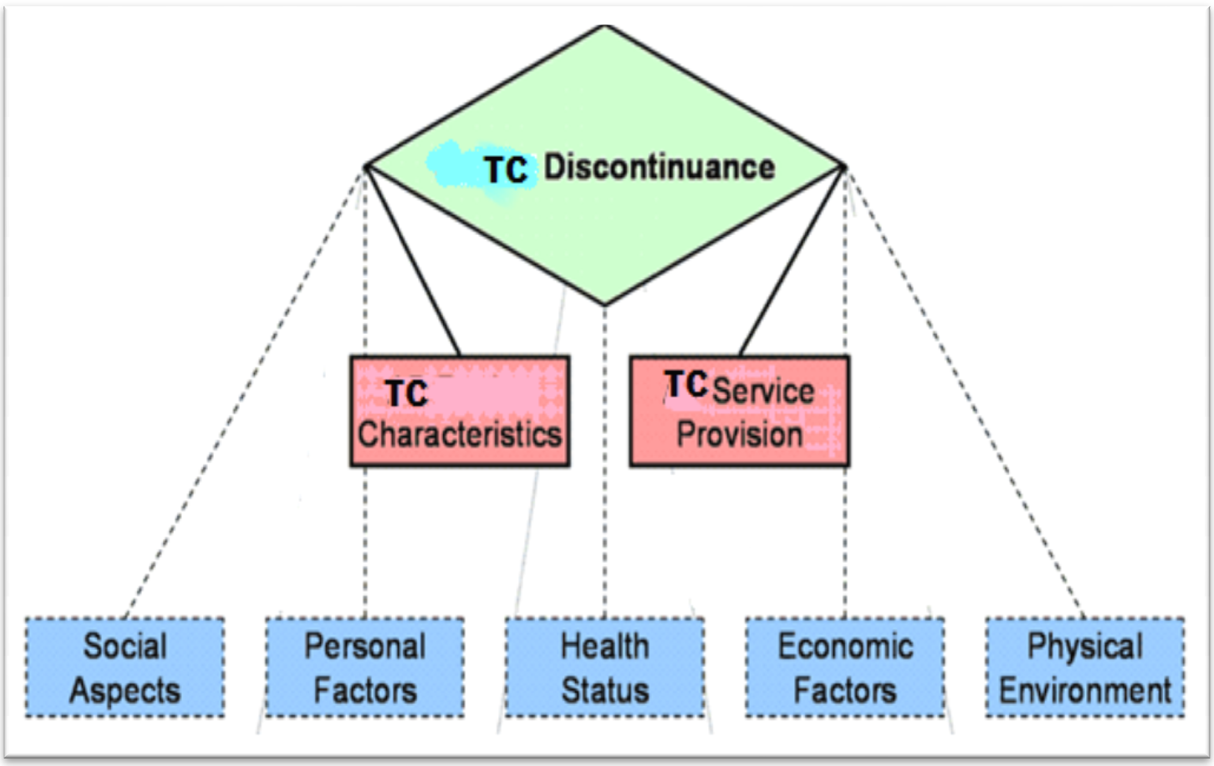
2.4 Conceptual Model for this study

This section outlines the concepts used in this study and shows how they relate to the study and to each other. The dependent variable is discontinuance, which is the decision to discard an innovation. Tissue culture technology on the other hand refers to the cultivation of plant cells, tissues, or organs on specially formulated nutrient media (ISAAA Website). The conceptual model presented in figure 2 below depicts how the two concepts are closely related. Figure 2 shows that discontinuance decision is as a result of those characteristics within the technology and the perceived service that the technology provides. Technologies which pose technical challenges to adopters and the challenges not addressed in time are more likely to be rejected. Indeed, an individual may become dissatisfied with an innovation because the innovation has a flaw, turns out to be inappropriate for its original purpose or does not have a perceived relative advantage over its counterpart (in this case, conventional suckers). The decision to reject an innovation may also be as a result of misuse of the innovation by the adopter. Other factors which play part in technology discontinuance include: social aspects, personal factors, health status, economic status and the physical environment as indicated in the figure below. A study by Miller and Mariola (2009), for instance, found that discontinuance was the result of those characteristics within technology itself and the large socio-economic context in which adoption takes place. Another study by Nnadi and Akwiwu (2007) found that discontinuance decision was related to personal characteristics (age and education) and the social environment (access to credit and market).

Rogers' theory of diffusion (2003) highlighted that adopters who had a positive perception of the technology and were able to receive observable returns from adoption were likely to continue with the use of the technology despite the challenges that it may hold. Those who experienced problems with the adopted technology were likely to discontinue it for a better alternative.

Once a technology is developed and disseminated to farmers, it is the discretion of the adopting farmers to decide whether to continue with its use or discontinue it altogether. The decision to discontinue would be based on the above mentioned factors. It is assumed that a farmer will continue to use the adopted technology when he or she enjoys its benefits such as increased yields and incomes. When no such benefits are realized, it is likely that the technology stands to be discontinued. The conceptual framework shows the linkages between the factors and discontinuance decision.

Figure 2: Discontinuance Decision



Source: Authors own interpretation

Chapter Three

3.0 Research Methodology

This chapter explains the research design that guided this study and explains also the different methods used for data collection and analysis. Furthermore, it discusses the strengths and limitations of the methods used based on practical experience of the research work.

3.1 Research Design

This section explains the research strategy used. This research was interested in finding out what caused smallholder farmers to discontinue the previously adopted tc-banana technology. In order to gain a holistic view of the study topic, a case study approach was used. Case study approach is useful in investigating a contemporary phenomenon in its natural setting (Yin, 2003). A case study could be an individual, small group, an organization or a nation. In this study, the phenomenon of discontinuance is investigated. Qualitative methods of data collection were mainly used to gather information in the field. The field work was conducted on the month September of 2010 for two weeks. The data collection methods used to collect information while at the field include: in-depth interviews, key-informant interviews, informal interviews and personal observation. Interviewing was the main data collection technique, guided by a set of open-ended questions. This technique allowed for a free exchange of information between the researcher and the respondents. To acquire a suitable sample for this study, purposive sampling and snowballing sampling techniques was used. The sampling procedures were important because of two main reasons: (1) the nature of this study which required that the sample obtained have farmers thought to have discontinued the technology and (2) logistical consideration such as time, capital and personnel.

3.2 Study site

The present study was carried out in Makuyu division, one of the four divisions of larger Maragwa district in Central province. The other administrative units within the district are Kigumo, Kandara, and Maragua (see table below). According to the Welfare Monitoring Survey of 1997, the number of people living below the poverty belt in the district was about 33.3 percent of the total district population (Kenya, 2005). Those hardest hit were women and children. The district has a high population growth of 1.8 per cent per annum which has effect on land demand as well as social and economic development.

Table 1: Area of the District by Administrative units (Km^2)

Division	Area (sq. Km^2)	Population	Density	Locations
Makuyu	195	58,695	299	3
Kandara	234	157,141	672	6
Kigumo	210	79,098	372	3
Maragua	200	93,666	468	5
Gatare Forest	226	-	-	-
Total	1,065	387,778	447	17

Source: Maragwa District Strategic Plan 2005-2010

The District lies between the altitude of 1100 and 2950m above sea level, which receives bi-modal rainfall patterns with an average of 1200mm during the long rains (March to May) and 1000mm during the short rains (October to December). The climate is thus appropriate for farming especially large-scale farming. The major occupation of the people is farming.

The study area, Maragwa district, lies in the main and marginal coffee zones where banana been the main source of livelihood for smallholder farmers. The collapse of the coffee sector in the mid-eighties saw banana crop rise as an important economic crop for the smallholder farmers in the district other than coffee. In 2003 it was estimated that 3355 hectares of arable land in the district was under banana, producing a total of 38,040 tons which was valued at Ksh 285.3 m (MOA 2004). This was second to tea which earned the highest income value. Banana production nevertheless has been on the decline (Wambugu and Kiome, 2001). Farmers in the district were also observed to have abandoned the previously adopted tc-banana technology. This study therefore needed to find the root cause of the problem. Since there is so little on the subject of discontinuance, the intention of this research was not to carry out a full sociological survey of farmers but a more in-depth qualitative research.

3.3 Unit of Analysis and Sampling

The unit of analysis of this study is the tc-banana farmer. The researcher selected 45 farmers purposively for interview. The selection was based on farmer's experience with adoption of the technology.

Before the start of the field work, the researcher met and discussed with the director of Biotechnology at JKUAT University and informed him of the purpose of the research. The purpose of the visit was to gain a deeper understanding of the technology in question, familiarise himself and also observe how it is produced in the laboratories. After much discussion with the Director, the researcher made a visit to KARI offices in Thika and thereafter interviewed one of the officials. Here, information on the genesis and objective of the introduction of tc-banana project was collected and analysed. The researcher then visited the District agricultural office and had discussion with the District Agricultural Officer (DAO), who was able to shed light on the study topic i.e. discontinuance.

In order to get in touch with farmers, the researcher sought help from the District Agricultural Officer who then forwarded him to the Divisional Agricultural Extension Officer (DAEO). With the help of the DAEO, he was able to locate 45 tc-farmers for interview. Qualitative approach is preferred when a detailed understanding of an issue is required and which can be established by talking to people within their context (Yin, 2003). The nature of this study and study topic justified the use of this approach. In this regard, the researcher interviewed farmers in their natural setting; individually from the comfort of their homes or farms or place of meeting. Representatives of banana farmers including the chairmen and secretaries were also interviewed. Prior to the interviews, a checklist of key topics had been prepared in advance to guide the interviews. The respondents were interviewed face-to-face with their consent. Data generated from the interviews focused on farmer characteristics and reasons for discontinuance.

Apart from farmer interviews, semi-structured interviews were conducted with key informants. Only four informants were interviewed. These are: one KARI official, the director of biotechnology at JKUAT, the district agricultural officer (DAO) and the divisional agricultural extension officer (DAEO).

In total, a sample of 49 respondents was selected for interview including farmers (see table 2 below). 45 farmers were selected for interview. Four (4) informant interviews were also conducted.

Table 2: Sample Achieved

Respondent (s)	No
Farmer interviews	**45**
4 Informant Interviews	**4**
1. District Extension Agricultural Officer (DAO)	**1**
2. Divisional Agricultural Extension Officer (DAEO)	**1**
3. Director of Biotechnology, JKUAT	**1**
4. KARI staff	**1**
Total	**49**

Source: the author

3.4 Data Sources and Data Collection Methods

This study was informed by both primary and secondary sources. The research started by reviewing relevant documents such as books, newspaper articles, web resources, brochures, reports from various sources. These documents helped in understanding of the subject and in formulation of the questionnaire used for collecting data. The primary data collection methods used included: in-depth interviews, key-informant interviews and personal observation.

A structured questionnaire containing both close and open ended questions was designed to elicit information on the research questions under investigation (See table 2 below). Interviewing involved asking respondents' specific questions but guided by a checklist. The researcher was able to listen and note the farmers' responses and occasionally pose additional questions to bring clarity on an issue that needed clarification. Although a checklist guided the interviews, farmers were encouraged to express their opinions and to speak openly about 'private' and 'sensitive' issues. Each interview lasted about 20 minutes, although it was important that clarification on key issues was obtained.

Informal interviews were a preserve of the researcher. This technique helped in developing a rapport between the respondents and the researcher. Informal interviews were carried out throughout the data collection period in order to elicit information that was difficult to capture during the formal interviews. They also gave the researcher an opportunity to interact with the farmers and seek clarification over issues not well articulated in other methods used.

In addition, personal observation was used side by side with other methods. The researcher observed how tc-bananas were cultivated as he went with farmers round their plots. He also observed the relationships between farmers and their local leaders. Through observation method, the researcher was able to capture the non verbal behaviour of the respondents and the physical conditions of the area of study.

Table 2 below shows the research questions used to guide the study. The table is divided into four main columns. The first column indicates the specific research questions asked by the study. The second column shows the data needs of the research. The third column shows what instrument was used in data collection. And the last column shows how the data was analysed.

Table 3: Research Questions, Data needs, Instrument and Analysis

Research Question	**Data Needs**	**Instrument**	**Analysis**
What are the characteristics of the discontinuing farmer?	Age Gender Education level Experience	Farmers Interview guide	Percentage and frequencies
What do farmers report as the reasons?	Reason	Farmer Interview guide Key informants interview Observation guide	Themes

What are the advantages of suckers over tissue cultured plantlets?	Advantages of suckers	Analysis	Tables
What are the most important factors influencing farmers' discontinuance decision of tc-banana technology?	Factors influencing discontinuance	Content analysis	Themes, percentages,

Source: the author

3.5 Data Analysis:

Data obtained from interviews was carefully narrated for analysis. Qualitative data from respondents was organised into themes in a MS-Word document format. From the analysis, several themes such as technical factors and socio-economic characteristics emerged. Quantitative data collected through semi-structured interviews was cleaned, coded and analysed using SPSS 16.0. It is presented in form of percentages and frequencies.

Strengths and Limitation of the Study

The qualitative method used in this study allowed for a deeper understanding of discontinuance variable and the issues (i.e. technical characteristics) that would have been difficult through other methodologies. Qualitative methods are also easy to re-design (Seidel, 1998).

The researcher enjoyed full cooperation from all respondents which was very useful for obtaining information.

Nevertheless, there were logical constraints in the study. First, this study required movement from place to place locating farmers for interview and therefore required adequate financial support to conduct it. The second challenge was obtaining a sampling frame. The initial sampling was based on obtaining the sampling frame from the DAEO office but none was available. Nonetheless, I was able to locate farmers in the study area through the help of the divisional agricultural extension officer (DAEO) and made a promise to him that he would receive the findings and recommendations after completion of this study report.

Another problem involved asking questions that required respondents to recall events in the past. These included questions such as the amount of produce harvested and quantity sold. In this regard, farmers were asked only about the previous year harvest (2009).

A third challenge was the interpretation of the research questions from English into local language-Kikuyu. Thus, I had to use an interpreter. The location agricultural extension officer was able to help translate the research questions from English to the local language and sought clarification when needed from the respondent.

Chapter Four-Study Findings and Discussion

4.0 Introduction

Increasing agricultural productivity is one of the important reasons as to why smallholder farmers in Kenya adopt a particular agricultural technology. Yet, several factors influence the continued use of a technology, and this may limit it from achieving its goal of reducing food security and poverty in rural Kenya. In this chapter, I have examined the reasons as to why farmers in Maragwa District discontinued the adopted tissue cultured (tc) banana technology. Exclusively, this chapter addresses the four specific research questions presented in chapter one of this report. The results presented in the chapter are based on in-depth interviews with farmers and key informants, personal observation and secondary information such as the internet. Data was analysed both qualitatively and quantitatively

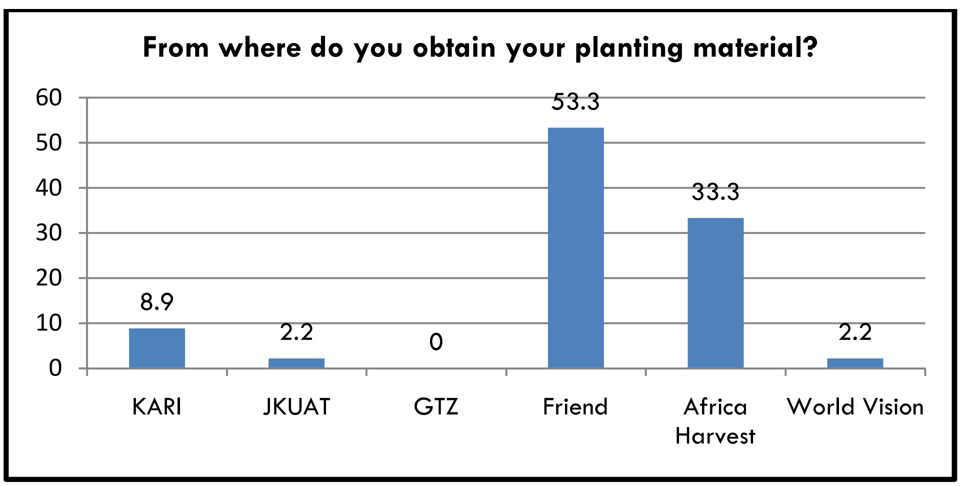
Specifically, this chapter has four main sections. The first section looks at the characteristics of a discontinuing farmer and attempts to give a clear picture of this farmer. The second part outlines farmers' reasons for discontinuance of tc-banana technology and then discusses their perceptions and opinions with regards to adoption. The third section looks at the characteristics of tissue culture highlighting its advantages and disadvantages. The fourth section of the report discusses the important factors influencing discontinuance decision. Two broad factors are discussed in this section, that is, the technical and socio-economic factors. The last section provides two case studies showing farmers' experiences with the adopted technology.

4.1 Question 1: What are the characteristics of a discontinuing farmer?

The initial objective of this research was to identify and distinguish the discontinuing farmer from the continuing farmer. To establish this, farmers were asked whether they were growing tissue cultured bananas. Only those who responded positively were selected. A farmer was considered to be a tc-farmer if he or she was growing one or more tc-banana stems. Once it was clear that the respondent was indeed a tc-farmer, discontinuance variable was investigated. Discontinuance is the decision a farmer makes to abandon a technology after previously accepting it (Rogers, 2003). In this study, a farmer was considered to have discontinued tc-banana technology when he or she obtained planting materials from own field or from neighbours or relatives when establishing or expanding his or her own banana plot. Indeed, farmers are always required to acquire new planting materials for planting. These materials can be obtained directly from laboratories by farmers (where tc-plantlets are produced) or through the dissemination process (whereby technology providers, extension staff or non-governmental organizations provide tc-plantlets to farmers). Farmers are always advised to seek new planting materials and not to use suckers from old banana orchards for fear that they might be contaminated with pests and diseases.

An overview of the research findings suggests that there was a high rate of discontinuance among tc-growing farmers. When the respondents were asked to state where they had acquired their planting materials, a majority (53.33 %) indicated that they had obtained their planting materials from friends, neighbour and relatives (see figure 3 below). Indeed, these respondents were of the opinion that suckers from tc-plants were as good the original mother plants. All other responses scored less than 40 percent: 33.33 percent of respondents said they had obtained their planting materials from Africa Harvest; 3.89 percent said they had obtained their planting materials from JKUAT; 2.2 percent said they had obtained their planting materials from KARI (2.22%) and 2.2 percent had obtained their materials from World Vision as highlighted in the table below. None of the respondents said that they had obtained their materials from GTZ which is also a major supplier of tc-materials.

Figure 3: Source of Planting Materials



Source: *Field Data, 2010*

It is interesting to note that although some farmers had obtained their planting materials directly from the technology providers, these farmers still believed that first generation suckers of tc-stems were as the good as the mother plants. These farmers confessed during the interview that they had used suckers from their own tc-mother stems when expanding own plots. Others had the intention of using the suckers as opposed to tc-plantlets to expand their plots in future. It is important to point out that although this was a well-known practice among smallholder farmers, it is a forbidden practice. According to an informant, farmers are recommended to always use tc-plantlets when establishing new banana orchards or expanding their orchards. This is because suckers obtained from own orchards are likely to be contaminated by soil borne pests and this entailed a risk of spreading disease or pests to other growing tc-stems. And consequently it could defeat the very purpose as to why the technology was introduced in the first place.

4.1.1 Characteristics of the tissue culture farmer

In literature, studies have shown that discontinuance decision is related to personal characteristics such as age, gender and education level (Nnadi & Akwiwu, 2007; Miller and Mariola, 2009). It was thus of interest to this study to observe and note the personal characteristics of respondents (farmers). Data on farmers' ages, gender, land size and level of education was collected and analysed. The study also captured information on farmer's experience in tissue culture production. In this section, I have discussed the personal characteristics of tc-farmers in much greater detail. A summary of the descriptive statistics is listed in table 4 below.

Table 4: A summary of descriptive statistics of tissue culture farmers

Characteristics	Semi-structured interviews
Number of respondents	45
Mean age (years)	Mean 57.4
Mean land size under tc	0.4667 acres
Mean farming experience	4.62
Proportion of male	55.6 percent
Proportion of female	44.4 percent

Source: Author

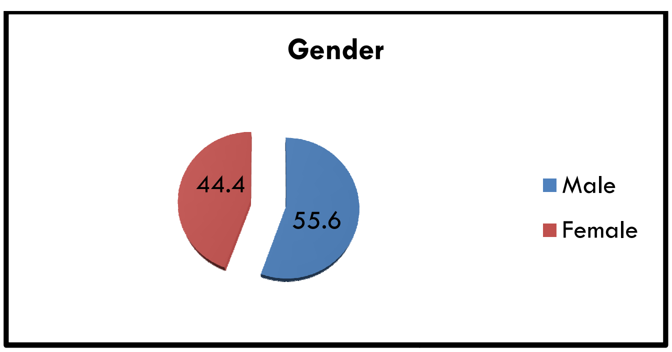
4.1.2.1 Age and Experience

Age has often been used as a measure of farmers' experience in use of a technology. On the one hand, young farmers may be more knowledgeable about new practices and more willing to bear risks that come with adoption. On the other hand, older farmers may have more experience and resources that allow them to decide effectively positively on technology use. A review of the respondent ages indicated that the highest age of farmers was 82 and the lowest 23. Their mean age is 57.4 with a standard deviation of 13.544. A question asked the respondents: How long they have been growing tissue culture banana? When their responses were analysed the results showed that averagely farmers have grown tc-bananas for 4.62 years. These results show that farmers in this area are quite experienced with cultivation of tc-bananas and growth of banana in general. This implies that they have had time to compare the performance of tc-plantlets with that of conventional suckers.

4.2.3 Gender

The distinctive feature of the respondents is that a majority were men. About 55.6 percent of the respondents were males while the rest (44.4 percent) were females. Although in literature women have dominated smallholder banana farming (Qaim 1999), this result depict that men were getting more involved in banana farming.

Figure 4: Gender



4.2.4 Farm size

Most land in the study area is privately owned land. Also, majority of farmers are smallholder farmers. This study reinforces the fact that indeed most farmers own small plots. The average size of land under tissue culture production was 0.4667 acres. This finding agrees with Qaim's

(1999) finding which showed that the small-scale farmers had less than 0.5 acres while the large-scale farmers had farms bigger than 2 acres. Production in small land holdings can be expected to less effective and with much lesser yields as compared to large farms.

A majority of the respondents were growing tc-bananas alongside non-tc-bananas but in separate plots. Only a few farmers grew solely tissue cultured bananas stems in their pieces of plots. A question sought to establish the number of tissue cultured stems grown in a plot. The results showed that the maximum number of stems grown was 700 while the least was 10. Also, it was observed that apart from banana other crops are grown as well; these include maize, beans, Irish potato, mangoes, pawpaw and sweet potatoes. This observation actually affirms that smallholder farmers are risk averse and would try to maximise the use of their pieces of land by diversifying in other crops in order to get returns.

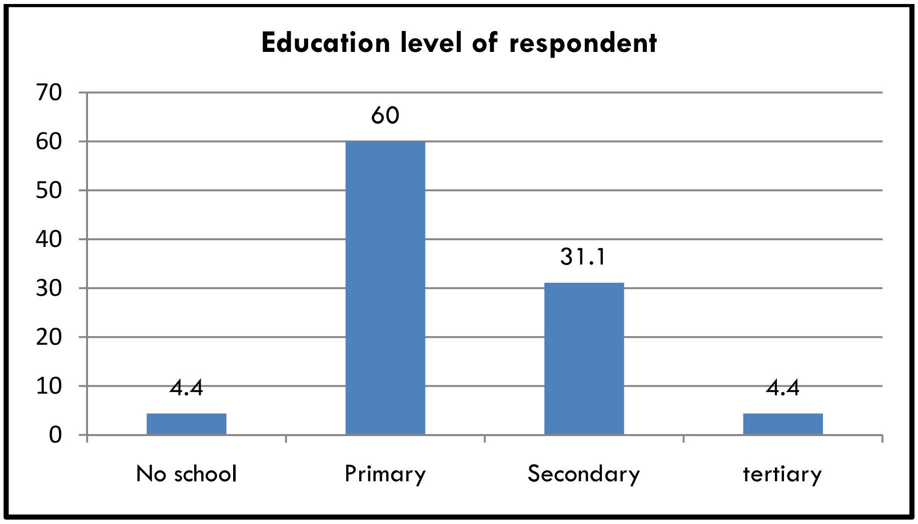
Table 5: Number of tc-Stems grown

	Mean	Maximum	Minimum
Number of Tc stems grown	143	700	10

4.2.5 Education Level

Education is among the key variables often associated with technology use. Educated farmers are better able to process information and search for solutions to alleviate their production constraints. There is a belief that education provides farmers with ability to perceive, interpret, and respond to new information much faster than those without formal education (Muyanga, 2009). In this regard, it was of interest of this study to document the levels of education of the respondents. The study results show that majority of the respondents (60 percent) had received some basic form of education (attended primary school), whereas only a few (31.11 percent) had attended secondary school. The rest were equally divided in their responses, some (4.4%) had received some form of tertiary education, while others (4.4%) had not been to school at all.

Figure 5: Education Levels of Respondents

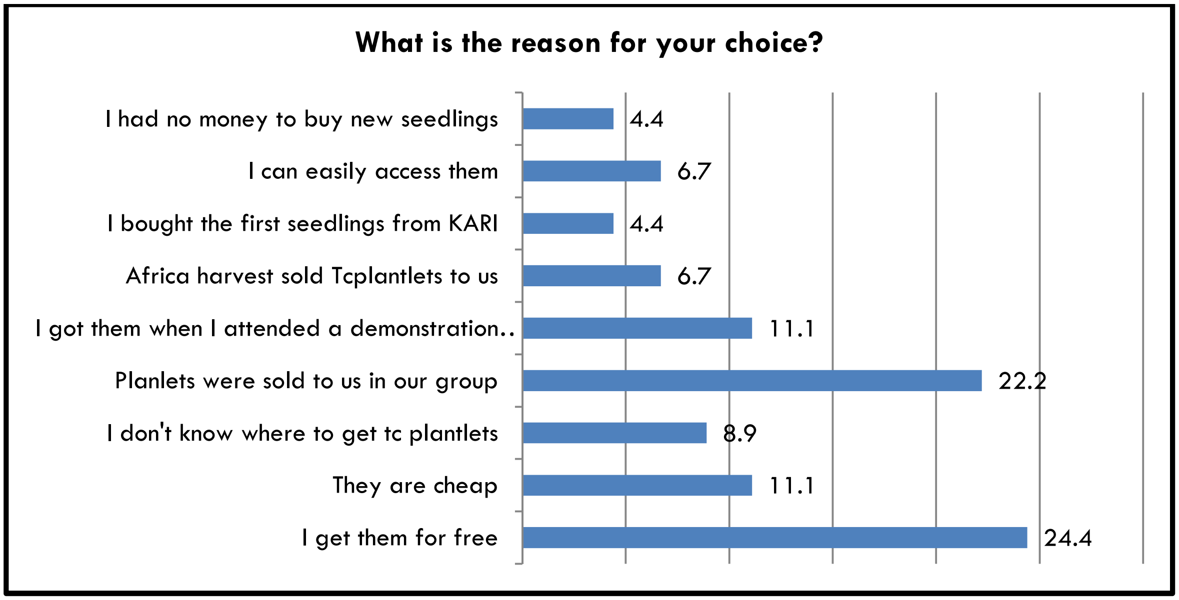


Source: Field Data, 2010

4.3 Question 2: What do farmers report as the reasons?

As was mentioned earlier, this study found that there was a high rate of discontinuance among tc-growing farmers. To further explore on this matter, respondents were asked to give reason for their choice of planting material. The results show that most of the respondents (over 60%) had acquired their planting materials cheaply or for free. Among the responses given, a majority (35.6%) said ‘the suckers were for free’ or ‘they were cheap’; a few (6.67%) said that it was easy to access the suckers. Some farmers (8.9%) did not know where to get the tc-plantlets while others (4.4%) cited the lack of money to purchase the materials.

Figure 6: Reason for choice



Source: Field Data, 2010

Another question further asked the respondents how much each paid for his or her suckers. The study results show that suckers are quite cheap compared to tc-plantlets. The price of one sucker was less than Ksh60; it ranged from between Ksh30 and Ksh60. On the other hand, the cost of one tc-plantlet at market price ranged from Ksh80 to 100.

Apparently, majority of the respondents who had used suckers believed they were growing tc-bananas regardless of where they had obtained them. They were convinced that suckers obtained from tc-mother stems were equally tc-varieties.

The respondents who had access to the right materials- tc-plantlets-were also asked to give reasons for their choice of materials. A majority (22.2%) of the respondents indicated that they had bought the tc-plantlets at banana farmer groups where it was sold to them. Some (4.4%) had bought their first plantlets from KARI, while others (11.1%) had bought their plantlets when they attended a demonstration organised by the technology providers.

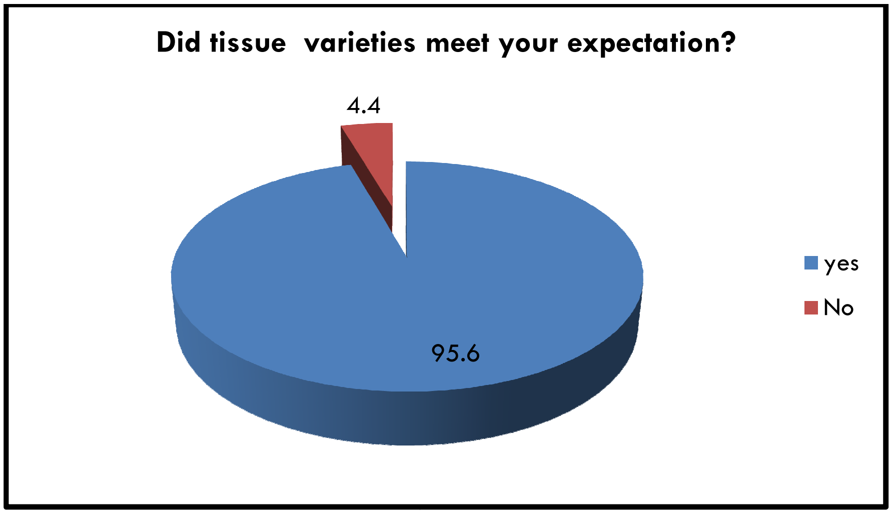
When these respondents were asked how much each paid for the plantlet, the study found that those who had obtained their tc-plantlets from 'Africa Harvest' bought them at a subsidised price of Ksh80 per plantlet. Indeed, Africa Harvest not only provided for the planting materials but also trained the farmers on how to grow and manage their tc-bananas. Farmers were also trained on banana marketing and then sold the plantlets at the end of the training. Those without funds were offered loans to acquire the plantlets, in cash or in kind. Interestingly, some of the respondents during the interview indicated that they had had their first experience with tc-varieties when they attended the trainings or when they first joined farmer groups. It is quite certain that those farmers who had obtained their plantlets from 'KARI' and 'JKUAT' had bought them expensively, at a unit cost of Ksh100. Those who acquired their plantlets from 'World Vision' said they were given the plantlets free of charge. This was because World Vision (a non-governmental organisation) was advocating for food security in the area and was reaching out to farmers to cultivate bananas. Therefore, the organization provided the plantlets free of charge to poor farmers.

It is important to point out that there was general perception among all the respondents that first generation suckers from tc-mother stems were as good as tc-plantlets from laboratories. Majority of the respondents were of the opinion that suckers from tc-mother stems were similar to the tc-plantlets and thus opted not to buy the tc-plantlets from laboratories but to acquire suckers from their tc-plots.

4.3.1 Farmer Perception of Tissue Cultured Bananas

The perceived attribute of an agricultural technology has been associated with discontinuance behaviour. In line with this view, farmers were asked two questions: First, to state whether the tc-banana varieties had fulfilled their expectations and second, to give the advantages and disadvantages of tissue culture varieties. When asked the first question, majority of the respondents (95.56) responded positively; only a paltry 4.44 percent said 'it did not' (see figure below).

Figure 7: Perception of tissue cultured varieties



Source: *Field Data, 2010*

When the respondents were asked a second question, why? Those who answered 'yes' were of the opinion that tissue culture varieties were more productive than conventional suckers. A look at the responses given by the respondents reveals a wide range of advantages offered by the technology in question. The three broad advantages were fast growth rate of plants, high yields and uniform production.

One respondent said:

> *"Tissue culture varieties grow very fast and mature early than local varieties. After one year one get results; big banana bunches which when you sell you get good money. Another advantage is that the stems of tissue cultured bananas do not break easily and are short. Therefore you don't need to stake them. The local varieties require one to stake them because they are very tall or else one loses his or her bananas."*

Although many of the respondents had responded positively to the first question, others responded negatively. Indeed, these farmers had had negative experience with the technology in question. In general, however, all the respondents reported having had experienced some kind of difficulty with tc-banana varieties. Of course, it was the interest of this research to concentrate on the negative reasons that the respondents gave. Comments such as 'it did not work' or 'it didn't work as I thought it would' were prevalent. On this note, the respondents were asked why they were displeased with the varieties and some reported that young tc-varieties were sensitive to drought, while others said they were less resistant to diseases and pests. Ironically, a huge number of them were experiencing major difficulties with tc-varieties but were determined enough to continue using them in the hope that they would improve with time. As proof, one farmer I visited showed me four tc-stems which apparently had succumbed to diseases and pest, contrary to expectation. When asked how she was able to contain the problem in her farm, she indicated that she has successfully been using 'ash' (the common ash found in households). Although ash has not been proven scientifically, it is interesting to point out that it had worked so well for her and indeed was restraining the spread of pests/diseases to other parts of the farm. Evidently, this indigenous knowledge is of greater value to the farmer. Apart from bananas, this farmer has been applying this knowledge on potatoes to control spread of diseases and pests. In another farm, another farmer complained angrily of losing about all of his recently acquired tc-plantlets as a result of drought. And because he had bought the plantlets expensively, he felt angry and cheated.

Indeed, majority of the respondents were of the opinion that tc-plantlets were more expensive than conventional suckers.

The researcher assessed farmers' perceptions of tc-varieties by asking some of the respondents to compare growing of tc-bananas with growing of conventional bananas. A review of the responses given by the respondents reveal that tc-production is more laborious than non-tc-production. A majority of respondents said that the cultivation of tc-bananas was more laborious and requires more manure/ fertilizer and water. During an interview, one of the respondents gave a surprising remark when he was asked to compare between tc-banana and conventional suckers. He said:

> *"In the absence of care and water, the tissue culture variety rarely does well. It is sensitive, and like a 'grade cow', you have to take care of it for you to observe results. In the right conditions, the yields are more compared to suckers. On the contrary, conventional suckers are more like 'local breeds'; they are resistant to drought, pest and diseases. Although the yields are low but in the end you are sure of getting something. This is not always the case with tissue culture varieties; today it does well tomorrow it fails. There is just no consistency in yields."*

In short, famers attributed their decision to discontinue the adopted technology to a number of reasons (see table below). Broadly, these reasons can be categorised into three. The first is the lack of information on various aspects of the technology. A majority of the respondents cited not knowing where to get the planting material from; a few said they first heard of tissue culture banana when they attended trainings or joined banana groups. The second reason was the high cost of tissue cultured plantlets compared to conventional suckers. Majority of the respondents had obtained their planting material either for free or at a minimal fee. The third and last reason was the high requirement for water for growing tc-bananas. All respondents indicated that water was a major problem when cultivating tc-banana.

Figure 8: Reasons for Discontinuance

Reason	Overall Rank
High water requirement	1
High cost of tissue Tc-plantlets	2
Lack of information	3

Source: Farmer Interviews, 2010

4.4 Question 3: What are the advantages of suckers over tissue cultured plantlets?

This section looks at the characteristics of tissue culture plantlets against the characteristics of conventional suckers. There is a high likelihood that the negative qualities of tc-plantlets contributed to discontinuance decision among the smallholder farmers.

4.4.1 Advantages of Tissue Culture Plantlets

There are several—partly direct, and partly more indirect—advantages brought about by the use of tc-plantlets in comparison to conventional suckers. These advantages are:

Tissue culture banana plantlets are free of the most important pests and diseases that exist in Kenya, notably weevils, nematodes and fungi. However, without appropriate care and field hygiene (especially if planted in contaminated soils) banana plants can still be infested at a later stage. But nevertheless, unclean planting materials are the main source of diseases and pests. In this case, yield losses caused by pests and diseases could be reduced substantially by starting plantation cycles with clean tc-plantlets.

According to scientific research, tc plantlets show a considerable advantage in yield performance compared to clean conventional sucker material. This leads to shorter harvest-to-harvest periods, a higher bunch weight, and a higher annual yield.

Another frequently mentioned advantage of tc-plantlet is their uniformity and more simultaneous plantation development as compared to conventional material. Thus, orchard management is facilitated, and harvesting can be done over a short period, adjusted to market requirements.

Apart from the immediate yield gains, another major advantage associated with the use of tc-plants is that superior new banana seedlings can be introduced and disseminated much faster. The reason is that large numbers of healthy in tc-plantlets can be produced in a comparatively short period of time in the laboratory, whereas the speed of conventional propagation depends on the number of suckers produced by the mother plant. Under farmers' conditions one plant produces only around six suckers per year.

4.4.2 Disadvantages of Tissue Culture Plantlets

Apart from the advantages that tissue culture banana plantlets unquestionably have, there are also certain drawbacks:

The first limiting factor of using in tc-banana plantlets from the point of view of farmers is the higher price of the material if compared to conventional suckers. The current price of a tc-plantlet sold by Africa Harvest is around Ksh100, which—in the absence of suitable access to financial markets—is quite high for resource-poor farmers, regardless of the later benefits.

Another disadvantage of tc-plants is that they require added care and improved management. Since they have no nutrient reserves when transplanted, external stress is particularly harmful in the first five months after plantation establishment (Qaim, 1999). Without proper fertilization, weeding and enough water supply during this phase, the growth performance of tc-plants could be lower than that of traditional suckers. Likewise, transplanting in tc-plants into disease infected soils can be more damaging than with conventional material. Nonetheless, it is obvious that the technology can only be successful when farmers alter their traditional practices of neglecting the banana crop in terms of labor and input allocation.

While most of the diseases are removed from the banana plant in the tissue culture procedure, viruses can still be transmitted through tc-plants. Although banana viruses so far do not constitute a problem in Kenya, there is a risk that they could be brought into the country via imports of tc-material from infected areas of the world.

4.5 Question four: What are the most important factors influencing farmers' discontinuance of the technology?

Although discontinuance decision is pegged on several factors, this study categorizes the factors into two broad categories, namely: technical and socio-economic factors. Discontinuance decision is as a result of those characteristics within the technology itself and the large socio-economic context in which adoption takes place (Miller and Mariola, 2009). According to Miller and Mariola (2009), when the technical problems associated with use of the technology are not addressed, there was a high possibility for discontinuance among adopters. In this regard, it was thus important to consider the technical and socio-economic challenges surrounding adoption of tc-banana technology. But before I discuss these challenges, it is important first to understand and outline the characteristics of tissue culture technology.

4.5.1 Tissue Culture Technology

Tissue culture is a relatively simple technique that has been used for commercial propagation in several countries including Costa Rica, Israel and South Africa, since the mid-1980s. It is a biotechnological tool for multiplying disease-free planting material. Small plant parts, tissues or cells obtained from a desirable variety are grown under laboratory conditions to produce numerous tiny plantlets (Karembu, 2007). In essence, tissue culture is a propagation method and not a technology *per se*. The technique allows for quick, *en masse* multiplication of adequate clean planting materials commonly referred as tc-plantlets and reduces the problem of pests and diseases for banana growers. In other words, these plantlets are pathogen free, that is, devoid of pests and diseases. Within short periods of time, a single plant can be multiplied in to several thousand plants. Tissue culture technique allows for mass production of species that are difficult to regenerate under conventional methods of propagation i.e. suckers. Conventionally, one banana plant produces about 10 suckers in a year but with tc-technique, over five hundred plantlets can be produced in one year. In addition, it allows for production of pathogen free plants which exhibit increased vigour, yield and mature early.

4.5.2 Technical Factors

Although two broad factors are hereunder outlined, this section highlights the technical factors which influence farmers' discontinuance behaviour. Assuredly, tc-banana technology, like all other technologies, is faced with a number of technical challenges which affect its continued use. Therefore, when the technical problems are not addressed, discontinuance becomes an option for the adopting farmers (Miller and Mariola, 2009).

One technical challenge clearly outlined in literature with regards to tc-banana technology is its susceptibility to pests and diseases. According to scientists, tc-banana technology, although believed to be pathogen free, is not resistant to diseases/pests. Wambugu and Kiome (2001) highlighted that the sterile operational nature of tissue culture procedures only excludes fungal, bacteria and pest from production system but not viruses. Viruses such as banana bunchy top and banana streak virus can still be transmitted through the plantlets, unless measures are taken to prevent the transmission from happening (e.g. virus indexing). Although Kenya lacks facilities for virus indexing, which is needed to ensure bananas are free from viruses, Wambugu and Kiome asserted that there is no need for alarm since Kenya is generally free from banana viruses.

Even though viruses may not a threat to Kenyan farmers, the presence of pests and diseases in farms is a threat and challenge to smallholder banana farming. During the survey, some farmers complained of the problem of pests and diseases in their farms. Although some farmers were trying to contain the problem, the yields were negatively affected. The problem was made worse by the lack of water needed for proper growth of seedlings. As a result, many of them were harvesting very little or nothing. Ironically, most orchards established with conventional suckers were thriving though with low yields compared to tc-orchards. During the interviews, when the respondents were asked why tc-varieties were performing dismally compared to local varieties, majority of them indicated that tc-plants had a high affinity for water, thus are affected by moisture stress as opposed their counterpart. Indeed, this observation explains why farmers were growing tc-bananas alongside conventional ones. Clearly, farmers were determined to get results. And with conventional suckers they were sure of harvesting something however little.

In an attempt to improve the quality of tc-plantlets, scientists recently have established a new approach. According to an informant, scientists have developed a new way of controlling field pests by use of micro-organisms known as "*fungal endophytes"*. Endophytes are micro-organisms which spend part or whole life within the tissues of a banana plant and symbiotically form mutual relationship with the host plant. He indicated that laboratory tests confirm these micro-organisms protect the host plant by killing the pests, notably banana nematodes and weevils. Thus, it is believed that the inoculation of tc-plantlets with the micro-organisms boosts the plants resistance against pests. However, even with this new technological development, it is quite unfortunate that it is yet to reach the farmers who need it most.

One other challenge with tissue cultured plants is that they require more care and management than what farmers give them. Indeed, tc-plants after transplanting require more care and attention. According to an informant, without sufficient nutrient, weeding and water, the performance of tc-plantlets can be worse than that of conventional suckers. This he highlighted could be the reason why farmers are reverting to suckers and not taking up the new technology.

4.5.2.1. Labour requirements of tissue cultured bananas

Qaim (1999) in his study showed that the cost of labour for the establishment of banana orchard is higher for famers using tc-plants than that of conventional suckers. In his analysis, the main labour intensive activities are land preparation, planting, manure application, weeding, watering, de-suckering, de-leafing, propping, harvesting and marketing. This study however reveals watering as the major labour demanding activity in tc-banana production.

Conventionally, bananas are grown under rain-fed conditions. Planting is normally done at the onset of rains. Lack of water is therefore a huge problem to tc-farmers. Majority of farmers indicated that they had experienced challenges growing tc-varieties because of little or no rain. Unlike conventional suckers, tc-plants demand a lot of water for their growth. Apart from water, these plants need extra attention, in terms of labour. The high demand of water, according to an informant, can be explained by the fact that tc-plants do not have a rhizome that acts as a storage reserve for initial growth of roots and leaves, unlike conventional suckers. The growth of tc-plant depends on its own roots and leaves, and as a result its leaves are more active than those of its counterpart. Farmers are required therefore to water their tc-plants more frequently than usual to receive better yields.

Besides watering, other activities which added to cost of production included digging of holes for planting and de-suckering. Whereas the digging of holes is done once, that is, during planting new suckers, de-suckering (removal of excess suckers) is a continuous activity. According to an informant, de-suckering is an important procedure because tc-plants produce numerous suckers while growing that have to be removed continuously to avoid competition of suckers for soil nutrients and water with the mother plant. Otherwise, if the procedure is ignored, yield would decline and push farmers to revert to old ways of doing things which will be quite unacceptable.

It is important to highlight that although tc-production is believed to be labour intensive, majority of the respondents (95.56 %) indicated that they work part time; only a paltry 4.44 percent worked full time and or have employed someone to manage their orchards. The results are quite interesting because it is acknowledged that production of tc-banana is quite laborious (Qaim, 1999, Mbogoh et al, 2003). It requires extra resources and high level techno-management practices especially in preparing holes, de-suckering, watering, applying of manure and, to some extent, fertilizer. This implies that farmers who fail to take care of their orchards have very slim chances of reaping from tc-growing.

Nevertheless, an informant revealed that a majority of tc-farmers still grow their bananas without the applying the recommended practices and this has affected yields negatively. The inability to follow the necessary guidelines, he outlined could be due to lack of technical information on how to produce and manage tc-bananas.

4.5.2.2. Cost of Tissue Cultured Plantlets

Apparently, the cost of tc-plantlets is still a real issue for smallholder farmers. The study results revealed that indeed the cost of tc-plantlets is considerably higher than that of conventional suckers. On the one hand, conventional suckers were obtained free of charge or at a small fee, usually between Ksh30 and 60. The price of tc-plantlets on the other hand ranged from between

Ksh80 and Ksh100. Note, those who bought the plantlets at Ksh80 bought them at a subsidized price; otherwise the market price of was Ksh100 per tc-plantlet. Despite the reduced price, most farmers still indicated that the plantlets were expensive and thus were unable to purchase in large-some. Although a few were willing to pay despite the cost, some would not risk buying when they were unsure about the results in terms of yields. And this required convincing from agricultural extension agents or other farmers who were using them.

Generally, majority of the respondents complained that the plantlets were expensive. Although taking loans was an option for such farmers, accessing loans was a real challenge to most of them. This study shows that very few farmers had access to loans. Although the issue of loans will be discussed in another section of this chapter, the results indicate that lack of credit limits technology access among poor farmers.

4.5.3 Socio-economic Factors

This section looks at the socio-economic factors which influence farmers' discontinuance behaviour. In economics, a decision of the farmer to adopt or discontinue a technology has always been portrayed as a rational process. In reality, however, discontinuance decision is not always rational but irrational. Several factors shape farmers overall decision. Since the technical factors have already been discussed, this section only concentrates on the social and economic factors. In other words, it looks at the environment in which the technology was introduced and adopted. This is because studies have associated farmers' discontinuance behaviour with the socio-economic context in which adoption takes place (Miller and Mariola, 2009). Fundamentally, farmers' will choose to continue to use a technology only if the adopted technology maximises returns, perceived in terms of yields and incomes (Mbogoh et al, 2003; FAO, 2009). The decision making process is often two-fold. On the one hand, a farmer would continue to use a technology if he or she expects economic gains. Often, these gains are perceived in monetary terms. While on the other hand, a farmer would choose to discontinue the use of a technology if he or she begins to experience problems or if no economic benefits are observed.

Although discontinuance behaviour was fairly high among poor farmers, majority of the respondents (95.56%) indicated that tc-banana technology had met their expectation. Only a few (4.44 percent) stated it did not. Among those who responded positively, these were of the opinion that tc-varieties were more productive than conventional suckers. Factors contributing to farmers' positive reaction were fast growth rate of plants, high yields and uniform production. Whereas conventional suckers may take up to 18 months to mature, tc-plants take less time to mature. Once maturity is attained, all is harvested at the same time thus providing farmers' with substantial sum of monies. Nevertheless, although farmers perceived tc-plants as superior to conventional suckers, many still grew them alongside non-tc-varieties. Indeed, these were facing challenges growing tc-varieties. A review of farmers' responses when asked about the challenges faced, majority of them indicated that tc-plants were more sensitive to drought than conventional suckers, while some said the plantlets were expensive. Others complained that they were susceptible to diseases and pests.

4.5.3.1. Tc-Banana Production

Banana is an important economic crop for smallholder farmers in Central Kenya. The crop is predominantly grown by women (Qaim, 1999) and under rain-fed conditions. But because of little rain or no rain, irrigation has become an option. According to Wambugu and Kiome (2001), banana is an important horticultural crop and a staple food for most rural people simply because of its present and potential value i.e. food, income and nutritional security. The surplus production of the crop provides for a reliable source of income and further contributes to household food security. Besides being a source of carbohydrates, essential vitamins and minerals, the crop is attractive to smallholder farmers because of its appropriateness for intercropping. Besides being a staple food, bananas have for long been regarded as ideal baby food (Mbaka et al, 2008).

According to an informant, farmers have grown bananas for years as a staple food alongside coffee. The coffee industry however collapsed (in the 80s) thereby pushing farmers into banana farming. As a result, banana became a dominant source of livelihood for rural farmers thus replacing coffee. Indeed, it is an economic crop grown not only for its food value but also for its market value.

Beside banana, other crops grown in the study area include: maize, beans, Irish potato and sweet potatoes. These crops are intercropped with banana. Among these crops however banana shows great potential for increased production. During the interviews, majority of respondents indicated that banana was their source of livelihood. These stated that bananas provide for food and incomes. In a question asking about farmers' average banana output, results indicate that farmers harvested bananas with a bunch weight of more than 40kgs. Nevertheless, it is important to point out that several factors contributed to higher yields but the most critical was water. During the rainy seasons, tc-farmers indicated having harvested big bunches but as a result of poor rains, the harvest was very little.

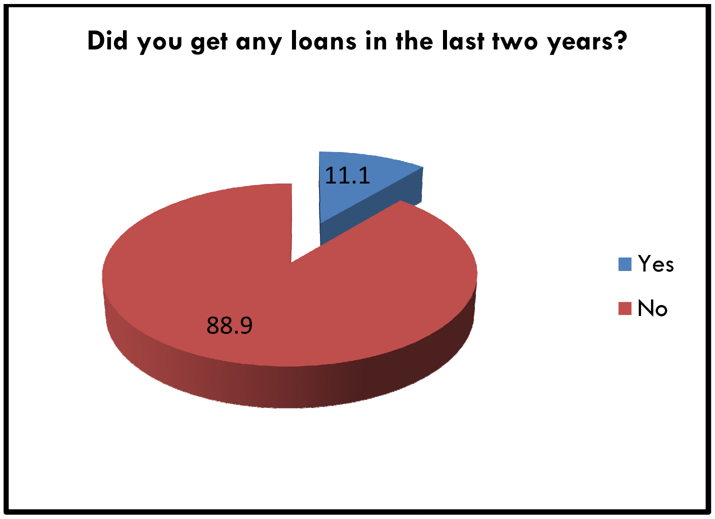
Table 6: Average Banana output

	Minimum	**Maximum**	**Mean**
How many bunches	2	80	19.6
How many kgs	90	1200	530

4.5.3.2. Access to Credit

Smallholder farmers lack the resources to purchase inputs. They may need to borrow to finance for seedlings and inputs so as to maximise benefits from new technologies. Studies have also linked farmers' discontinuance behaviour with their ability to access credit. For instance, a study by Nnadi and Akwiwu (2007) found out that discontinuance decision behaviour of yam technology in Imo State of Nigeria was related to credit opportunities among other factors. In this study, the results show that access to credit is a real challenge. Indeed, few farmers had access to credit facilities even though tc-plantlets were expensive. A question asked respondents whether they had obtained loans in the last two years. A majority (88.9 %) responded negatively (see figure below), only an insignificant proportion of 11.1 percent responded positively. To further explore this matter, this group of respondents were asked why they had never taken loans. Some cited responses such as 'difficulty in paying' while others simply said they 'just didn't want to'.

Figure 9: Information on Credit



Source: Field Data, 2010

In one interview, one respondent openly said that, “the problem was not getting the loan but paying it”. He argued that, “when one gets a loan and his or her crops perform dismally, one fall into deep problems. One runs into a debt he or she never had”. Another respondent was reluctant to take a loan because he was retired and had no salary. Clearly, these responses depict why some farmers prefer not taking loans even though they are readily available.

In a nutshell, credit access is a challenge to poor smallholder farmers. Unfortunately, commercial banks rarely lend to smallholder farmers because of the perception that it might be too risky or failure to honour pledge to pay. Raising collateral so as to obtain a loan can be a real challenge for the poor. This is partly why family members, friends, informal savings are important sources of credit or planting materials for those unable to access formal credit. Note, without formal credit, technology access will still be a major challenge for poor smallholder farmers.This is probably because there are no sources of formal credit for agricultural activities in the area. Even households who have access to informal credit rarely use it to purchase farm input.

4.5.3.3. Access to Market

Banana marketing is a primary activity in the study area. At farm level, bananas are mostly sold to middle men. Here, there is no fixed price for bananas. The selling price is usually negotiated between the seller and buyer but on the basis of bunch size. A bunch can be sold as a whole or weighed and sold in Kilograms. Farmers willing to sell their bananas in bunches have to bargain to get a high price for their commodity. Often, these negotiations happen while at the farm. The results of this study shows that the price of one whole bunch ranged from Ksh50 to Ksh400 but depending on size. During the interview, I asked one farmer why she was selling bananas from her farm and she said it was expensive to deliver few bunches to the market as opposed to many.

Whereas some farmers sold bananas while at the farm, others took them to the market individually or through farmer groups. Farmers who belonged to farmer groups had easy access to market compared to individuals. In an interview with the representative of the group, I asked of the aim of these established groups. He indicated that groups serve to strengthen farmers bargaining capacity and limit exploitation by middlemen. It is through such groups that farmers were able to sell bananas in bulk thus attracting prices. Here, bananas are weighed and sold in Kg and not in bunches. This is because selling in Kg was more accurate than selling in bunches. The price ranged from Ksh7 to Ksh13 depending on bunch weight. Indeed, bargaining ceases to be an option with this kind of measure. Another respondent highlighted that previously middlemen would exploit individual farmers who sold bananas as bunches. During the negotiations, the middlemen would demand low prices for the bananas. But with groups, it becomes impossible to exploit farmers. In a nutshell, belonging to banana groups had reduced the market problem and strengthened farmers bargaining capacity, whereas not being in a group predisposes farmers to exploitation by middlemen.

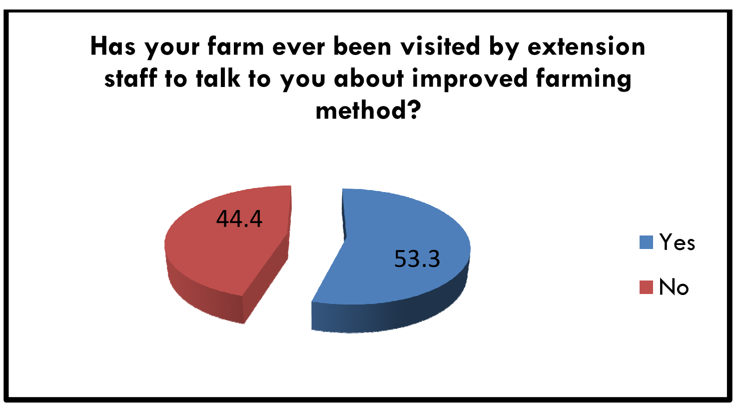
4.4.3.4. Poor Infrastructure

Banana is highly perishable crop. And like any other perishable product, it is important that it reaches the market at the right time so as to avoid crop losses. Within the study region however it was observed that some roads were in a poor state. Poor infrastructure such as roads, storage and ripening facilities pose additional challenges for farmers. Wambugu et al (2002) reported that post harvest losses have been observed in areas where there were poor road networks and where farmers lacked storage and ripening facilities.

4.4.3.5 Lack of Information

In literature, discontinuance decision has been associated with lack of information. Extension agents often provide advice to farmers. Miller and Mariola (2009) observed that farmers who did not receive any assistance with the adopted technologies discontinued them. They recommend that provision of extension services to farmers is necessary so as to ensure the continued use of innovations. Farmers need to be convinced to make use of technology. Therefore, extension work is important to persuade them to adopt or to continue using the technology. Extension work is also useful in inculcating specific technological knowledge among farmers and this leads to change in perception or behaviour (Glover, 2009). The results of this study indicate that over half of the respondents had access to information. Respondents were asked whether they had been visited by an extension staff to talk about improved method. About 53.3 percent said 'yes' (see figure below) while a significant proportion (44.4%) responded negatively indicating that a sizable minority of farmers did not have access to information.

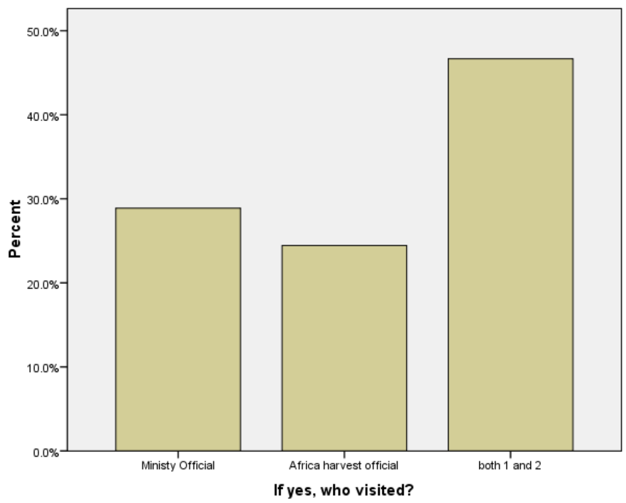
Figure 10: Access to Information



Source: Field Data, 2010

Among those who responded positively, another question was posed, who normally visits them? Some stated the Ministry official while others Africa Harvest. A sizable majority (46.7%) had been visited by both (see figure below).

Figure 11: Who visited?



Source: Field Data, 2010

Among those who were never visited by an extension worker, a question was asked where they get their information. Many cited other farmers, or friends or relatives. Apparently, these farmers visit one another to observe and find out on how one is growing and managing his or her bananas. Then, they would try out what they had learnt or observed. In some farms, I observed that farmers were growing tc-bananas without exactly following the recommendations i.e. regular de-suckering. While in other farms, farmers who had received training on management of banana were keen to observe the required practices. Of course, such farmers were likely to receive higher yields than their counterparts who neglected the needed procedures.

Another thing the researcher noted was a general feeling that tc-banana was a specific variety. Farmers did not seem to understand that tissue culture was a propagation method. This could be due to the language used during technology dissemination. Most people including scientists refer to the bananas as tissue culture bananas, rather than tissue cultured or tissue culture propagated bananas, which might make one to think of the technology as the product rather than the process that it really is (Mbaka et al, 2008). Thus, farmers referred to tc-bananas as tc-varieties. Indeed, this makes it difficult for such farmers to seek new plantlets when planting because they believe they have the right ‘varieties’. Therefore, they would go for suckers from tc-stems thinking they were the same as the tc-plantlets. Without knowing, they would transfer diseases and pests in their farms.

4.6 Case Examples

In this last section two case studies are presented which depict the reasons as to why some farmers discontinue previously adopted technology. The first case presents a background and challenges of a tc-banana farmer. The second case presents the experiences of a tc-banana farmer group in a farmer group and his challenges as well.

Case 1: The Challenges of a Tc-Banana Farmer

Mr. Mburu, of age 54, is one the many farmers growing tissue cultured bananas. He comes from Kamahoha location, Makuyu division. Currently, he is working with the Ministry of Agriculture as a Divisional Horticultural Officer. He ventured into tc-banana farming in 2002 though he has for long grown local bananas. He has a farm of about 6 acres but grows tc-banana in half acre of his farm. He started with 50 plantlets but later expanded his orchard with additional 300 plantlets, a total of 350 plantlets. He sourced his first plantlets from a known public research institute (KARI) during his duties as a Ministry official. But when he expanded his farm, he got his suckers from the mother stems of tc-bananas. Mr. Mburu has divided his banana farm into two sections. On one section he grows tc-bananas and on the other non-tc-bananas. The tc-bananas are supplied with water using drip irrigation as opposed to the non-tc-bananas. Mburu installed his irrigation system from a loan he obtained from K-rep bank. When asked why the other varieties were not watered, he said the local variety was able to withstand moisture stress but not tissue cultured varieties. However, he was keen to notice that tc-varieties are more productive than the local varieties because of water supply. On average, he can harvest 20 bunches a month from all his banana plots. Each bunch weighs about 35Kg to 70kg depending on size of bunch and variety of banana. tc bananas usually weigh more than their counterpart. Mburu sells his bananas to middlemen directly from his farm and at price of Ksh13 per kilogram.

Previously, he used to take his bananas to the market but later declined because of the problem of distance to the market. Occasionally, his tc-banana plot has been affected by Sigatoka disease but he argues that it has not been a threat. Because of good harvest and his experience in tc-farming, farmers from the area have been seeking not only suckers but advice from him. Most farmers who come to him buy the suckers at a cheaper price. Cheaper than what most technology providers offer. Apparently, these farmers believe that they are growing tissue cultured bananas as well.

Case 2: Experiences of a Tc-Banana farmer in a Farmer group

Mr Moses Mbau Gakuru is a tc-banana farmer. He is aged 54 and is a chairman of a banana group called 'Mulika banana farmers'. A group that was established and registered in 2006 and now trains banana farmers on managing bananas orchards, handling of harvesting, transporting and business skills i.e. price negotiation. Mr. Gakuru has a farm size of 2 acres and uses the whole farm to grow bananas. Like many farmers in the area, he is growing tc-banana alongside non-tc-banana. In his farm, he has about 200 tc-banana stems and 150 non-tc-bananas growing stem growing side by side. Gakuru has been growing tc-bananas for four years now even though he has grown local bananas for years. He first bought his tissue cultured plantlets from a non-governmental organization, Africa Harvest. According to him, Africa Harvest has been training farmers from his group on management of tissue cultured bananas and accessing market. Indeed, it was during his first training with this organization that he bought his tc-plantlets. The plantlets were sold to him at a subsidised price of Ksh80 each. However, from time and again, he has used suckers directly obtained from his tc-mother stems especially when expanding his banana orchard. Gakuru argues that since his training, he has received good harvest from his orchard. He however noted that banana yields have been fluctuating due to rain-fall patterns. In rainy seasons, he could harvest over 10 bunches a month but in drought season he has received very little from Tc-varieties. In his words, "I expect very little from tissue cultured banana plot when there is no rains". After harvest, he takes his bananas to 'Mulika' banana group, and from there sells to middlemen, at a unit price of Ksh12 per kilogram. These middle men he noted are reliable buyers of the group and therefore present no problem to the group.

In summary, this chapter has discussed the reasons as to why smallholder famers in Maragwa District discontinued the adoption of tc-banana technology. The result findings indicate that there was a high rate of discontinuance among the tc-growing farmers. The results also show that there is lack of or little knowledge among farmers of the need to use clean planting materials. Finally, this chapter has presented the most notable factors which influenced farmers' discontinuance decision, that is, technical factors and socio-economic factors. On the one hand, technical factors include factors such as pests and diseases, labour requirements of the cultivation of tc-bananas and costs of plantlets. On the other hand, the socio-economic factors include factors such as access to credit and information, poor infrastructure and access to markets.

Chapter Five-Summary of Key Findings and Recommendations

5.0 Introduction

In this concluding chapter, a summary of key findings are presented in line with the research question presented in chapter one. Recommendations are also given.

5.1 Summary of Key Findings

The first research objective sought to document the characteristics of the discontinuing farmer. In this study, a farmer was considered to have discontinued tc-banana technology when he or she obtained planting materials from own field or from neighbours or relatives when establishing or expanding his or her own banana plot. Indeed, farmers are always required to acquire new planting materials for planting

An overview of the research findings suggests that there was a high rate of discontinuance among the tc-growing farmers. Majority (53.33 %) indicated that they had obtained their planting materials from friends, neighbour and relatives. Of course, these respondents were of the opinion that suckers from tissue cultured plants were as good the original mother plants

A review of the respondent ages indicated that the highest age of farmers was 82 and the lowest 23. Their mean age is 57.4 with a standard deviation of 13.544. Averagely, farmers have grown tc-bananas for 4.62 years. This shows that they are quite experienced with cultivation of tc-bananas and growth of banana in general. The distinctive feature of the respondents is that a majority were men. About 55.6 percent of the respondents were males while the rest (44.4 percent) were females. Majority of the respondents (60 percent) had some basic education (primary education), whereas only a few (31.11 percent) had attended secondary school

This study reinforces the fact that indeed most farmers in Maragwa district own small plots. The average size of land under tissue culture production was 0.4667 acres. Production in small land holdings can be expected to less effective and with much lesser yields as compared to large farms

The second research objective sought to give reasons for farmers' discontinuance decision. Various reasons have been attributed to farmers' discontinuance decision. The first is lack of information on various aspects of the technology. A majority of the respondents said they did not know where to get the planting material from, while a few said they first heard of tissue culture banana when they attend the training or joined banana groups.

The second reason is the high cost of tissue cultured plantlets than that of conventional suckers. Majority of the respondents had obtained the planting material either for free or at a minimal fee.

The last reason is the high requirement for water for the tc-plantlets during their entire period of growth. All respondents indicated that water was a major problem for the cultivation of tissue cultured bananas.

The next objective sought to find the disadvantages of tc-banana plantlets over conventional suckers. The first limiting factor of using in tc-banana plantlets from the point of view of farmers is the higher price of the material if compared to conventional suckers. The current price of a tc-plantlet sold by Africa Harvest is around Ksh100, which—in the absence of suitable access to financial markets—is quite high for resource-poor farmers, regardless of the later benefits. Another disadvantage of tc-plants is that they require added care and improved management

Finally, the fourth objective sought to establish the most important which influence farmers' discontinuance decision of tc-banana technology. Among smallholders in Maragwa district, the discontinuance decision can be attributed to two broad classes of factors: 1) **Technical factors**-those characteristics of the technology itself, including its labour demands and 2) **Socio-economic factors-**factors related to the larger socio-economic context in which adoption takes place

Technical factors: One technical challenge with regards to tc-banana technology is its susceptibility to pests and diseases. According to scientists, tc-banana technology, although believed to be pathogen free, is not resistant to diseases/pests.

Labour requirements: Tissue culture production is labour intensive. It requires extra resources and high level techno-management practices but majority of farmers still grow tc-bananas without the applying the recommended practices. Majority of them were experiencing major difficulties with the varieties but were still using them in the hope that they would improve with time

Cost of Tissue Cultured Plantlets: the cost of tc-plantlets is still a real issue for smallholder farmers. The result of this study revealed that indeed the cost of tc-plantlets is considerably higher than that of conventional suckers

Socio-economic Factors: The first socio-economic factor is *Access to credit*. The results show that access to credit is a real challenge. Indeed, few farmers had access to credit facilities even though tc-plantlets are expensive. Smallholder farmers lack the resources to purchase inputs.

Access to Market: Whereas some farmers sold bananas while at the farm, others took them to the market individually or through farmer groups. Farmers who belonged to farmer groups had easy access to market compared to those who sold them individually.

Poor Infrastructure: some roads within the study region were in a bad state. Poor infrastructure such as roads, storage and ripening facilities pose additional challenges for farmers

Lack of Information: The results of this study indicate that over half of the respondents (53.3) had access to information; a sizable minority of farmers did not have access to information. Farmers did not seem to understand that tissue culture was a propagation method. This could be due to the language used during technology dissemination

5.2 Conclusions

Based on the discussions of this chapter, this study drew four major conclusions. First, there was a high rate of discontinuance among the tc-growing farmers. Majority (53.33 %) of farmers indicated that they had obtained their planting materials from friends, neighbour and relatives and not from the recommended sources. Farmers are required to obtain tc-plantlets from laboratories when establishing new banana orchards or expanding their orchards. This is because suckers obtained from own orchards are likely to be contaminated by soil-borne pests. Use of diseased suckers entails a risk of spreading disease or pests to other growing tc-stems and could defeat the very purpose as to why the technology was introduced.

Second, there is lack of or little knowledge among farmers of the need to use clean planting materials. Knowledge on tc-production among the farmers was low. Majority of the farmers believed suckers obtained from tc-mother stems were equal or same as tc-plantlets generated in laboratories. This is a false perception. Farmers were also growing tc-bananas were growing tc-bananas alongside non-tc-bananas but in separate plots. From this observation two conclusions can be made: first, these farmers were risk averse and thus were not willing to do away with their local varieties in favour of tissue tc-bananas. Second, they were yet to be fully convinced of the superiority of the technology over the conventional suckers. In addition, most farmers did not clearly understand that tissue culture was a propagation method.

Third, although tissue cultured banana plantlets are free of the most important pests and diseases (notably weevils, nematodes and fungi), without appropriate care and field hygiene (especially if planted in contaminated soils) banana plants can still be infested at a later stage. An observation was made that some tc-stems of the farmers had succumbed to diseases and pest, contrary to expectation.

Finally, this chapter has discussed the most notable factors which influenced farmers' discontinuance decision. For the purpose of addressing the fourth objective of this study, this chapter concludes by presenting two main factors which influence farmers' discontinuance decision. These factors are categorised as follows: technical factors and socio-economic factors. On the one hand, technical factors include factors such as pests and diseases, labour requirements of the cultivation of tc-bananas and costs of plantlets. On the other hand, the socio-economic factors include factors such as access to credit and information, poor infrastructure and access to markets.

5.3 Recommendations

For the tissue culture banana technology to be adopted in a sustainable manner, the following measures are suggested:

1. Farmers need to be educated to understand and appreciate the benefits of tissue culture technology as a tool for crop propagation.
2. It is imperative that the potential risks or disadvantages associated with tc-banana technology be communicated and carefully explained to the farmers. In this case, the possibility of encountering problems should always be made clear. Without proper

communication and transparency, the potential of the technology to improve the lives of the rural poor can be easily be lost.

3. There is need to carry out research on the short longevity of tissue cultured banana orchards as compared to orchards established with conventional suckers.
4. Besides demonstrations, stakeholders should consider the possibility of organizing study tours for farmers groups to other areas where the technology has been deployed successfully. This would help farmers to make more informed decisions and understand the technology as well.
5. The findings of this study demonstrate that banana is an important crop that deserves the same or more attention from the government as is given to other cash crops such as coffee and tea.
6. Possibilities of reducing the cost of production of tc-plantlets should be considered. These might consider tax waiver on laboratory materials and consumables, or subsidies from sector specific funding from government.

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Appendix 1

Case Study Questionnaire

My name is **Raphael J. Indimuli**. I am a student at the Institute for Development Studies, University of Nairobi. I am conducting a research which seeks to identify specific factors that contribute to the discontinuance in adoption of tissue culture banana technology among smallholder farmers. This research is solely for research purposes. I will be honoured if you can take your time to answer a few questions.

Farm identification

Questionnaire serial number…………………. Start Time………………

Name of the respondent ………………

Division………..

Date of the interview ………………..

Background Information

1. Age (years)……………..

2. Gender

Male		1
Female		2

3. Education level:

Primary		1
Secondary		2
Tertiary		3

4. What is the size of your farm …………….. acres

5. What area of your farm is under tissue culture bananas?.......................................

Technical Characteristics

6. How many tissue culture banana stems do you have in your farm?...........

7. For how long have you been growing tissue culture bananas?...............

Source of planting material

8. From where do you get your planting material?

KARI		1
JKUAT		2
GTZ		3
Friend		4
Other		5

9. What is the reason for your choice?……………………………………

10. If plantlets were bought, at what price did you buy them? …………………………………..

11. What is your banana output …………………….. Bunch/ Kg

Market

12. Who is in charge of selling bananas from farms? ………………………………………………………..

13. At what price do you sell your bananas? ....

14. Who are main buyers? ....

15. At which market do you sell your bananas? ……………………………………… Distance………………… km

Perception

16. Did the tissue culture varieties meet your expectation?

Yes		1
No		2

17. If ***No*** Why? ....

Farm Labour

18. How many of your family members work on the farm full or part time?

Profile of Family labour	
Number working full time	
Number working part time	
Note: Working full time mean those not engaged in any off farm activity *Those working part time are engaged in off farm activities or any other for any other reason*	

Information on credit

19. Did you get any credit in the last two years?

Yes		1
No		2

20. If *yes* how much and from where?

Source	Amount	Year received	Use

21. How much of this credit goes to banana production?. …………………………………….

22. If credit was used on bananas, on which operation was it used?....................................

Access to information

23. Has your farm ever been visited by extension staff to talk to you about improved farming method?

Yes		1
No		2

24. If *yes* who visited?

25. How many times……………………………………

26. When was the last visit? ……………………………………………

27. Who normally gets into contact with the extension officers when they visit your farm?

Thank you very much for your co-operation

End time…………………………………………

Appendix 2-Key Informant Interview Guide

District Agricultural Extension Officer

My name is **Raphael J. Indimuli**. I am a student at the Institute for Development Studies, University of Nairobi. I am conducting a research which seeks to identify specific factors that contribute to the discontinuance in adoption of tissue culture banana technology among smallholder farmers. This research is solely for research purposes.

Area of discontinuance

i. Which areas in the district are farmers discontinuing the use of tissue culture banana technology?

ii. What are the reasons for farmers' discontinuance of the technology?

Appendix 3

Key Informant Interview Guide

My name is **Raphael J. Indimuli**. I am a student at the Institute for Development Studies, University of Nairobi. I am conducting a research which seeks to identify specific factors that contribute to the discontinuance in adoption of tissue culture banana technology among smallholder farmers. This research is solely for research purposes.

i. What reasons do farmers' report for discontinuing Tc-banana technology?
ii. What are challenges of tc-plantlets as opposed to conventional suckers?

How can the problems in adoption be improved?