

**FACTORS INFLUENCING ADOPTION OF TISSUE-CULTURE  
BANANA TECHNOLOGY BY SMALL SCALE FARMERS  
NEIGHBOURING THE NATIONAL YOUTH SERVICE YATTA FIELD  
UNIT, MACHAKOS DISTRICT, KENYA**

**BY**

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**A Project Report**

**Submitted to the Graduate School in Partial Fulfilment of the  
Requirements for the Award of Master of Science Degree in Agricultural  
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## DECLARATION AND RECOMMENDATION

### DECLARATION

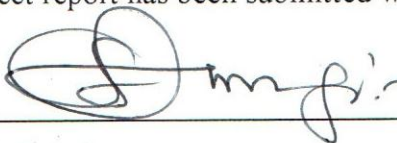
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Dr. W. O. Ochola

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## **DEDICATION**

To my beloved wife Agnes Muli and children Melvin and Victorine for their patience and understanding during my long stay away from home. To my father Julius Wambua Makuu and mother Beatrice Munyiva Wambua for educating me. To all the sons and daughters of the Wambua family who will aspire to learn.

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I would also like to thank the Kithimani Division Agricultural Office for availing the list of farmers growing TC bananas in the location.

Finally, special thanks go to all the respondents for the friendly co-operation that enabled data collection to be carried out successfully.

## ABSTRACT

Banana production by small-scale farmers in the country has been declining over the last decade due mainly to crop infestations by pests and diseases, particularly panama disease, sigatoka, weevils and nematode complexes as well as environmental degradation. Although the use of clean, disease-and-insect-free planting materials made available through tissue-culture (TC) propagation techniques has been advocated to help stem the decline, there has been low adoption of its use. The purpose of this study was to explore and analyse the factors influencing adoption of TC banana technology by small-scale farmers neighbouring National Youth Service (NYS) Yatta Field Unit. The research design was an ex-post facto and the specific variables investigated included farmers' level of adoption, socio-economic factors (age, gender, marital status, education level, land tenure, access to credit, income, size of banana farm, labour and market), out-reach programmes to neighbouring farmers, and farmers' perception of the TC banana technology. The accessible population was made of the small-scale households living along the three sources of water (Yatta Canal, Thika and Athi Rivers) and only those within 30 Km from the NYS Field Unit growing bananas. Proportionate random sampling technique was used to select 120 households. Data was collected using a structured questionnaire and analysed using descriptive statistics while the hypotheses were tested using  $\chi^2$  statistic at 5% level of significance. The results indicate that adoption level of the TC banana technology was low (40%) (N = 120) and depends on various farmer characteristics. Significant relationships were found between adoption and level of education, land tenure, source of income, hired labour, credit and market. However, there was no evidence of significant relationship between adoption and the age and marital status of the farmer. The distance from NYS - Yatta Field Unit to the farmer's homestead and the NYS - Yatta Field Unit out-reach programme significantly influences adoption of TC banana technology by the neighbouring small-scale farmers. Farmer's perception of TC banana technology had no significant relationship with the adoption of the technology. It was concluded that to effect adoption, the TC banana technology must be matched with appropriate field management packages that are implementable within the farmers' socio-economic circumstances. The study recommended strengthening of NYS-YFU out-reach programme to increase its farmer coverage, effectiveness, efficiency and impact on livelihoods of the small-scale farmers.

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## LIST OF ABBREVIATIONS AND ACRONYMS

CBS	-	Central Bureau of Statistics.
FAO	-	Food and Agriculture Organization of the United Nations.
IDRC	-	International Development Research Centre.
ISAAA	-	International Service for the Acquisition of Agri-Biotech Applications.
KARI	-	Kenya Agricultural Research Institute.
MALDM	-	Ministry of Agriculture, Livestock Department and Marketing.
MOA	-	Ministry of Agriculture.
NYS	-	National Youth Service.
RF	-	Rockefeller Foundation.
TC	-	Tissue-Culture.
YFU	-	Yatta Field Unit.

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background Information

Agriculture plays an important role in Kenya's economy with a large number of people (75% or more) depending on agriculture for food and income (Muiruri & Mwangi, 2001). The sector, also supplies food and markets the surplus to a large fraction of the country's population most of whom live in the rural areas. According to Qaim (1999) production of bananas in Kenya is largely a small-scale farm activity, with a national average of 0.32ha per farm and the crop is cultivated on about 74,000 hectares, which make up to 1.7 percent of the country's total land used for crop production. Banana ranks eighth in the government's crop priority list for enlarging food production in order to keep pace with population growth (MALDM, 1998). Among the horticultural crops, banana is generally the most important one with respect to area and income generation (FAO, 1998).

MOA (1997) indicates that in Kenya, bananas are produced for different purposes. The dessert type (*Musa acuminata*) varieties constitute the most popular fruit among urban and rural consumers, and the cooking type varieties (*Musa balbisiana*) are an important staple food, particularly for rural households. A typical banana holding is 0.3 hectares, which makes up 13 percent of the total farm area on average (Nguthi, 1996). The average banana yields in Kenya are about 14 tonnes per hectare falling significantly below the potential yields of more than 40 tonnes in tropical areas (Hallam, 1995). Apart from the low input levels, this yield gap is attributed to the widespread use of pathogen- infected planting material (suckers) that transmit banana pests and diseases in the country (Nguthi, 1996).

In 1995, Jomo Kenyatta University of Agriculture and Technology (JKUAT) began the micropropagation of TC banana in Kenya, partially funded by the World Bank and currently the University's laboratory produces around 20,000 plantlets a year, which are sold to farmers in nearby banana growing areas (Kahangi, Muthee & Chege, 2002). The main objective of the biotechnology launched by JKUAT, KARI in 1996/1997 and facilitated by

ISAAA is to improve the availability of *in vitro* planting materials especially to the small-scale and resource-poor banana farmers (Qaim, 1999).

The Israeli government in collaboration with the Kenyan government introduced TC banana plantlets at the National Youth Service (NYS) Yatta field demonstration farm in 1996 with an aim of disseminating the same technology to the neighbouring farmers (NYS, 1997). During field days, neighbouring farmers are invited to participate and learn about TC banana technology among other new farming technologies. Also once every year the farmers are invited to participate in on-spot–courses conducted by Israeli experts in the unit where they learn more on TC banana technology. The extension staffs in Yatta Division also bring farmers into the unit during field tours to learn about the TC banana technology hoping that the farmers will adopt the technology eventually. Despite these attempts, the adoption of TC banana technology has been largely low. This may be attributed to several social, environmental and economic factors as well as farmer characteristics circumstances.

Various factors that influence adoption have been documented. Dasgupta (1989) categorizes these factors into personal, socio–economic and situational. Adoption tends to be specific to particular innovation, environment and the individual (Leagans, 1979; Maina, 1996). It is also clear that the introduction of new technologies such as TC banana technology can make positive contribution to the socio-economic status of poor farmers (Mbogoh, 2001). The independent variables considered in the study include farmers' age, gender, marital status, level of education, source of income, farm size, availability of inputs, credit, labour, market and NYS-YFU outreach programme to the neighbouring farmers as well as farmers' perceptions of the TC banana technology in relation to their adoption levels of the technology (dependent variable).

## **1.2 Statement of the Problem**

Despite the fact that farmers neighbouring NYS Yatta field unit have had the opportunity and exposure to TC banana technology promoted by the unit, banana production is generally poor. The poor yields have been associated with the continued planting of suckers that are affected by or susceptible to common banana pests and diseases (Qaim, 1999). This is despite the breakthrough in clean and pest and disease free plantlets produced through TC biotechnology. The promotion of the TC banana technology by NYS Yatta Field unit has not

improved the situation (NYS, 1997). The adoption levels of the technology among neighbouring small-scale farmers are still low. The situation continues to threaten food security, employment and income generation in banana production in the area and therefore, there was need to identify and establish factors affecting the adoption of the technology in the area.

### **1.3 Purpose of the Study.**

The purpose of the study was to explore and analyse factors that influence adoption of TC banana technology promoted by NYS, Yatta field unit among the neighbouring small-scale farmers as a response to increasing food production and farm income.

### **1.4 Objectives of the Study**

The following were the specific objectives of the study:

1. To determine the adoption levels of TC banana technology by small-scale farmers neighbouring NYS-Yatta field unit.
2. To determine the relationship between the socio-economic status of the neighbouring small-scale farmers and adoption of TC banana technology.
3. To determine the influence of the NYS Yatta field unit outreach programme activities on the adoption of TC banana Technology by the neighbouring small-scale farmers.
4. To determine the relationship between the perceptions of small-scale farmers of TC banana technology introduced by NYS Yatta field unit and their adoption of the technology.

### **1.5 Hypotheses**

Objectives two to four were translated into hypotheses one to three respectively.

H<sub>01</sub>: There is no statistically significant relationship between farmers' socio-economic status and adoption of TC banana technology.

H<sub>02</sub>: The NYS Yatta unit outreach programme does not significantly influence the adoption of TC banana technology among the neighbouring small-scale farmers.

Ho<sub>3</sub>: There is no statistically significant relationship between the perceptions of small-scale farmers on TC banana technology introduced by NYS Yatta field unit and their adoption of the technology.

## **1.6 Scope of the Study**

This study was carried out in Machakos District, Yatta Division, Kithimani location (namely Kithimani, Kithendu, and Ndalani sub-locations). It focused on small-scale farmers (with less than five hectares) along the three sources of water (Yatta canal, Thika and Athi-Rivers) and only those growing bananas within 30km from NYS Yatta field unit. The study looked at selected socio-economic factors (age, gender, marital status, education, income, labour, farm size, inputs and market) outreach programme as well as farmers' perception in relation to adoption of TC banana technology.

## **1.7 Significance of the Study**

The findings from this study may be beneficial to farmers who are directly involved in adopting the TC banana technology. Secondly, the institution would find out whether it is achieving its goal of disseminating new farming technologies. An understanding of the factors that influence adoption of TC banana technology may enhance the design, development, packaging and dissemination of appropriate TC banana technology in the area. The findings of the study may also form collaborative initiatives involving research, extension, farmers and other stakeholders. The study may also generate useful information needed to understand the adoption process involving TC banana technology and other new farming innovations under similar socio-economic, environmental and farmer circumstances. The results may also help understand the underlying factors related to the present food insecurity and poverty levels in the study area and methods of addressing them through improved food production by promotion of TC banana.

## **1.8 Assumptions of the Study**

The following were the assumptions of the study:

- That farmers neighbouring NYS Yatta field Unit are homogeneous with respect to their opportunities of exposure to TC banana technology.

- Those other extraneous variables such as farmer-to-farmer exchange of materials, indigenous traditional knowledge, and conventional extension service are similar to all small-scale farmers growing bananas in the study area.

## 1.9 Limitations of the Study

The obstacles met during the study include:

- The ex-post facto design used may be limited as it is used to study independent variables, which have already occurred and are inherently not manipulatable by the researcher. This may lead to less straight forward interpretation of results and ambiguity because independent variables in the natural setting tend to operate simultaneously. To overcome this handicap the variables that cannot be controlled were in-built into the study, and co-variant statistical method was used to control their variance.
- Farmers' perceptions are not the same in any given time, this is due to changing socio-economic factors and farmer circumstances, and therefore, it is very difficult to measure farmers' perceptions at one point in time. During the questionnaire administration, the respondents were asked to give season-independent perceptions that could reflect their adoption and opinions regardless of the time.

## 1.10 Definition of Terms

**Adoption** – Refers to the integration of technical information into a farmers' farming practice (Rogers, 1995). In this study, the term adoption is used to refer to the use of tissue-culture banana plantlets by the farmer in the study area and, is measured by the level of adoption of TC banana technology operationalised through (number of farmers using TC banana technology, duration of use and source of TC banana plantlets).

**Compatibility** - Refers to the extent to which the technology fits into the farmers view about what ought to be, what he does on the farm, and how he does it (Rogers, 1995). In this study, compatibility is measured using likert scale with items related to farmer's preference of tissue culture varieties as compared to local varieties and how tissue culture banana technology fits into farming activities.

**Complexity** – Refers to the degree to which the technology is perceived as relatively difficult to understand and to use (Rogers, 1995). In the study, complexity is measured using likert scale with items related to tissue culture banana technology management practices in comparison to the local varieties.

**Field Unit** – Refers to a demarcated and protected land under the management of National Youth service (NYS Act, 1969).

**High Adoption-** In this study, the term refers to the percentage of farmers who have planted an acre or more of TC bananas (450 plants and above).

**Level of Adoption** - Refers to the extent to which farmers use the TC banana technology operationalized through use of TC seedlings, recommended spacing, application of fertilizer or farm yard manure, watering, desuckering, propping, pest and disease control.

**Low Adoption-** In this study, the term refers to the percentage of farmers who have planted less than a quarter acre of TC bananas (less than 100 plants).

**Moderate Adoption** – In this study, the term refers to the percentage of farmers who have planted a quarter to three quarter acres of TC bananas (100-449plants)

**Neighbouring Farmer-**Refers to a small-scale farmer living along Yatta canal, Thika River or Athi River and within 30 km from NYS Yatta field unit.

**Observability** –Refers to the degree to which results of adopting a technology are visible to others (Rogers, 1995). In this study, observability is measured using likert scale with items related to marketability of tissue culture bananas, yields, prices as compared to local varieties.

**On Spot Course** – Refers to training session usually one or two weeks whose venue is where a particular farming technology is been practiced (NYS, 1997). In this study, this is measured by the percentage of farmers who have attended courses in the NYS Yatta field unit.

**Perceptions of the Technology-** Refers to the qualities of the technology as understood by farmers. These qualities include relative advantage, compatibility, complexity, trialability and observability of the technology (Rogers, 1995). In this study, farmer's perception is measured using likert scale with items related to relative advantage, compatibility, complexity, trialability and observability of the TC banana technology.

**Relative Advantage-** Refers to the degree to which farmers perceive the technology as superior to the practices they have replaced (Rogers, 1995). In this study,

relative advantage is measured using likert scale with items related to the yields, fetched prices, cost of TC banana seedlings and occurrence of pests and diseases.

**Tissue-Culture Banana Plantlets-** Refers to banana varieties that have been genetically propagated using the laboratory- based micro propagation techniques (KARI, 1999). In this study, this is measured using a questionnaire with items related to source of the tissue culture plantlets, the number of farmers who have planted and the number of years.

**Technology** – Refers to the systematic application of scientific knowledge to practical purposes (Amudavi, 1993). In this study, the term refers to tissue-culture banana plantlets and is measured using a questionnaire with items related to tissue culture banana technology.

**Small-Scale Farmer-** In this study, small-scale farmer refers to a farmer who has farm size of less than five hectares and this is measured using a questionnaire with items related to size of farm and the size of farm under TC bananas.

**Socio-economic Factors** - In this study, the term refers to selected factors which include, gender, education, income, farm-size, farm inputs, labour, credit and marketing channels. In the study, this is measured using a questionnaire with items related to gender, education level, income, farm size, hired labour, land tenure systems, credit and marketing channels.

**TC Banana Technology** - This refers to a package of innovations comprising the banana planting materials (plantlets) as well as the bundle of additional inputs and production factors (KARI, 1999). In the study, this is measured using a questionnaire with items related to TC banana planted, source of banana planting materials , availability of farm inputs and use of selected tissue culture banana technologies (application of manure/fertilizer, watering, desuckering, propping, pests and disease control, weeding, use of recommended spacing and pruning).

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Introduction

This chapter summarizes literature review related to adoption of TC banana technology. Specifically, it entails the Kenyan banana sector, TC banana technology, role of NYS-FYU in disseminating and distributing TC banana plantlets, theoretical perspective to Technology diffusion process, related Research findings on the factors that influence adoption, and the conceptual framework.

#### 2.2 The Kenyan Banana Sector

The importance of bananas throughout the world, and Kenya cannot be over-emphasized. In Kenya according to Qaim (1999) the crop is cultivated on about 74,000 hectares, which makes up 1.7 percent of the country's total land used for crop production. Among the horticultural crops, banana is generally the most important one with respect to area and income generation (FAO, 1998). Also, banana ranks eighth in the government's crop priority list for enlarging food production in order to keep pace with rapid population growth (Nguthi, 1996; MALDM, 1997).

The crop is mainly grown and managed by smallholder farmers, predominantly women (Kahangi, *et al.*, 2002). Table 1 shows the average banana production statistics for the provinces of Kenya during the period 1996-1997.

**Table 1: Average Banana Production Statistics for the Provinces of Kenya (1996-1997)**

Province	Area (ha)	Production (t)	Yield (t/ha)	Production share%
Central	16,913	169,316	10.0	16.5
Coast	5,743	55,341	9.6	5.4
Eastern	9,669	97,144	10.0	9.5
Nairobi	48	409	8.5	0.0
North Eastern	271	1,522	5.6	0.1
Nyanza	30,234	574,740	19.0	56.1
Rift valley	2,688	39,781	14.8	3.9
Western	7,800	86,107	11.0	8.5
<b>Total</b>	<b>73,366</b>	<b>1,024,360</b>	<b>14.0(average)</b>	<b>100.0</b>

Source: MALDM (1996, 1997).

According to Wambugu, *et al.*, (2002) bananas are produced for different purposes in Kenya. The dessert type varieties constitute the most popular fruit among urban and rural consumers, and the cooking type varieties are an important staple food, particularly for rural households (MOA, 1997). Besides being a source of carbohydrates, essential vitamins and minerals, banana is attractive to smallholder farmers because it is appropriate for inter-cropping (KARI, 1999).

The crop is mostly cultivated on comparatively small farms with an average banana holding of 0.3 hectares as shown in Table 2. Qaim (1999) indicates that although it is still a semi-subsistence crop, commercialisation has expanded in recent years. Reasons for this are the higher market demand due to the rising degree of urbanization as well as diminishing farm incomes from the more traditional cash and export crops, notably coffee.

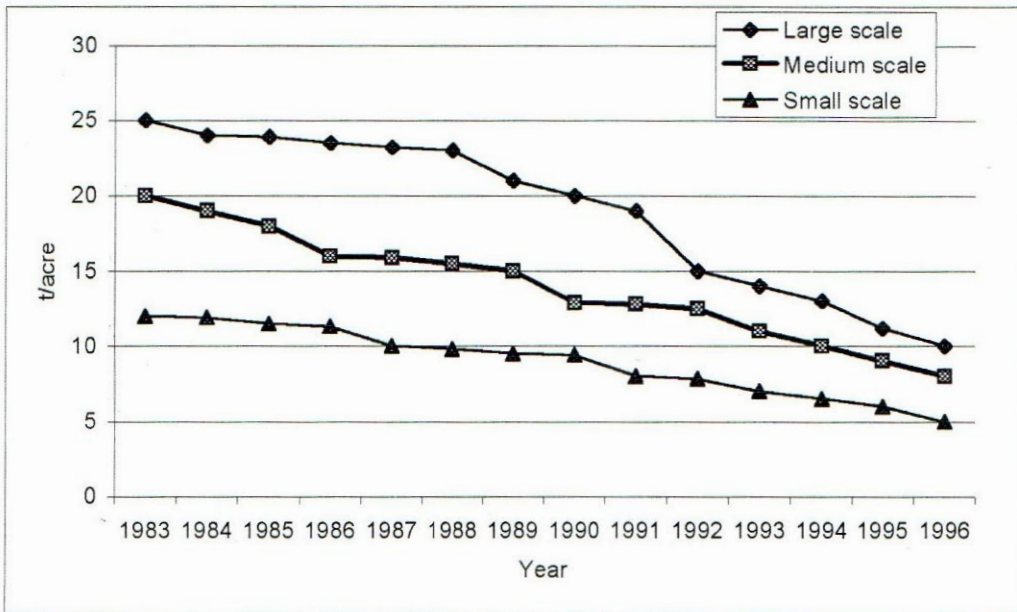
**Table 2: Characteristics of Banana Farm Types**

	Small-scale	Medium –scale	Large scale
Average banana (hectares)	0.3	1.1	4.9
Average home –consumer share (%)	37.1	24.6	4.0
Average ripening share (%)	33.7	48.3	84.0
Share in terms of farm numbers (%)	79.6	18.6	1.9
Share of national production (%)	36.9	41.0	22.1

Source: Qaim, (1999) p.8.

Over the last two decades however, banana production in Kenya and the Eastern Africa region has been on the decline (MOA, 1994). The average banana yields in Kenya is about 14

tonnes per hectare (5.7 tonnes per acre) falling significantly below the potential yields of more than 40 tonnes in tropical areas, Figure 1 (Qaim, 1999).



**Figure 1: Estimated Banana Yield Curves Over a 14-year Plantation Cycle in Kenya.**

Source: Qaim, (1999) p.37.

Apart from the low input levels, this yield gap is brought about by the widespread use of pathogen- infected suckers that transmits banana pests and diseases, which are estimated to reduce yields by up to 90% (MOA, 1994). The resulting yield losses make bananas an expensive commodity for consumers, and reduce the cash earnings of producers as well as the potential of the crop to contribute to the food security of rural households (Wambugu, 2001)

The introduction of Tissue-culture (TC) techniques for banana propagation was thus perceived as having the potential to help reverse the situation since it would ensure timely availability of clean planting material (Kahangi, *et al.*, 2002). JKUAT first demonstrated that a domestic market for tissue-cultured plantlets existed in Kenya; the college pioneered the use of tissue culture in Kenya during the early 1990s. In 1996/97, Kenya Agricultural Research Institute (KARI) launched an international collaborative program with the aim of providing resource- poor small-scale farmers with pathogen –free banana planting material through the use of Tissue-culture (TC) biotechnology (KARI, 1999).

The program was institutionally supported by the international service for the Acquisition of Agri-biotech Applications (ISAAA) and was sponsored by the Rockefeller Foundation (RF) and the international Development Research Centre (IDRC) (Wambugu *et al.*, 2002). It is in the context that TC had the potential to improve banana production amongst smallholder farms that the overall project on “Banana Biotechnology to benefit small-scale Banana Growers in Kenya” was conceived (Kahangi *et al.*, 2002).

The project intended to build and upgrade banana TC capacity, to expand the genetic base of banana and the varietal choice for growers by exchanging and introducing selected superior banana varieties with enhanced pest and disease resistance and higher yield from reputable breeding programmes, develop sustainable distribution system of the TC materials to the smallholder farmers, and commercially evaluate the adaptability of this technology within current farming practices in Kenya (KARI, 1999 ; Wambugu *et al.*, 2002).

Wambugu *et al.* (2002) states that four banana-growing regions were identified. Thika in the central Province, Kisii in the Nyanza Province, Embu in the Eastern Province, and Mtwapa in the coast Province. These Provinces adequately represented the major Agro-Ecological Zones (AEZ) of Kenya. They are also the major banana growing regions in the country (Qaim, 1999). Table 3 gives the characteristics of the trial sites within these areas.

**Table 3: The Characteristics of Sites where Tissue-Culture Banana Trials took Place**

Site	Province	AEZ	Altitude (metre)	Rainfall (mm)	Participating farmers
NHCR-Thika	Central	UM <sub>3</sub>	1500	900	On-station
Kiharu-Maragwa	Central	UM <sub>2</sub>	1400	1750	14
Gathiga-Kirinyaga	Central	UM <sub>4</sub>	1300	600-950	4
RRC-Kisii	Nyanza	UM <sub>1</sub>	1750	1800	On-station
Kenyenya	Nyanza	UM <sub>1</sub>	1700	1800	2
Suneka	Nyanza	LM <sub>2</sub>	1500	1500	12
RRC-Embu	Eastern	UM <sub>3</sub>	1500	100-1250	On station
Embu-Gatituri	Eastern	UM <sub>2</sub>	1450	100-2000	6
RRC-Mtwapa	Coast	CL	0-50	>2000	On-station
Mtwapa	Coast	CL	0-50	>2000	1

Key: NHCR= National Horticultural Research Centre, RRC= Regional Research Centre,

UM= Upper Midland, LM= Lower Midland, CL= Coastal Line.

Source: CBS, (1996) p. 341.

To facilitate the acquisition of these materials, KARI and ISAAA collaborated to identify distribution mechanism channels- schools, churches, on-farm trials, markets, and several key farmers in different areas to establish nurseries and distribution points (Wambugu *et al.*, 2002). It is on this basis that the Israel government introduced TC banana plantlets in NYS Yatta field demonstration farm in 1996, with the aim of disseminating the same technology to the neighbouring farmers (NYS, 1997). The TC banana plantlet cultivars introduced include, Williams, Grande Naine, Petite Naine, and Dwarf Cavendish.

The NYS- YFU Demonstration farm acts as a learning centre where neighbouring farmers, schools and CBO's in the division come to learn the various farming technologies, promoted by the unit, TC banana technology being one of them. Also, once every year, the Israel experts conduct on-spot courses in the unit, and some of the neighbouring farmers are invited to participate and learn more about the farming technologies practised in the units' demonstration farm.

### **2.3 Theoretical Perspective of Technology Diffusion Process.**

This study was guided by the diffusion paradigm. Rogers (1995) defined diffusion as the process by which an innovation is communicated through certain channels over time among the members of a social system. An innovation is defined as an idea, practice or object perceived as new by a unit of adoption (Sachs, 1993).

Surry (1995) noted that though diffusion is the process by which an innovation spreads within a social system, an innovation, however, diffuses within a social system through its adoption are thus closely interrelated even though they are conceptually distinct. Adoption is defined as the decision to make full use of an innovation as the best course of action available (Rogers, 1995). The descriptions of the four elements in the diffusion process are as follows.

#### **2.3.1 Innovation**

According to Rogers (1995), an innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption. Many new ideas are technological innovations. Consequently, "innovation" and "technology" are often used as synonyms. According to Lefebvre and Lefebvre (1996) a technology is a design of instrumental action

that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome.

The spread of any new technological innovation depends particularly upon the characteristics of the innovation (Rogers, 1995). The five characteristics features of adoption of any technology, which help to explain the difference in adoption rates, include the following:

#### *Relative advantage*

This is the degree to which an innovation is considered to be better than the one it is going to replace. Technologies that produce quick results are more rapidly adopted (Rogers 1995; Van den Ban & Hawkins, 1999).

#### *Compatibility*

This is the degree to which an innovation is compatible in value with those existing in the area. Practices that are compatible with existing ideas and beliefs are adopted faster than those, which are inconsistent with farmer's values, needs, objectives and level of farming technology (Rogers, 1995).

#### *Complexity*

This is the degree to which an innovation is seen as relatively difficult to understand and use. Innovations that are more easy and simple to understand are easily accepted than complex ones. Complexity may be a barrier to adoption (Rogers, 1995).

#### *Trialability*

A new innovation or technology that can be practised on a limited basis is generally adopted more rapidly than one that cannot. Trying on a small scale enables a farmer to develop less uncertainty because of use of little money (Rogers, 1995)

#### *Observability*

This is the degree to which the results of an innovation are visible to potential adopters. A new idea that has visible results is adapted more rapidly thus farmers must see a need for a practice (Rogers, 1995).

### **2.3.2 Communication Channels**

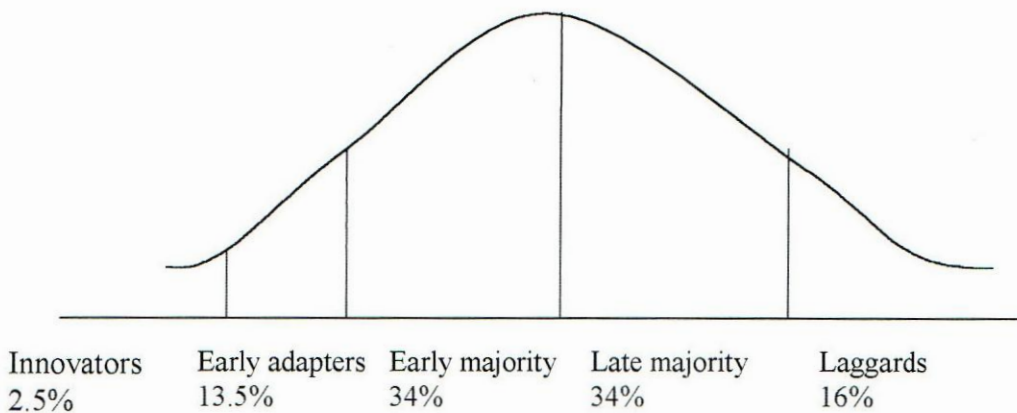
Communication is the process by which participants create and share information with one another in order to reach a mutual understanding (Rogers, 1995). Diffusion is a particular type of communication in which the message content that is exchanged is concerned with a new idea (Ibid). Thus, the diffusion process involves the spread of a new idea from its source to potential adopters, and it is composed of (i) an innovation (2) an individual or other unit of adoption that has knowledge of or experience with using the innovation (3) another individual or unit that does not yet have knowledge of the innovation (4) a communication channel connecting the two units, that is, the means by which messages get from one unit to the other (Surry, 1997). According to Rogers (1995), mass media communication channels are often used to inform potential adopters about the existence of an innovation, that is, to create awareness and knowledge, whereas interpersonal communication is considered more effective in influencing individual's decision to adopt.

### **2.3.3 Time**

Time relates to the speed with which an innovation is adopted –by potential adopters and according to Rogers (1995) there are three most widely used theories of diffusion namely; (1) the innovation –decision process or the adoption process by which an individual passes from knowledge of an innovation to its adoption or rejection of the innovation (2) the innovativeness of the adopting unit compared with other members of a system (this gives rise to adopter categories) and (3) the rate of adoption of an innovation in a system, these three concepts are discussed briefly here below.

The innovation–decision process theory (Rogers, 1995) states that diffusion is a process that occurs overtime and can be seen as having five distinct stages namely, knowledge, persuasion, decision implementation, and confirmation. Surry (1997) further, explain that knowledge occurs when an individual (or any other decision- making unit) is exposed to the innovations' existence and gains some understanding of its functions. Persuasion occurs when an individual or any other decision-making unit forms a favourable or non-favourable attitude towards the innovation. Decision occurs when an individual or any other decision-making unit engages in activities that lead to a choice to adopt or reject the innovation.

Implementation occurs when an individual or any other decision-making unit puts an innovation to use. Re-invention is especially likely to occur at implementation stage (Sachs, 1993). Confirmation occurs when an individual/or other decision making unit seeks reinforcement of an innovation decision already made, but he or she may reverse this previous decision if exposed to conflicting messages about the innovation (Surry, 1997). Individual innovativeness theory according to Rogers (1995) is the degree to which an individual or other decision-making unit is relatively earlier in adopting new ideas than other members of a system. Fig 2 shows the bell shaped distribution of individual innovativeness and the percentage of potential adopters theorized to fall into each category.



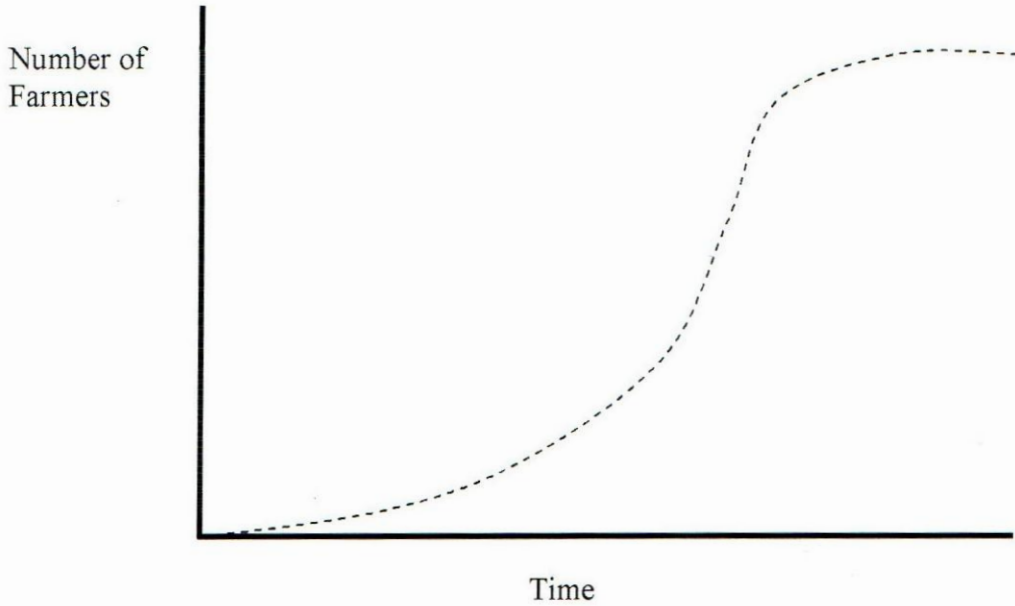
**Figure 2: Bell Shaped Curve Showing Categories of Individual Innovativeness and Percentage within each Category.**

Source: Rogers (1983) p. 247.

Rogers (1995) observed that these categories have different characteristics, which include personal variables (age, marital status and gender); socio-economic status (education, income, land tenure, labour, farm size, credit, farm inputs and marketing channels) and communication behaviour (outreach programmes and extension service). These characteristics are also used to explain why an individual or other adopting unit has adopted or failed to adopt a certain technology or innovation (Surry, 1997). Some of these personal, social- economic and situational variables of farmers are related to adoption in this study.

Rate of adoption - the third widely-used diffusion theory discussed by Rogers (1995) is the theory of rate of adoption, which states that innovations are diffused over time in a pattern that resembles an S-shaped curve. It is usually measured as the number of the system that adopt an innovation in a given time period. Rate of adoption theory states that an innovation

goes through a period of slow, gradual growth before experiencing a period of relatively dramatic and rapid growth (Figure 3). The theory also states that following the period of rapid growth; the innovations rate of adoption will gradually stabilize and eventually decline (Surry, 1997)



**Figure 3: S-Curve Representing Rate of Adoption of an Innovation over Time.**

*Source:* Surry (1997) p. 4.

There is variation in the slope of the “S” from innovation to innovation as well as from one social system to another and these differences are due to varying characteristics of innovations as perceived by the adopters as well as varying characteristics of the adopters (Surry, 1997).

#### **2.3.4 Social System.**

Rogers (1995) defines a social system as a set of interrelated units that are engaged in joint problem solving to accomplish a common goal. The members of a social system may be individuals, informal groups, or organizations who work towards a common goal. Rogers (1995) further states that when new ideas are invented, diffused and adopted or rejected, leading to certain consequences, a social change occurs. The general convention is to use the term diffusion to include both planned and spontaneous spread of ideas. The social systems therefore constitute a boundary within which an innovation diffuses (Rogers, 1995).

Organizations and changes aides in conjunction with change agents can have a significant impact on the adoption of an innovation within a certain social system (Rogers, 1995). Their function is to be a mediator between the social system and the innovation that is introducing a change into the system (Surry, 1997). They can help the members of the social system to understand and use the innovation, thus allowing the members to see the attributes of the innovation and go through the innovation process smoothly (Rogers, 1995).

In a nutshell, critical elements in the diffusion perspective that are significant to this study include farmer's personal characteristics (age, marital status and gender); socio-economic status (education, income, credit, inputs, farm size, market, labour and land tenure), the NYS-outreach programme, as well as farmer's perception towards TC banana technology which include, relative advantage, complexity, compatibility, Trialability and Observability.

#### **2.4 Related Research Findings On The Factors That Influence Adoption.**

Wambugu *et al.*, (2002) in their study "Socio-economic impact of biotechnology applications in Kenya" indicated that adoption of agricultural innovations varies in different areas and by different groups of farmers depending on their socio-economic status. Maina (1996) in his study "factors related to the adoption of technical maize production among farmers in Njoro division" and Leagans (1979) in his study "Adoption of modern agricultural technology by small-scale farm operations" attest to this fact by noting that adoption tends to be specific to particular innovation, environment and individuals. They further state that by recognising and accepting the individuality of each farmer and the uniqueness of his particular circumstance one can understand better how the general principle of adoption behaviour are developed and applied.

These sentiments of the two authors are borne out clearly as one examines other findings of various researchers. Qdenya (2003) in his study "Adoption of agricultural innovations by farmers neighbouring research institutes in western Kenya" found out that age, gender, education level, land tenure and sources of income had no significance with the adoption of agricultural innovations. However, he found out that significant attributes influencing adoption were hired labour, credit, farmers' equivalent practices, yield of the innovations, sustainability, social acceptability, economic viability, taste and resistance to pests and diseases. Qaim (1999) in his ex-ante study "Assessing the impact of banana biotechnology in

Kenya” found that there is no relationship between adoption and farm size. This was incomplete contrast to the traditional belief that small-scale farmers cannot benefit from modern biotechnological application. Amudavi (1993) in his study” influence of the socio-economic factors on adoption of maize related technologies” found that farm size is positively related to adoption of new innovations. Many technological advances require large farm size and therefore farmers with large size farms adopt more advanced technologies than the small size holders. He also found that there is no relationship between adoption and age as well as gender.

However, other researchers, for example, Misiko (1976) in his study “incentives and disincentives influencing farmer adoption of agricultural innovations” and Maina (1996) found that there is a positive and significant relationship between adoption and credit availability, extension contact and farm size. Like Amudavi (1993); Weir and Knight (2000) in their study “adoption and diffusion of agricultural innovative in Ethiopia” found that there is a significant and positive relationship between adoption and level of education, age and gender. Qaim (1999) found that there was no significant relationship between adoption and farmers’ perception of TC banana technology.

To explain the variability in the findings various researchers have given different reasons. Misiko (1976) reported that the positive relationship between adoption and land size was due to the use of credit facilities available only to farmers with over 15 hectares of land. Amudavi (1993) on the other hand reported that lack of a relationship between adoption and farm size was due to (a) simplicity of the innovation considered (b) high awareness level of the innovations and (c) a lot of influence from neighbours.

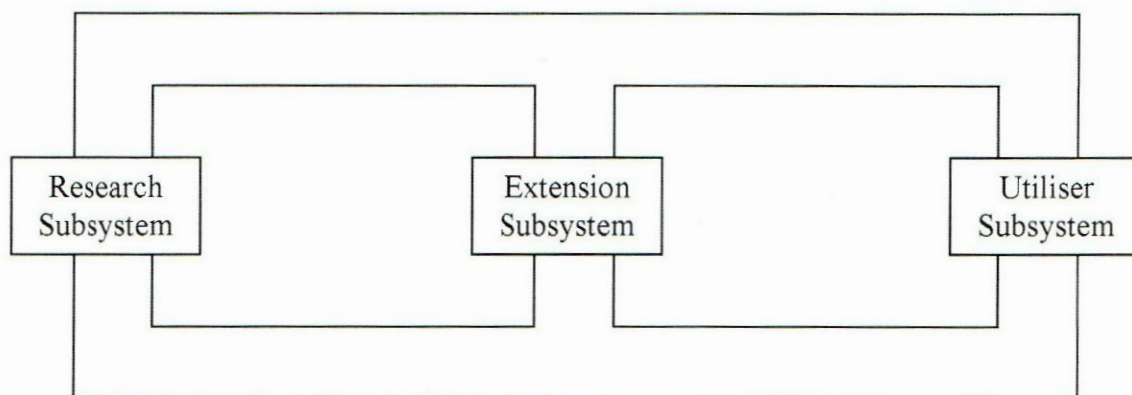
Qaim (1999) reported that the significance between adoption and the availability of labour was due to labour constraints in specialized tasks, which inhibit adoption of a new technology or limit its productivity. Consequently the informative role of NYS Yatta field unit in transferring the TC banana technology to farmers in combination with the extension message of how to use it successfully.

Since no TC banana technology adoption study has been done in Yatta Division, this study aims at finding out where Yatta falls as regards to factors influencing adoption of TC banana

Technology by small- scale farmers neighbouring NYS-Yatta field unit and subsequently suggest suitable recommendations to enhance adoption.

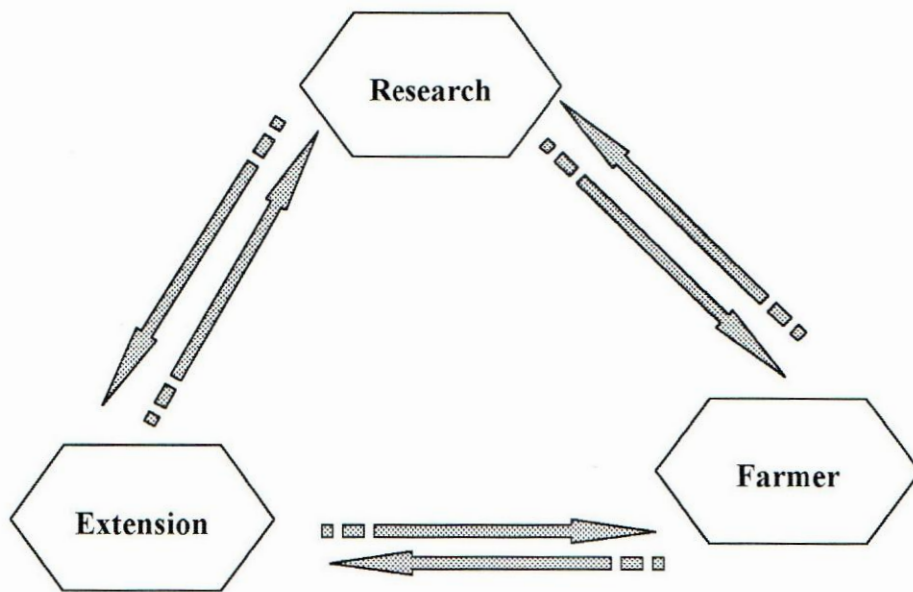
## 2.5 Theoretical Framework

This study adopted the Agricultural Knowledge and Information Systems (AKIS) paradigm introduced by Niels Røling. An AKIS is a set of agricultural organizations and /or persons, and links and interactions between them, engaged in processes as the generation, transformation, transmission, storage, retrieval, integration, diffusion and utilization of knowledge and information, with the purpose of working synergically to support decision making, problem solving and innovation in a given country's agriculture (Røling, 1990). The system is characterised by its key subsystems: agricultural education, agricultural research and agricultural extension (Figure 4).



**Figure 4: AKIS Simple Model, Adopted from Rolling (1990)**

The AKIS paradigm offers to assist in reviewing potential partners for collaboration in research, extension and training. Figure5 Postulates that researcher generate technologies/innovations, and the farmers discuss their problems with extension agents who ultimately seek possible solutions from the researchers and give a feedback to the farmers. The incorporation of the AKIS into the planning and operation of the major institutions and organizations involved in agriculture (KARI, MOARD, NGO's, CBO's, Universities, NYS) could assist scientists and extensionists in improving and strengthening technology transfer strategies.

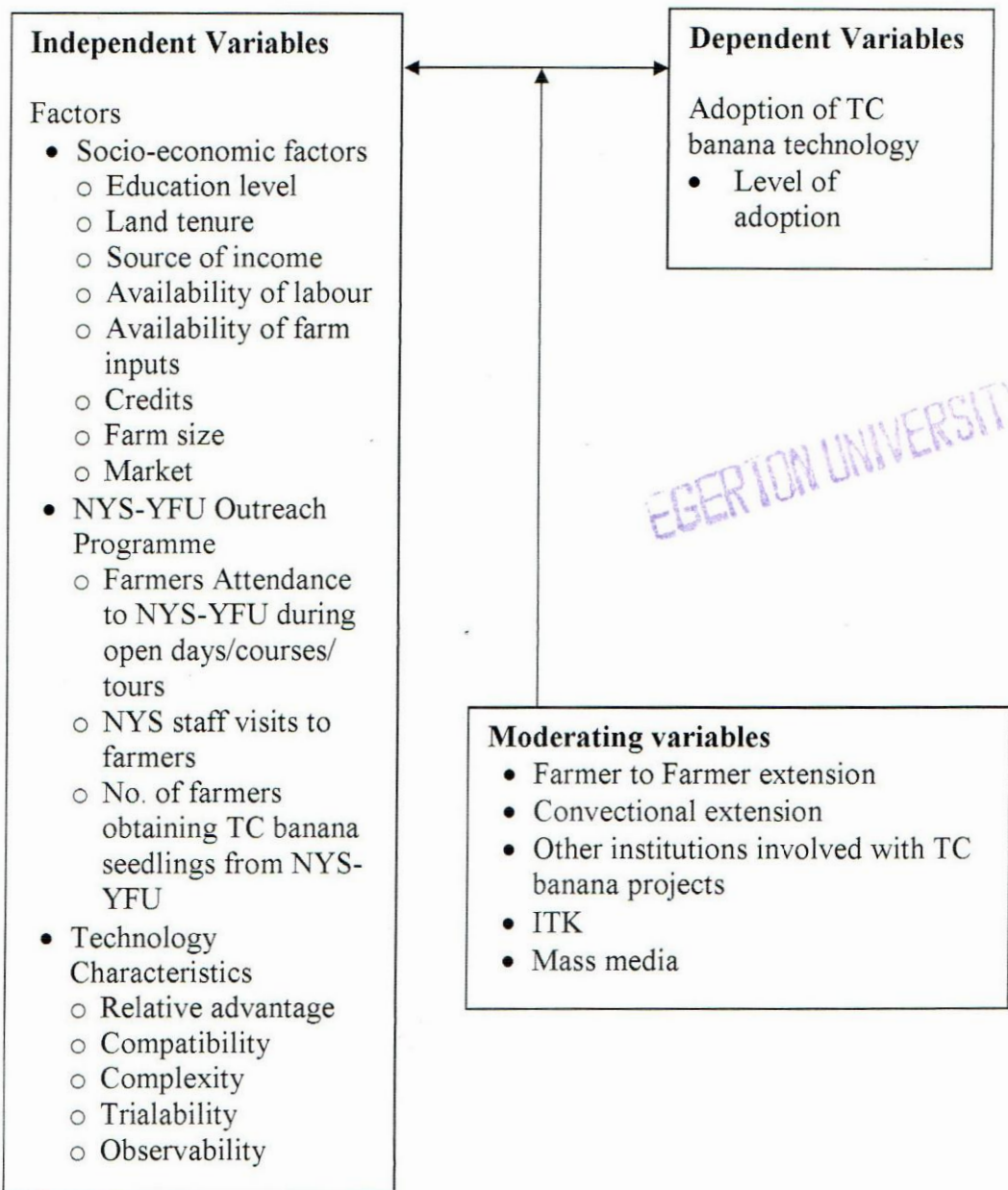


**Figure 5: The Technology – Triangle “Transfer of Technology”**

Source: Röling (1990)

## 2.6 Conceptual Framework

The conceptual framework of the study is shown in Figure 6. It shows the factors that influence the adoption of TC banana technology including the independent variables such as; (socio-economic factors, out-reach programme, and farmers perception to Tissue culture technology) and the moderating variables (farmer to farmer extension, convectional extension, other institutions involved with TC banana projects, ITK and mass media).



**Figure 6: A Conceptual Framework Showing Factors Influencing Adoption of TC Banana Technology by the Small-Scale Farmers Neighbouring NYS-YFU**

The framework has been used to formulate the objectives, hypotheses, instruments and tools, and also to evaluate specific factors related to farmer characteristics and the characteristics of the technology that gives the farmer relative advantage, understanding, and enhance compatibility, Trialability, Observability of tissue culture banana adoption in the study area.

The moderator variables such as (farmer to farmer extension and extension from other services as well as mass media and ITK) were assumed to be constant and simple random sampling was used to select farmers within each stratum.

## CHAPTER THREE

### RESEARCH METHODOLOGY

#### 3.1 Introduction

This chapter provides a logical description of how the research was done. It consists of the research design, the study area, population of the study, sampling size, Sampling techniques and procedures, instrumentation, validation of the instruments, reliability, data collection and analysis.

#### 3.2 Research Design

This study adopted an ex-post facto design whose purpose is to explore and describe. An ex-post facto study is used when experimental research is not possible, such as when people have self-selected levels of an independent variable or when a treatment is naturally occurring and the researcher could not control the degree of its use. The researcher starts by specifying a dependent variable and then tries to identify possible reasons for its occurrence as well as alternative explanations (Keppel, 1991) This type of study is very common and useful when using human subjects in real-world situations and the investigator comes in "after the fact" (Keppel, 1991). The design involved a sociological inquiry in form of survey often used by researchers to gather data from a fairly large group of persons, often by personal interviews or using questionnaires, (Wiersma, 1995). Survey is used to collect information from a sample that has been drawn from a predetermined population and the information is collected at just one point in time (Fraenkel & Wallen, 2000). It is used to achieve the objective of how the responses are distributed on each questionnaire item (Borg & Gall, 2003). Kathuri and Pals (1993) add that a survey study explores and describes a phenomenon, looks for information that describes existing occurrences by questioning and interviewing individuals.

However, the ex- post facto design used may be limited as it is used to study independent variables which have already occurred and are inherently not manipulatable by the researcher (Keppel, 1991). Consequently, this leads to less straight forward interpretation of results and ambiguity because independent variables in the natural setting tend to operate simultaneously (Wiersma, 1995). Survey may be limited by the one- point in time data collection principle as

adoption of the technology may vary from season to season. In order to overcome this handicap the variables that cannot be controlled such as farmers' personal characteristics (age, gender, and marital status) are in-built into the study and their variance was controlled through co-variant statistical analysis.

### **3.3 The Study Area**

This study covered Yatta division in Machakos district. The NYS-YFU is located in Kithimani location in Yatta division approximately 85km south-east of Nairobi and 35km from Thika Town along Thika-Garissa road. Yatta division is one of the 11 (eleven) divisions of Machakos District. It borders Kilimbogo to the North, Kangundo division to the West, Masinga to the East and Mwala to the South. The division covers an area of 1,039 square kilometers (sq.km). It is divided into 4 locations, namely; Kithimani, Matuu, Ndalani, and Mavoloni. (DDP, 1997).

The division ranges in altitude from 900-1300m above sea level with a rainfall range from 500-700mm per annum. The rainfall occurs in a bimodal pattern with long rains starting in mid March to June and short rains from October to December. The temperatures range from 21.6<sup>o</sup> C to 28.0<sup>o</sup>C during the year. The division lies in Agro Ecological Zone (AEZ) Lower Midland Five (LM5) (DDP, 1997-2001). The division lies in Yatta plateau and on the plateau the slope is very gentle (0-5%). The soils are shallow, well drained, mixture of sandy clays, sandy loams, red soils and clay soils, with a pH of 5-7 (DDP, 1997).

The natural vegetation is open woody grassland. The main sources of water are Rivers: Athi and Tana and Yatta canal/furrow, which is an off-take of Thika River and is approximately 60 km long. The average landholding is 5 hectares and the main activities are mixed farming. The main crops are: maize, beans, pigeon peas, cowpeas, sorghum, sweet potatoes, green grams and cassava. Fruit trees include; citrus, mangoes, guavas and paw paw. Other crops such as sugar cane, French beans, bananas and some Asian vegetables are grown under irrigation along the three sources of water. The livestock kept is limited to Zebus, some crosses, poultry, rabbits, shoats, and apiculture (DDP, 1997-2001).

The land tenure system is freehold. The land was fully surveyed and the farmers were issued with allocation numbers. However, majority have not been issued with title deeds (DDP,

1997). Sources of income are limited because generally the area lacks income generating agricultural enterprises. The farmers are mainly subsistence and sometimes they sell even the little crop harvest to meet other basic needs. Off-farm employment is the main source of income and also, sand harvesting and horticultural crops along the Yatta canal, rivers Athi and Thika contribute somehow to the areas income. Charcoal burning and small business constitute about a third of the farm income (DDP, 1997).

Maize is the staple food for the community, although it does not perform well due to inadequate rainfall and other constraints. Beans, cowpeas, and pigeon peas are important pulses in that order. Fruit trees such as mangoes, citrus, paw paw, tomatoes and bananas provide residents with vitamins, as well as farm income. Most of these fruits and vegetables are seasonal and for most of the year farmers either have to buy very expensively or do without. Poultry and shoats and cattle are kept mainly for selling to either buy maize or beans or to meet other household needs. The division experience frequent crop failures and hence has to rely heavily on the market for food, and even relief food (DDP, 1997).

### **3.4 Population of the Study**

The total target population were all the small-scale farmers of Yatta division (15000) and the accessible population was 1500 small-scale farmer's households in Kithimani location, specifically those found along the three water sources (Yatta Canal, Athi and Thika rivers) and only those growing bananas within 30 km from NYS Yatta field unit. Yatta division was selected because:

- The NYS Yatta field unit is located there (in Kithimani location).
- Similar research has not been done in the division
- The division has great potential to increase banana production.

### **3.5 Sample Size and Sampling Procedure**

Using the recommendation by Kathuri and Pals (1993), the minimal sample for survey type of research should be 100 for major subgroups and 20-50 for each minor sub-group. However, the extra 20 were to take care of subject mortality. The population list obtained from Kithimani divisional agricultural office was used to select the individual farmers and a

proportionate random sample size of 120 was made. A table of random numbers was used to select the individual farmers from the lists. The selected farmers were distributed according to Table 4.

**Table 4: Selection of Households by Source of Water**

<b>Source of water</b>	<b>No of households</b>	<b>Proportions %</b>	<b>Sample size</b>
Yatta furrow	1000	77	92
Athi-river	200	15	18
Thika river	100	8	10
Total	1300	100	120

A simple random sampling would have given every farmer an equal chance of being chosen but without uniformity (Frankel, & Wallen, 1990). Hence, proportionate random sampling procedure was adopted in the survey based on the three sources of water. This is because stratified sampling would spread farmers more uniformly around the three sources of water (Yatta canal, Thika and Athi rivers) while retaining the principle of randomness within the 30Kms from the NYS Yatta field unit. The proportionate random sampling ensured that no sub-population is omitted from the sample, and avoids overloading in certain sub-populations (Borg, & Gall, 2003).

### **3.6 Instrumentation**

A comprehensive questionnaire with structured questions was used to collect data with items relating to the objectives of the study and hypotheses to be tested. The questionnaire as a data-gathering instrument is preferred because it enables the researcher to collect data from a large number of respondents within a time limited during which the research is conducted. Further, this instrument enables the researcher to get responses, which the respondents would feel shy to give in a non face-to-face interaction (Kerlinger, 1973). The questionnaire, which was structured, consisted mainly of close-ended questions and few open-ended questions. Information collected by the instrument included personal characteristics of the respondent, socio-economic characteristics, tissue culture banana technology, NYS field unit outreach programme and farmers perceptions towards adoption of tissue culture banana technology.

### **3.7 Validation of the Questionnaire**

The questionnaire was tested in order to check its content, construction, and criteria validity. First, peers and lecturers in the Department of Agricultural Education and Extension helped to check for suitability and complexity of the questions and their comments were used in reframing some of the questions.

### **3.8 Reliability**

A pilot test was conducted using thirty small-scale farmers who did not take part in the main study. The pilot study was done in Matuu location 10km from the study site and the farmers' chosen were having the same characteristics as the target population. This was necessary for checking whether the questionnaire is measuring what is supposed to measure, and corrections were made before printing and administering it. Cronbach's coefficient Alpha test was done to determine how items in the questionnaire correlate among themselves. After correcting some of the items in the instrument, the coefficient of reliability was maintained at 0.75. This was accepted based, on the recommendations by Mugenda and Mugenda (1999) of a threshold of 0.7.

### **3.9 Data Collection Procedures**

After obtaining a letter from the Department of Agricultural Education and Extension to enable the researcher to get a research permit from the Ministry of Science and Technology, the researcher was introduced to the farmers by Frontline Extension Workers via Kithimani Divisional Agricultural Office. After sampling the respondents using the list of farmers obtained from the Divisional Agricultural Office, the researcher interviewed the selected farmers following the questionnaire. Each question was read to the head of household and the responses recorded, and in cases where the respondents could read and write they filled the questionnaires themselves. Where respondents were not available, the researcher visited the households a second time. All responses were checked at the end of each day to ensure that the responses were meaningfully recorded.

### **3.10 Data Analysis**

Data collected by use of questionnaire were processed before analysis. It was coded and cleaned and the Statistical Package for Social Science (SPSS) programme was used to

analyse it. Objective one was analysed using descriptive statistics. Thus, frequencies, means, percentages and graphs were used to describe the adoption pattern of TC banana technology. Hypotheses 1, 2 and 3 were analysed using chi-square an inferential statistic at  $\alpha = 0.05$  level of significance. This was because data on the farmers' characteristics, NYS-YFU outreach programme and perceptions of the farmers on TC banana technology were recorded in discrete form. Table 5 summaries the specific statistics used for each objective and hypotheses.

**Table 5: Summary of Data Analysis**

<b>Hypotheses</b>	<b>Independent Variables</b>	<b>Dependent Variable</b>	<b>Statistical analysis</b>
H(0)1: There is no statistically significant relationship between adoption of TC banana technology and farmers' socio-economic status	<ul style="list-style-type: none"> <li>○ Education</li> <li>○ Income</li> <li>○ Land tenure</li> <li>○ Farm size</li> <li>○ Labour</li> <li>○ Markets</li> <li>○ Credit availability &amp; inputs</li> </ul>	Adoption of TC Banana Technology <ul style="list-style-type: none"> <li>● Level of adoption</li> </ul>	Chi-square
H(O)2: The NYS Yatta Field unit outreach programme does not significantly influence the adoption of TC banana technology among neighbouring small-scale farmers	<ul style="list-style-type: none"> <li>○ Farmers' visits to NYS-YFU</li> <li>○ NYS staff visits to neighbouring farmers</li> <li>○ No. of farmers obtaining TC banana plantlets from NYS-YFU</li> </ul>	Adoption of TC Banana Technology <ul style="list-style-type: none"> <li>● Level of adoption</li> </ul>	Chi-square.
H(0)3: There is no statistically significant relationship between the perception of small-scale farmers on TC banana technology introduced by NYS Yatta field unit and their adoption of the technology	Farmers perception of TC banana technology <ul style="list-style-type: none"> <li>○ Relative advantage</li> <li>○ Compatibility</li> <li>○ Complexity</li> <li>○ Trialability</li> <li>○ Observability</li> </ul>	Adoption of TC Banana Technology <ul style="list-style-type: none"> <li>● Level of adoption</li> </ul>	Chi-square.

## **CHAPTER FOUR**

### **RESULTS AND DISCUSSIONS**

#### **4.1 Introduction**

This chapter presents the results of the study in relation to each objective and hypothesis. The findings are presented and discussed in the following order:

1. Description of the adoption levels of TC banana technology by small scale farmers neighbouring NYS –YFU
2. Description of farmers' socio-economic characteristics affecting adoption of TC banana technology.
3. Description of the influence of the NYS – YFU outreach programme on the adoption of TC banana technology by the neighbouring small-scale farmers.
4. Description of farmers' perceptions of TC banana technology/
5. Analysis and testing of various hypotheses.

The discussions are based on results of the analysis as they relate to the study area, respondent characteristics and findings from related studies as well as established theories of adoption and technology dissemination.

#### **4.2 Description of Adoption Levels of TC Banana Technology**

The first objective sought to determine the levels of adoption of TC banana technology by small-scale farmers neighbouring the NYS – YFU. The data collected from the study yielded various frequencies of the respondent's adoption of the selected TC banana technologies namely: use of TC seedlings; use of recommended spacing; use of fertilisers or manure; watering; desuckering; propping; pests and disease control; weeding and pruning. The following sections describe the corresponding levels of the utilisation of these technologies in an attempt to show the respective adoption levels.

#### 4.2.1 Use of TC Banana Seedlings

Majority of the respondents (60%) did not use the seedlings and only 40% were using TC banana seedlings. Table 6 illustrates the frequencies and proportions of the respondents who use TC banana to various levels.

**Table 6: Distribution of Respondents by use of TC Banana Seedlings**

Level of Adoption	No. of TC Banana plants	Frequency	Percent
High	450and above	4	3.3
Moderate	100-449	8	6.7
Low	50-99	15	12.5
Very Low	Below 50	21	17.5
Do not use	0	72	60.0
<b>Total</b>		<b>120</b>	<b>100.0</b>

Out of the 40% of the farmers using TC banana seedlings only 10% planted at least a quarter of an acre (100)or more of TC banana plants, while 60% did not use the TC seedlings at all. By implication, this is a very low level although this finding is higher than the 30% reflected in the unit’s annual preliminary report (NYS-YFU, 1999). The study also investigated the source of the planting materials used by the adopting farmers. From Table 7, only 28.3% of the farmers obtained their planting materials from the NYS-YFU as compared to 39.2% who bought the seedlings from farmer’s self-help-groups, KARI and JKUAT. The proportion of farmers sourcing their planting materials from the unit reflects the adoption level reported in the annual report.

**Table 7: Distribution of Respondents by Source and Type of Planting Materials**

Source	Type	Frequency	Percent
NYS Yatta Field Unit	Suckers	34	28.3
Farmers self-help groups	Seedlings	41	34.2
KARI	Seedlings	3	2.5
JKUAT	Seedlings	3	2.5
Neighbours and Friends	Suckers	39	32.5
<b>Total</b>		<b>120</b>	<b>100.0</b>

The study revealed that 60.8% of the respondents would prefer using TC banana suckers as opposed to 39.2% who would prefer using the TC seedlings (Table 7). The study indicated that the preference is driven by cost of planting material. TC suckers obtained from NYS-Yatta Field Unit, neighbours and friends are cheaper and are obtained either for free or at affordable cost ranging from Kshs.5 to Kshs 10. This implies that to enable more farmers to use TC banana seedlings as recommended, the question of high prices of the seedlings has to be addressed. This is consistent with what Qaim (1999) found out that apart from the prohibitive seedling prices, the use of suckers tends to encourage transmission of soil borne pathogens for example, nematodes from farmer to farmer. The study also indicated that 94.2% of the respondents lacked adequate supply of TC banana seedlings and was a major constraint (Table 8). The cost and accessibility of clean TC planting materials is therefore a significant factor in the adoption of TC banana technology.

**Table 8: Distribution of Respondents by Availability of Planting Materials**

Availability	Frequency	Percent
Not available	5	4.2
Inadequate	113	94.2
Adequate	2	1.6
<b>Total</b>	<b>120</b>	<b>100.0</b>

#### 4.2.2 Use of Recommended Banana Spacing

The spacing recommended by the Divisional Agriculture office was taken into account. The average plant spacing in a pure TC banana crop is 3 by 3 metres (450 plants per acre). At the time of the study only 62.5% of the respondents used the recommended spacing as compared to 37.5% who used the non-recommended spacing (Table 9).

**Table 9: The Extent to which the Respondents Use the Recommended Spacing**

Level of adoption	Frequency	Percent
Above recommended spacing (>3x3m)	29	24.2
Within recommended spacing (3x3m)	75	62.5
Below recommended spacing (<3x3m)	16	13.3
<b>Total</b>	<b>120</b>	<b>100.0</b>

Those farmers operating below the recommended spacing associated this with land shortage while those operating above the recommended spacing associated this with lack of technical knowledge. From the reasons given, it is evident that a knowledge gap exists that need to be bridged through NYS-YFU outreach programme, the mainstream public extension service and other extension delivery systems in the area. The extension packages should include plant spacing and farm planning.

#### 4.2.3 Use of Fertiliser or Manure

The use of fertilisers and farmyard manure is an important component of the TC banana technology advanced by the unit to the neighbouring farmers. The study found out that, 52.5% of the farmers use manure as recommended as illustrated in Table 10. However, farmers strongly opposed the use of fertilisers, as they believed that synthetic fertilisers could affect the quality of bananas by making them soggy and tasteless.

**Table 10: Distribution of Respondents by Application of Farmyard Manure**

<b>Application</b>	<b>Application Rate (debes)/hole</b>	<b>Frequency</b>	<b>Percent</b>
Above	above two	11	9.2
recommended	Two	63	52.5
Below	Below two	46	38.3
<b>Total</b>		<b>120</b>	<b>100.0</b>

The usage of either synthetic inorganic fertilisers or manure depends to a large extent on this belief as well as on their relative availability and cost. The fertiliser and manure availability levels as indicated by the respondents are shown in Table 11. Manure is more available than fertilisers. The table also indicates that manure is largely inadequate. Only 52.5% of the respondents used recommended amount of manure on their banana crop (Table 10). The result is that the benefits of manure are only partially realised. The TC banana technology extension package must therefore be accompanied with elaborate manure utilisation advice including local manure processing and application techniques.

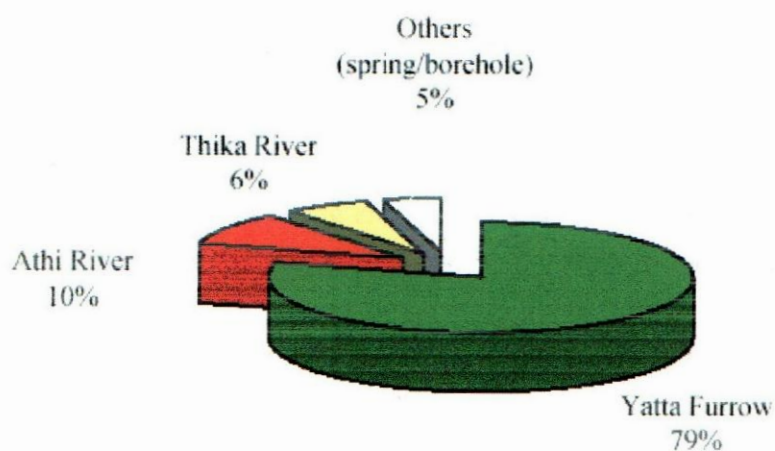
**Table 11: Distribution of Respondents by Fertiliser and Manure Availability**

Availability	Fertiliser		Manure	
	Frequency	Percent	Frequency	Percent
Not available	77	61.2	0	0.0
Inadequate	42	35.0	89	74.2
Adequate	1	0.8	31	25.8
<b>Total</b>	<b>120</b>	<b>100.0</b>	<b>120</b>	<b>100.0</b>

However, of the respondents who used fertilisers (35.0%) did not apply the fertiliser as recommended. Optimum yields cannot be achieved by those who do not use fertilisers. Those farmers who did not apply fertilisers or manure at the recommended rates gave various reasons. The majority (61.2%) indicated that the fertilisers were unavailable due to lack of funds to purchase and (74.2%) indicated that the manure was inadequate.

#### 4.2.4 Water for TC Banana Crop

Table 12 shows that (99.2%) of the respondents irrigated their bananas. The farmers mainly sourced their irrigation water from the adjacent water bodies including the two rivers and a canal (Figure7). Majority of the farmers (79%) source their water from Yatta canal, (6%) from Thika River, (10%) from Athi River and only (5%) from other sources like boreholes or springs

**Figure 7: The Distribution of Respondents by Source of Irrigation Water**

Out of those who irrigated their crop, only 25.0% used the recommended rate, while the majority (70.8%) watered below the recommended rate (Table 12).

**Table 12: Distribution of Respondents by Watering Frequency**

<b>Level of watering</b>	<b>Rate( litres/plant/week)</b>	<b>Frequency</b>	<b>Percent</b>
Above recommended	Above 20	4	3.4
Below	20	30	25.0
Do not use	Below 20	85	70.8
	0	1	0.8
<b>Total</b>		120	100.0

This was attributed to inadequate water for irrigation especially during the dry spells because the study area suffers from frequent drought. This confirms what Wambugu *et al.*, (2002) found out that low watering frequency affects the performance of bananas because the young tissue culture plantlets are extremely tender and sensitive to water stress. The TC banana technology dissemination should be accompanied with appropriate irrigation water management packages.

#### **4.2.5 Desuckering**

Only 11.7% of the respondents indicated not practising desuckering, and 9.2% practised desuckering as recommended. The rest of the respondents 76.6% did it below the recommended level. The study obtained this information by investigating the extent to which the respondents practised desuckering and a summary of the findings are shown in Table 13.

**Table 13: Distribution of Respondents by De-suckering Frequency**

Level of adoption	No of suckers/stool	Frequency	Percent
Above recommended	3	3	2.5
Within recommended	4	11	9.2
Below recommended	5	92	76.6
Do not use	6 or more	14	11.7
<b>Total</b>		<b>120</b>	<b>100.0</b>

This concurs with what Wambugu *et al.* (2001) found out that de-suckering was rarely carried out and the tendency was to find very many suckers under one stool, which ultimately affect the overall performance of the banana crop.

#### 4.2.6 Propping

Propping (stalking) is an important husbandry practice in TC banana production for supporting mainly tall varieties, which are prone to wind damage. This management practice is poorly done with 11.7%stalking their banana crop as recommended. Most farmers (76.6%) stalked two to one plants per stool and 11.7% did not stalk at all. (Table 14)

**Table 14: Distribution of Respondents by Propping of TC Bananas**

Level	No of plants stalked/stool	Frequency	Percent
High	4	3	2.5
Moderate	3	11	9.2
Low	2	40	33.3
Very low	1	52	43.3
Do not use	0	14	11.7
<b>Total</b>		<b>120</b>	<b>100.0</b>

This can be explained by farmers' preference for the medium and short banana varieties and also inadequate labour as indicated by 88.3% of the respondents (Table 15). Propping is a relatively labour intensive practice.

**Table 15: Distribution of Respondents by Availability of Labour**

<b>Availability</b>	<b>Frequency</b>	<b>Percent</b>
N/Adequate	4	3.3
Inadequate	106	88.3
Adequate	10	8.4
<b>Total</b>	<b>120</b>	<b>100.0</b>

#### 4.2.7 Pests and Disease Control

The major pests and diseases affecting TC banana crop in the study area include sigatoka, panama wilt and nematodes (NYS, 1997). The control of these pests and diseases is therefore important for the production of the crop. Farmers in the study area practice pest and disease control to varying levels. Majority (91.6%) of the respondents indicated they did not control pests and diseases (Table 16).

**Table 16: Distribution of the Respondents by Pests and Disease Control**

<b>Level of Control</b>	<b>Frequency</b>	<b>Percent</b>
Low	2	1.7
Very Low	8	6.7
Do not use	110	91.6
<b>Total</b>	<b>120</b>	<b>100.0</b>

The farmers indicated that they saw no diseases and pests on the banana crop and hence no need to control them. This however contrasts with recent report about the existence of the pests and diseases. The farmers' reasoning can only be associated with the lack of technical knowledge for identification of the signs of the pests and diseases. There is, therefore, a need for education of the farmers on pests and disease control especially for those who obtain suckers from other farmers. Otherwise those farmers who use TC banana seedlings agreed that TC bananas have few if no pests and diseases as advanced by research (KARI, 1999; Qaim, 1999; Mbogoh, 2001).

#### 4.2.8 Weeding

All the respondents weeded their banana crop but at varying frequencies (Table 17). It was observed that only 3.3% of the respondents had their bananas fields' weed- free, 49.2% weeded at least thrice per month and 47.5% weeded only once or twice.

**Table 17: Distribution of the Respondents by Weeding**

<b>Level of Weeding</b>	<b>Rate / Month</b>	<b>Frequency</b>	<b>Percent</b>
High	4	4	3.3
Moderate	3	59	49.2
Low	2	54	45.0
Very Low	1	3	2.5
<b>Total</b>		<b>120</b>	<b>100.0</b>

This was attributed to labour shortage. The consequence of less weeding is poor yields due to competition for nutrients between the weeds and the banana crop. For optimum production, TC banana requires weed- free fields, a practice, which is highly labour intensive hence, the low levels of weeding registered in the study area. The existing extension providers that target improved adoption of TC banana in the area should advocate less labour intensive weed control strategies.

#### 4.2.9 Pruning

Effective pruning improves yield in TC banana crop. Only 22.5% of the respondents pruned their banana crop as recommended, while 68.4% pruned below the recommended de-leafing standards and only 8.3% did not de-leaf their crop (Table 18).

**Table 18: Distribution of the Respondents by the Level of Pruning**

<b>Level of Pruning</b>	<b>No. of Pruning/Season</b>	<b>Frequency</b>	<b>Percent</b>
High	5	2	1.7
Moderate	3-4	25	20.8
Low	2	41	34.2
Very Low	1	41	34.2
Do not use	0	10	8.3
Missing		1	0.8
<b>Total</b>		<b>120</b>	<b>100.0</b>

Most of the respondents (88.3%) indicated labour inadequacy as a contributing factor to low levels of pruning practice (Table 15). Pruning is especially important against weevils, in order to eliminate potential hiding and breeding places (KARI, 1999).

### **4.3 Socio-economic Factors Affecting Adoption of TC Banana Technology**

The second objective of this study sought to describe the socio-economic factors that affect the adoption of TC banana technology. These were operationalised through the farmer's characteristics like age, gender, education level, marital status, farm size, land tenure, source of income, labour availability, access to credit, and marketing channels. The implications of each of these variables on the adoption of TC banana technology as revealed by the study are discussed in the following sections. Detailed descriptions of the factors are presented for some selected technologies.

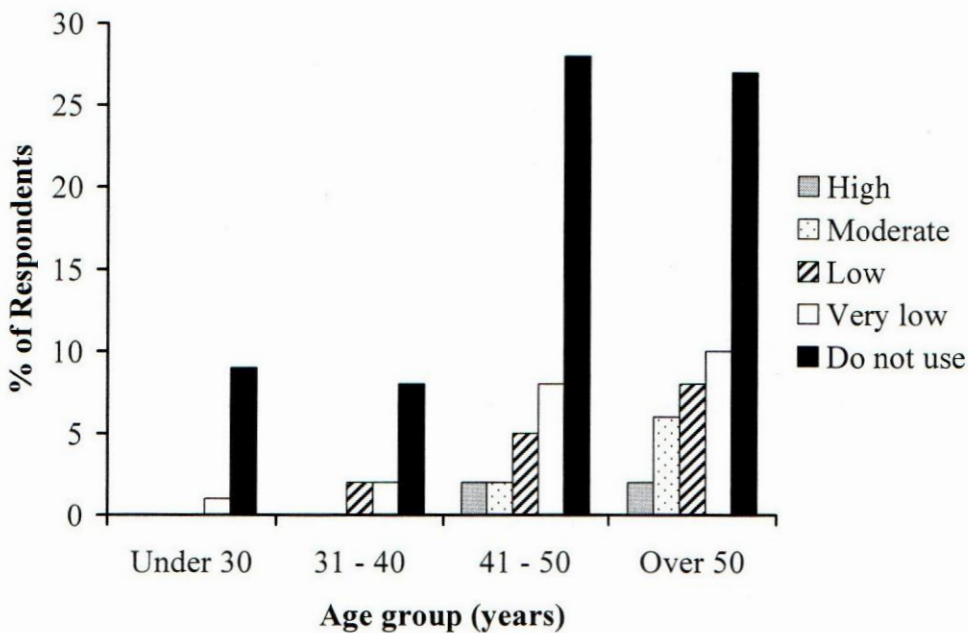
#### **4.3.1 Farmer's Age**

The age distribution of the farmers who took part in the study is shown in Table 19. The age of the farmers interviewed ranged from 22 to 80 years. The highest percentage of farmers (76.8%) was in range of 31 – 50 years with mean age of 45 years. Given that majority of the respondents were still in their prime working age, the level of adoption of TC banana technology would be expected to be high. Usually the highest adoption level of technologies is found within the middle age. The World Bank (1992) found out that relatively young farmers were more likely to adopt new technologies.

**Table 19: Distribution of Farmers by Age**

Age	Frequency	Percent
Under 30 years old	9	7.5
31-40 years old	42	35.1
41-50 years old	50	41.7
Above 51 years old	19	15.7
<b>Total</b>	<b>120</b>	<b>100.0</b>

Figure 8 illustrates the distribution of the levels of adoption of TC seedlings by the age of the respondents. In all the age categories, majority of the farmers do not use TC seedlings.



**Figure 8: The Distribution Levels of Adoption of TC Seedlings by Respondents' Age**

#### 4.3.2 Farmer's Gender

Male farmers constituted the largest proportion (87%) of the respondents interviewed while the rest (33%) were females (Table 20). The study revealed that men were supportive of the technology and usually are household heads with greater access and control over resources. This aspect was found not to affect the level of adoption of the technology. Table 20 illustrates a summary of the distribution of adoption levels of the use of TC banana seedlings by gender. None of the female farmers use TC banana seedlings at high levels while 4.6% of the male respondents do. For both gender groups, the largest proportion of respondents does

not use TC banana seedlings as planting materials (66.67% and 42.42% for males and females respectively).

**Table 20: Distribution of the Adoption Levels of TC Banana Seedlings by Gender of the Respondents**

Level of Use	Male		Female		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
High	4	4.60%	0	0.00%	4	3.33%
Moderate	6	6.90%	2	6.06%	8	6.67%
Low	8	9.20%	7	21.21%	15	12.50%
Very low	11	12.64%	10	30.30%	21	17.50%
Do not use	58	66.67%	14	42.42%	72	60.00%
<b>Total</b>	<b>87</b>	<b>100.00%</b>	<b>33</b>	<b>100.00%</b>	<b>120</b>	<b>100.00%</b>

#### 4.3.3 Marital Status

Table 20 indicates that 33% from a sample of 120 interviewed households were females. Out of these, 87.5% were married, 6.7% widowed, single 5% and 0.8% divorced (Table 21).

**Table 21: Distribution of Respondents by their Marital Status**

Marital Status	Frequency	Percent
Married	105	87.5
Widowed	8	6.7
Divorced	1	0.8
Single	5	5.0
<b>Total</b>	<b>120</b>	<b>100.0</b>

Despite banana being a predominantly woman's crop (Qaim, 1999) the banana TC attracted more men who are married (87.5%). In cases of widowed females, the eldest sons make decisions in consultation with the mother. There are also extreme cases where the widowed females are not allowed to decide on some land issues and have to consult with the brothers of the deceased. This was found to be a gender disparity and was consistent with Odenya (2003) and Wambugu *et al.* (2002) findings.

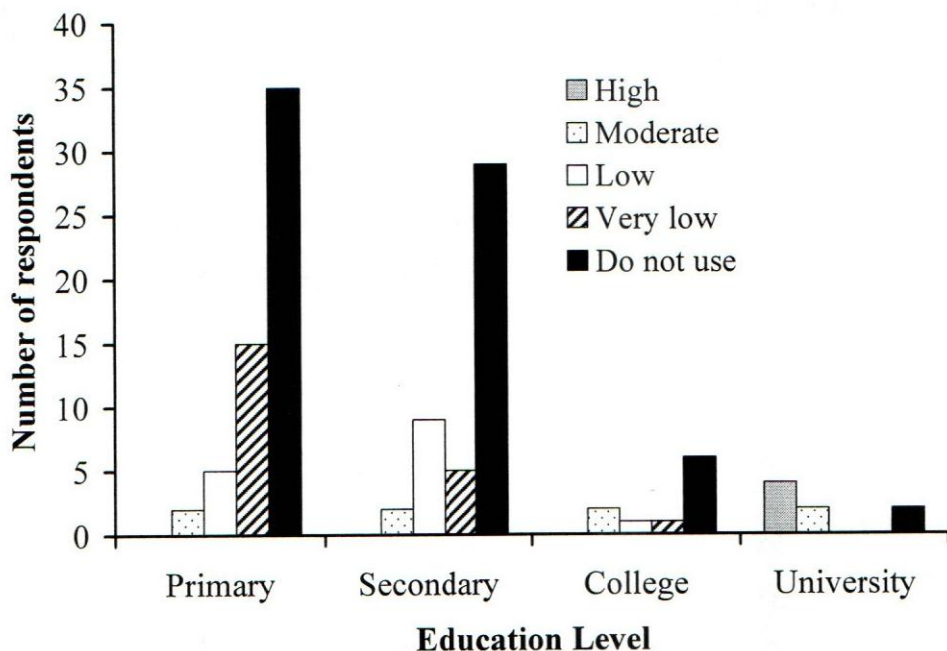
#### 4.3.4 Farmer's Education Level

The education level of farmers interviewed ranged from primary to university. Table 22 indicates that 47.5% of the respondents had received primary education, while 37.5% had received secondary education and 15% had post-secondary education.

**Table 22: Distribution of Respondents by Education level**

<b>Level of Education</b>	<b>Frequency</b>	<b>Percent</b>
Primary	57	47.5
Secondary	45	37.5
College	10	8.3
University	8	6.7
<b>Total</b>	<b>120</b>	<b>100.0</b>

A very likely expectation of such a distribution would be high adoption of this technology. This supports the assertion that education plays a strong role in determining the rates of adoption of any new technologies in developing countries because farmers with higher level of education have the ability to co-ordinate various production activities and can easily allocate resources on their farms effectively and efficiently (Amudavi, 1993; Van den Ban & Hawkins, 1999). Also these results may be due to income resulting from other jobs by highly educated farmers. Figure 9 illustrates that this was true with the respondents of this study.



**Figure 9: Distribution of Respondents' Usage of TC Banana Seedlings by their Level of Education**

#### 4.3.5 Land Tenure

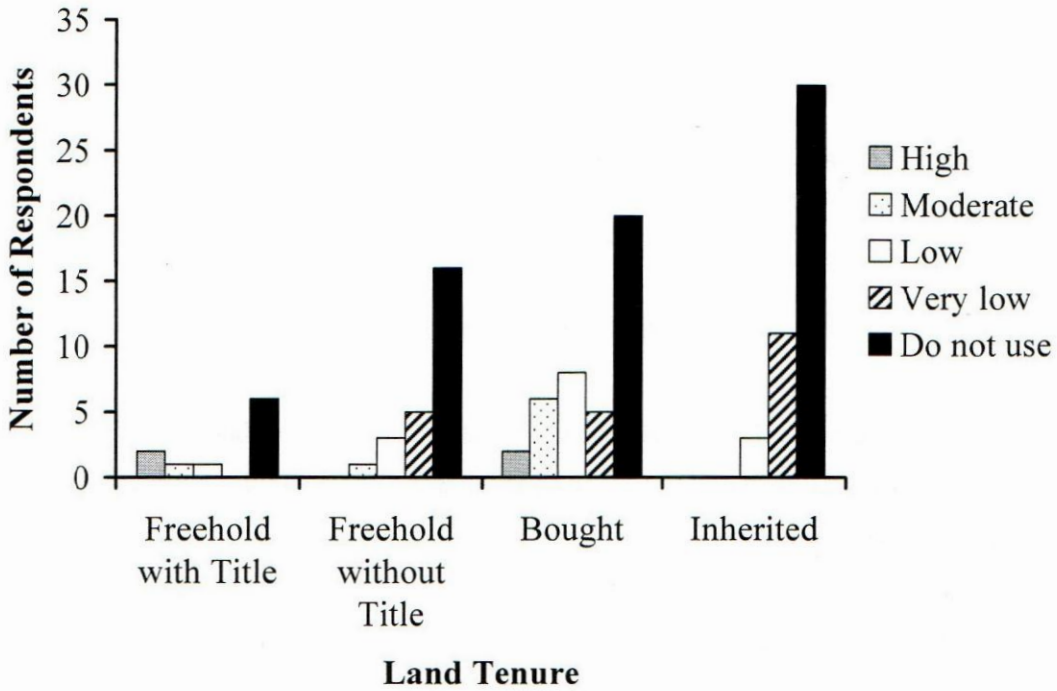
Land tenure systems in the study area include a variety of land ownership and utilization rights structures. About 8.3% of farmers interviewed had freehold tenancy with title and 34.2% bought the land. The majority (36.7%) inherited the land and 20.8% had freehold without title (Table 23)

**Table 23: Distribution by Land Tenure Systems**

Type of Land tenure	Frequency	Percent
Freehold with title	10	8.3
Freehold without title	25	20.8
Bought	41	34.2
Inherited	44	36.7
<b>Total</b>	<b>120</b>	<b>100.0</b>

Land ownership is an important factor in technology adoption. This is because farmers who own land have more control and access over farming operations than tenants and are expected to have higher adoption rates (Waghmare, 1989). Although most farmers in the study area

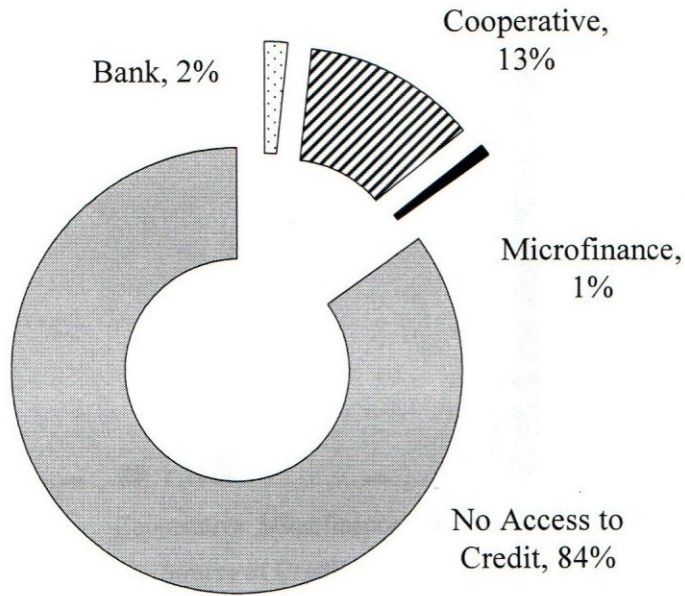
owned the land, the widespread lack of title deeds could have affected the adoption levels of TC banana technology as indicated by the relationship between adoption of TC banana seedlings and the type of land tenure in Figure 10. All the farmers interviewed who inherited their land use the TC banana seedlings at low and very low levels or do not use it at all. Those who use the seedlings at high levels belong only to the group of farmers who own their land and have title deeds or bought the land.



**Figure 10: The Relationship between TC Banana Seedlings Adoption Level and Land Tenure**

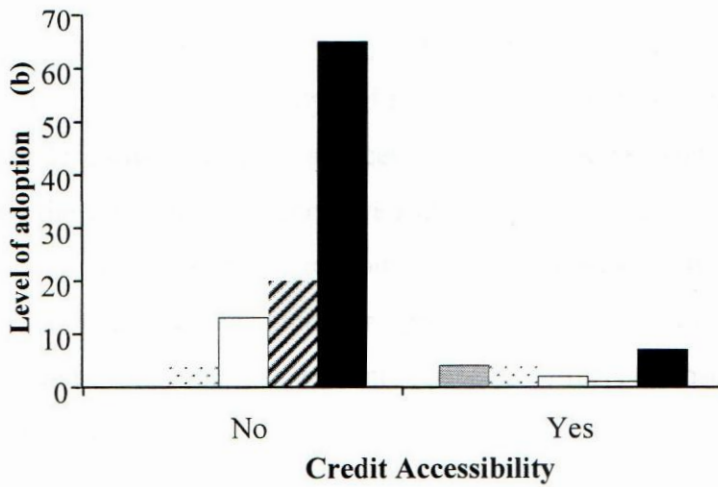
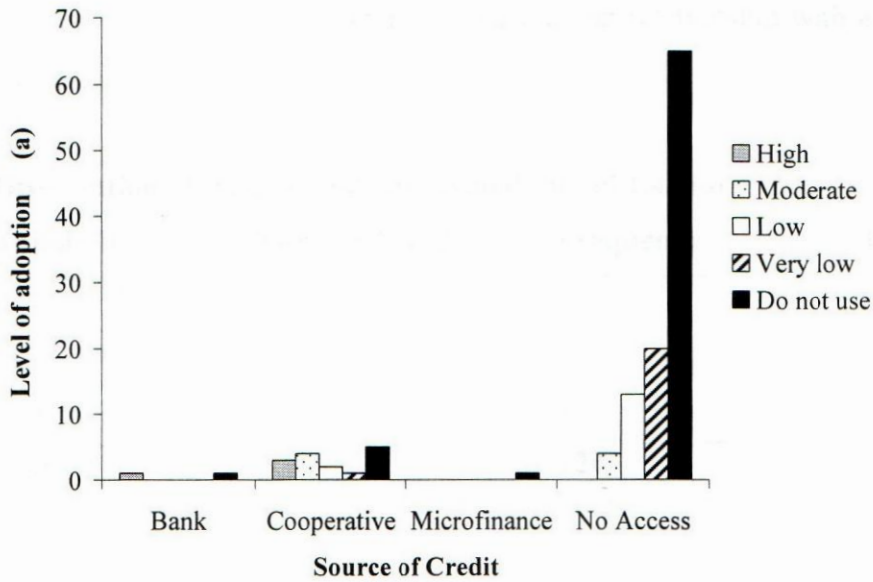
#### 4.3.6 Farmer's Access to Credit

Farmers who have access to credit are able to lessen their financial constraints. From the farmers interviewed, only 16% got credit while 84% had received none. The farmer's source of credit was mainly cooperative societies (13%) and 3% from others (Figure 11).



**Figure 11: Sources of Credit to Farmers in the Study Area**

Majority of the respondents lack access to any credit and therefore are unable to afford to purchase the necessary inputs with negative impacts on the levels of adoption of TC banana technologies that are capital intensive like irrigation, seedlings purchase, fertilizer and chemical use, desuckering and propping. For instance, Figure 12 illustrates that farmers with access to credit tend to adopt the use of TC banana seedlings more than those with no access to credit. This confirms what Qaim (1999) found that TC banana production is basically a high input, high output type of activity.



**Figure 12 a & b: The Relationship between the Credit Accessibility and Source with the Adoption Levels of TC Banana Seedlings Use**

#### 4.3.7 Labour

Farmers interviewed (78.3%) indicated to have hired 1 – 2 people to provide labour for the various banana production field activities (Table 24). About 21.7% did not hire labour since they could not afford to pay the average daily wage of Kshs. 100. However, the hired labour was not specifically for bananas alone but also for the other farm activities. This was consistent with Robinson (1996) that banana is rather seen as a security crop and receives a comparatively low priority in terms of labour and input allocation. Consequently this affects

the overall banana performance and yields but has a direct relationship with adoption of TC banana, which is labour intensive.

**Table 24: Distribution of Respondents by Availability of Labour**

<b>Availability</b>	<b>Number Hired</b>	<b>Frequency</b>	<b>Percent</b>
Not Available	0	4	21.7
Inadequate	1	106	70.0
Adequate	2	10	8.3
<b>Total</b>		<b>120</b>	<b>100.0</b>

#### 4.3.8 Farmer's Income

The sources of income, which largely depends on farmer's occupation, as well as the total income were investigated in this study and their effect on adoption of TC banana technology assessed. Table 25 shows the main sources of income for farmers in the study area while Table 26 shows the summary of descriptive statistics for income levels from banana and non-banana sources as well as off-farm sources. It is apparent that income from banana production in the study area accounts for approximately 18.29% of the total farm income. This is a significant proportion that warrants concerted efforts to ensure adoption of the more productive TC banana.

**Table 25: Distribution of Respondents by Source of Income**

<b>Source of Income</b>	<b>Frequency</b>	<b>Percent</b>
Farm produce	83	69.20
Salary	27	22.50
Business	10	8.30
<b>Total</b>	<b>120</b>	<b>100</b>

**Table 26: Descriptive Statistics of Various Farmer Incomes by Source**

Income	Min.	Max.	Mean	Std. Error	Std. Dev.
Bananas	0.00	100000.00	11578.33	1317.70	14434.71
Non-banana	1200.00	240000.00	42050.83	3477.92	38098.72
Total Farm	4000.00	1250000.00	63315.83	10750.07	117761.07
Total Off-farm	0.00	500000.00	64939.17	10807.18	118386.69

#### 4.3.9 Market for Bananas

Market for produce of agricultural commodities play a role in adoption decisions by farmers. Majority of the farmers interviewed (81.7%) sold their bananas to local middle men and traders at the farm- gate while 4.1% sold their bananas in nearby towns and only 14.2% did not sell their bananas (Table 27).

**Table 27: Distribution of Respondents by Marketing Channels**

Market	Frequency	Percent
Local/middle men	98	81.7
Urban	5	4.1
Home consumption	17	14.2
<b>Total</b>	<b>120</b>	<b>100.0</b>

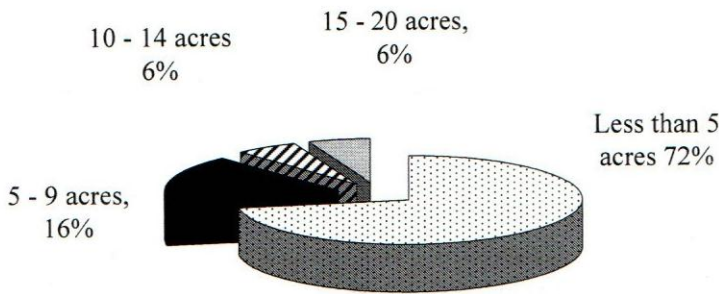
The farmers were not organized for the purposes of marketing their bananas collectively. Each of the farmers only produces small amounts of bananas at any given time, and sell in the form of complete bunches in their unripe stage to traders/brokers at fairly low prices (ksh100per bunch weighing 30kgs). Sometimes, banana bunches are sold directly by farmers in the local markets without the middle men. In rare cases, farmers also ripen the bunches on-farm for home consumption and retail the surplus to owners of small kiosks. This is an indication that farmers lack market know-how, and this further discourages them from trying to offer their bananas for sale in markets outside their district. Lack of proper marketing plans and also low prices offered by the brokers influence the adoption TC banana technology by farmers in the study area.

#### 4.3.10 Farm Size

Table 28 shows the summary of descriptive statistics concerning farm sizes and sizes of banana farms. The mean size of farmlands under banana in the study area was found to be 0.68 acres. This represents 15.45% of the mean acreage in the study area. As shown in Figure 13, majority of the small-scale farmers interviewed own small farms less than 5 acres.

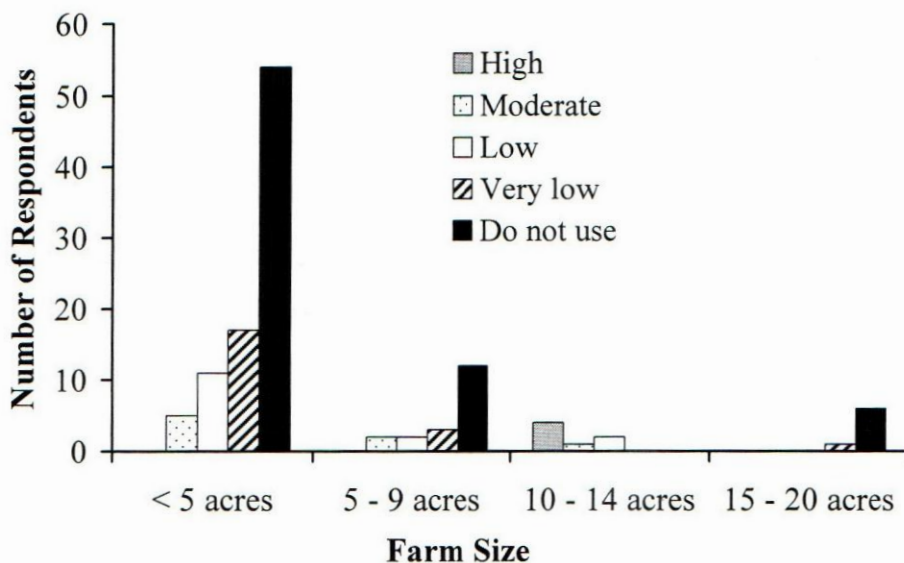
**Table 28: Descriptive Statistics for Farm Sizes in the Study Area**

	N	Min.	Max.	Mean	Std. Error	Std. Dev.
Farm size	120	0.5	20	4.40	0.36	3.91
Banana Farm size	120	0.1	4.0	0.68	0.056	0.61



**Figure 13: Distribution of Respondents According to Farm Sizes**

Farm size is directly related to acreage that farmers are willing to put under crops such as bananas. It therefore may influence the level of adoption of the given crop. In the study area farm size relates to adoption of specific technologies and practices of TC banana as indicated in Table 29.

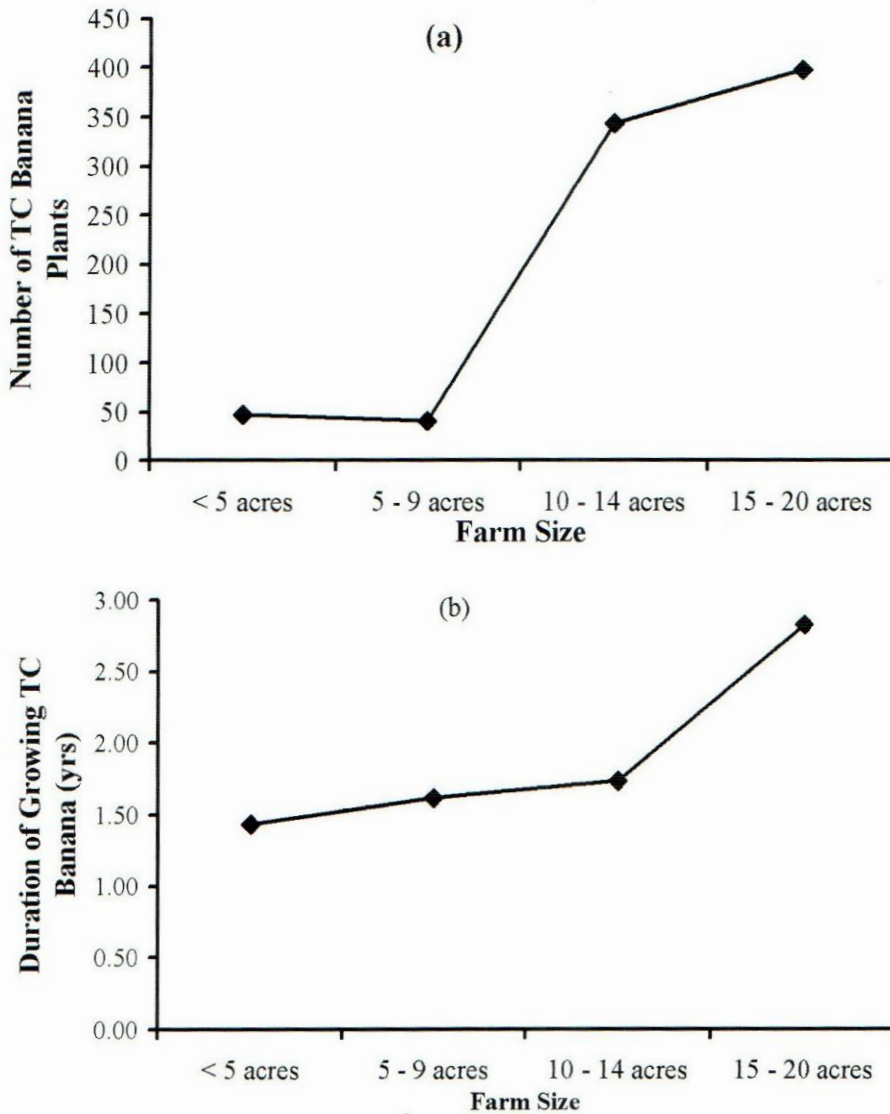


**Figure 14: Distribution of Farmers owning different Farm Sizes with different Levels of Adoption of TC Banana Technologies and practices**

**Table 29: The Summary of Descriptive Statistics Showing the Relationship between Farm Size and Adoption parameters - (a) Number of TC Banana Plants Planted; and (b) Duration of Growing TC Banana**

Adoption Parameter	Farm Size	N	Mean (plants)	Std. Dev.	Std. Error of Mean
Number of TC Banana plants	< 5 acres	70.60	46.84	5.02	70.60
	5 - 9 acres	75.00	40.52	9.30	75.00
	10 - 14 acres	424.71	343.36	129.78	424.71
	15 - 20 acres	435.00	398.42	150.59	435.00
	<b>Total</b>		<b>113.21</b>	<b>170.71</b>	<b>15.58</b>
(b) Duration of Planting TC bananas	< 5 acres	3.08	1.43	0.15	3.08
	5 - 9 acres	4.05	1.61	0.37	4.05
	10 - 14 acres	3.00	1.73	0.65	3.00
	15 - 20 acres	4.00	2.83	1.07	4.00
	<b>Total</b>		<b>3.28</b>	<b>1.61</b>	<b>0.15</b>

There is an apparent trend in the link between farm size and the two indicators of TC banana adoption shown in Table 29. Farmers owning larger farm sizes tend to plant more banana plants as indicated by the over 700 TC banana plants per farm planted by farmers with over 10 acres. The period in which the respondents have grown TC banana, as an indicator of TC banana adoption, also closely follows the farm size trend. Figure 15 shows these two trends and is a reflection of the S-shaped curve of adoption (Rogers, 1995). This is with the obvious assumption that the size of farms is directly related to stage of adoption.



**Figure 15: Relationship between Farm Size and Selected TC Banana Adoption indicators - (a) Number of TC Banana Plants and (b) Duration of Growing TC Banana**

#### 4.4 The Influence of the NYS-YFU Outreach Programme on the Adoption of TC Banana Technology

The third objective sought to determine the influence of the NYS – Yatta field Unit outreach programme on the adoption of TC banana technology by the neighbouring small-scale farmers. This variable was assessed by asking farmers

- The distance of their homesteads from NYS
- Whether the farmers have attended courses organised by the NYS-Yatta Field Unit
- The mode of learning used
- Whether the NYS-Yatta Field Unit staff visited their farmers
- Whether other extension staff visited their farms. These are described below.

The following sections discuss the findings of the study that relate to the extent to which the farmers in the study area have had contact with extension services offered by NYS-YFU based on the above indicators and how this contact has influenced the adoption of TC banana technologies.

##### 4.4.1 Farmer's Visit to NYS – YFU

Table 30(a) shows that 75.8% of the respondents had never visited or attended any courses organised by NYS-YFU. Only 24.2% of the respondents had visited the unit, of which 17.5% attended during open days, 5.9% visited during a field tour, and only 0.8% attended during the on-spot-course (30b).

**Table 30(a): Distribution of Respondents by Visits to NYS-YFU**

Visited NYS-YFU	Frequency	Percent
Yes	29	24.2
No	91	75.8
<b>Total</b>	<b>120</b>	<b>100.0</b>

**Table 30(b): Distribution of Respondents by Methods of Contact**

<b>Methods of Contact</b>	<b>Frequency</b>	<b>Percent</b>
Open days	21	17.5
Field Tours	10	5.9
On-Spot-Course	2	0.8
No Method	67	75.8
<b>Total</b>	<b>120</b>	<b>100.0</b>

It is therefore clear that despite the existence of the unit in the study area, most farmers do not visit the station. The station should encourage the local farmers to visit the station on special days to enhance dissemination of existing and future technologies to the neighbouring farmers. The study investigated if there is any apparent link between contact between the station and adoption of TC banana technologies (Table 31).

**Table 31: Percentage of Respondents who have visited the NYS-YFU on Open Days in Relation to their Levels of Adoption of various TC Banana Technologies<sup>1</sup>**

	Attendance of Open Days at NYS-YFU							
	No				Yes			
	H	M	L	D	H	M	L	D
TC banana seedlings	0.00	9.52	0.00	90.48	4.40	6.59	38.46	50.55
Recommended spacing	19.05	66.67	9.52	0.00	24.18	61.54	14.29	0.00
Fertilizer/manure application	19.05	47.62	33.33	0.00	6.59	53.85	39.56	0.00
Watering (irrigation)	4.76	47.62	47.62	0.00	1.10	21.98	75.82	1.10
Desuckering	0.00	4.76	85.71	9.52	2.20	10.99	75.82	10.99
Propping	0.00	4.76	61.90	33.33	0.00	4.40	51.65	43.96
Pest and disease control	0.00	0.00	14.29	85.71	0.00	0.00	7.69	92.31
Weeding	0.00	61.90	38.10	0.00	4.40	45.05	50.55	0.00
Pruning	4.76	23.81	66.67	4.76	1.11	18.89	70.00	10.00

Those farmers who have attended at least an open day at the station tend to adopt the technologies of TC banana to a relatively higher level compared to those who have not visited the station.

#### 4.4.2 NYS – Staff Visit to Farmers

Table 32 indicates a minority (18.3%) of the respondents having received NYS-Staff on their farm, only once in a year, while the majority 81.7% as never been visited by NYS-Staff. Given that the frequency of farmers' visits to NYS – YFU and NYS – Staff visits to farmers is quite low in the study area, it is unlikely that the NYS – Outreach programme would have an influence on the level of adoption of TC banana technology. However, the nearest farmers to the NYS-YFU, (49.2%) who constituted farmers within a distance of 0.5 Km to 10 Km benefited by either visiting the unit or being visited, and obtaining their banana planting materials. Table 33 summarizes the relationship between the number of farmers who use different planting materials and the distance of their homesteads from the station. Farmers

<sup>1</sup> The levels of usage of the TC banana technologies include H – high, M – moderate, L – low, and D – do not use.

closer to the station obviously use planting materials from the station more than those living further from the station.

**Table 32: Distribution of Respondents Visited by NYS-Staff**

Visited	Frequency	Percent
Yes	22	18.3
No	98	81.7
<b>Total</b>	<b>120</b>	<b>100.0</b>

**Table 33: Distribution by Homestead Distance from NYS-YFU**

Distance from Station	Source of Planting Materials					Total
	NYS-YFU	FSHG	KARI	JKUAT	Friends and Neighbours	
0.5 -1 KM	3	0	0	0	0	3
2 - 5 KM	12	3	2	1	6	24
6 - 10 KM	12	4	0	2	14	32
11 - 15 KM	4	9	1	0	13	27
16 -20 KM	3	9	0	0	6	18
21 -30 KM	0	16	0	0	0	16
<b>Total</b>	<b>34</b>	<b>41</b>	<b>3</b>	<b>3</b>	<b>39</b>	<b>120</b>

#### 4.5 Farmers' Perceptions towards TC Banana Technology

The fourth objective sought to determine the relationship between the perceptions of small-scale farmers of TC banana technology and the adoption of the technology. The likert scale containing ten statements or aspects of TC banana production was used to measure farmer's perception and the results are presented in Table 34.

**Table 34: Farmers Perceptions towards TC Banana Technology Characteristics**

	N Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Error	Std. Deviation Statistic
Compatibility	120	3	5	4.375	0.03463	0.379352
Relative advantage	120	3.25	4.75	4.31875	0.038572	0.422531
Complexity	120	3	5	4.241667	0.042663	0.467351
Observability	120	2	5	4.466667	0.066876	0.732594
Trialability	120	3	5	4.375	0.04743	0.519575

An important determinant of adoption by members of a social system is the way they perceive various attributes of a technology (Rogers 1995). Table 34 indicates that farmers had a strong perception on all the characteristics of TC banana technology such include, compatibility (4.375) felt that the TC banana fits well with other farming activities ,on relative advantage(4.318) felt that the TC bananas are more marketable than the local varieties, yield more and fetch higher prices as compared to the local varieties and also that the TC seedlings were expensive especially for the resource – poor farmers and this affected the adoption of the technology; on complexity(4.241) indicated that the banana plantlets require more management practices as compared to the local varieties.(4.466) felt that the TC banana technology was visible, that is they could easily see its benefits as opposed to the local varieties. And (4.375) reported that the technology can be tried on a small scale.

## 4.6 Analysis of Hypotheses

### 4.6.1 Hypothesis Testing for Socio-Economic factors.

The null hypotheses tested stated, “There was no statistically significant relationship between farmers’ socio-economic characteristics and adoption of TC banana technology”. The socio-economic factors were operationalised through farmer’s age, gender, educational level, farm size, land tenure, source of income, hired labour, credit availability and market. The results of cross tabulation tests, using chi-square statistic, are presented below.

#### 4.6.1.1 The Influence of Farmer’s Gender on Adoption of TC Banana Technology

Table 35 indicates that the farmer’s gender significantly influences adoption of TC technology as measured by the use of TC seedlings. The null hypothesis was, rejected ( $\chi^2 = 10.913$ ;  $df = 4$ ;  $p = 0.025$ ). This implied that there is significant relationship between gender and adoption of TC banana technology. This finding was inconsistent with Qaim (1999) that banana is predominantly women’s crop, moreover, it supported Wambugu *et al.* (2002) who

found out that decisions regarding TC banana technology are often made based on gender. This could be attributed to control of farm resources, where the TC banana attracted more men who as household heads make decisions on what is to be planted unlike the women who only have access to the use of land but do not have control.

**Table 35: Chi-square Results of Adoption of TC Banana Technology by Gender**

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.913(a)	4	.025
Likelihood Ratio	11.436	4	.022
Linear-by-Linear Association	.832	1	.362
N of Valid Cases	120		

#### 4.6.1.2 Farmers' Level of Education

The educational level of the farmer did have an influence on the adoption of TC banana technology. Table 36 indicates that the farmer's level of education significantly influences adoption of TC technology as measured by the use of TC seedlings. The null hypothesis was rejected ( $\chi^2 = 74.697$ ;  $df = 12$ ;  $p = 0.000$ ). This result concurs with Lionberger (1982) and Robinson (1996) that adoption can be influenced by adopter's level of education, especially when an individual has a positive attitude towards the technology. There is some impact of education on adoption as majority of the farmers had attained at least primary level education. Higher adoption levels are almost always associated with more than eight years of schooling (Lionberger, 1982). These findings concurs with those found by a World Bank (1992) evaluation of T & V that high levels of education among Kenyan household heads accounted for earlier and higher adoption of all farming practices.

**Table 36: Chi-square Results of Adoption of TC Banana Technology by Farmer's Level of Education**

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	74.697(a)	12	.000
Likelihood Ratio	40.467	12	.000
Linear-by-Linear Association	18.302	1	.000
N of Valid Cases	120		

#### 4.6.1.3 Adoption of TC Banana Technology by Farmer's Marital Status

Table 37 indicates that marital status does not significantly influence farmers' level of adoption of TC banana technology ( $\chi^2 = 13.247$ ;  $df = 16$ ;  $p = 0.655$ ) in the study area. This finding was inconsistent with Odenya (2003) who found out that married men and women were more supportive of the technology than the non-married. In this study, the different categorization used for farmers' marital status could have resulted into the lack of evidence to support a significant relationship between marital status and adoption.

**Table 37: Chi-square Results of Adoption of TC Banana Technology by Marital Status**

	Value	df	Asymp. Significant (2-sided)
Pearson chi-square	13.247 (a)	16	0.655
Likelihood Ratio	15.132	16	0.515
Linear-by-linear Association	23.535	1	0.111
N of valid cases	120		

#### 4.6.1.4 Influence of Land Tenure on Adoption

Farmers who own land have more control over farming operations than tenants. Thus they can easily make decisions to adopt or not to adopt new technologies (Waghmare, 1989). Table 38 indicates a significant influence of land tenure on adoption of TC banana technology ( $\chi^2 = 26.332$ ;  $df = 12$ ;  $p = 0.010$ ). The null hypothesis was therefore rejected that there was a significant relationship between the adoption of TC banana technology and the land tenure system. The result is consistent with Lionberger (1982) and Qaim (1999) and inconsistent with current *et al.* (1995) and Odenya (2000) who found out that adoption of

agricultural innovations was not influenced by the farmers land tenure system. Majority of the farmers had inherited their land from parents and the other family members hand rights to farm on their ancestral land. Also the small land sizes influenced adoption since they could not be sub-divided for issuance of title deeds.

**Table 38: Chi-square Results of Adoption of TC Banana Technology by Farmers Land Tenure System**

	Value	df	Asymp. Significant (2-sided)
Pearson chi-square	26.332(a)	12	0.010
Likelihood Ratio	27.736	12	0.006
Linear-by-linear Association	3.358	1	0.067
N of valid cases	120		

#### 4.6.1.5 Farmer's Main Source of Income

Table 39 indicates that the farmer's source of income significantly influenced the farmers adoption of TC banana technology ( $\chi^2 = 27.157$ ;  $df = 8$ ;  $p = 0.001$ ). The null hypothesis was rejected, as there was a significant relationship between adoption of TC banana technology and the farmer's main source of income. The result is consistent with Lionberger *et al.* (1982) and this can be attributed to the fact that the use of the technology entails a considerable high cost of production and therefore farmers with other sources of income can afford and adopt more than those without which was true for the study area.

**Table 39: Chi-square Results of Adoption of TC Banana Technology and the Farmer's Sources of Income**

	Value	df	Asymp. Significant (2-sided)
Pearson chi-square	27.157 (a)	8	0.001
Likelihood Ratio	27.945	8	0.000
Linear-by-linear Association	1.776	1	0.183
N of valid cases	120		

#### 4.6.1.6 Hired Farm Labour

Technologies can either be labour intensive or labour saving. Those that are labour saving are adopted faster than those which are labour demanding (Amudavi, 1993). Table 40 indicates that hired labour significantly influenced farmers' adoption level of TC banana technology ( $\chi^2 = 48.307$ ;  $df = 24$ ;  $p = 0.002$ ). The null hypothesis was rejected, as there was significant relationship between adoption of TC banana technology and hiring of labour for farm activities. The implication is that hiring of labour influenced the adoption of TC banana technology. This result was consistent with KARI (1999) that cost of hired labour was fairly high for resource – poor small-scale farmers and many of the farm households are producing bananas under conditions of relative labour shortages.

**Table 40: Chi-square Results of Adoption of TC Banana Technology by Hiring of Labour**

	Value	df	Asymp. Significant (2-sided)
Pearson chi-square	48.307 (a)	24	0.002
Likelihood Ratio	43.330	24	0.009
Linear-by-linear Association	9.786	1	0.002
N of valid cases	120		

#### 4.6.1.7 Availability of Credit

Table 41 indicates that credit has a significant influence on adoption of TC banana technology ( $\chi^2 = 33.685$ ;  $df = 4$ ;  $p = 0.000$ ). This was an indication that credit influenced the adoption of the TC banana technology. The null hypothesis was rejected, as there was significant difference between adoption and credit availability. Although majority of farmers interviewed had small land sizes and lacked title deeds to access credit from financial institutions, credit was found necessary to meet their financial obligation. This result was consistent with Wambugu *et al.* (2002) and Qaim (1999) that there was a high demand for credit, yet the majority of rural communities had no access to any credit and even when surplus cash is available, especially during the harvest season, it remains outside the formal financial system.

**Table 41: Chi-square Results of Adoption of TC Banana Technology by Availability of Credit**

	Value	df	Asymp. Significant (2-sided)
Pearson chi-square	33.685(a)	4	0.000
Likelihood Ratio	24.612	4	0.000
Linear-by-linear Association	19.678	1	0.000
N of valid cases	120		

#### 4.6.1.8 Marketing

Table 42 indicates that marketing has a significant influence of farmers' adoption of TC banana technology ( $\chi^2 = 59.630$ ;  $df = 8$ ;  $p = 0.000$ ). The general tendency was to have higher adoption with commercial orientation. Farmers with high commercial orientation are more receptive to innovative ideas because their goal is to increase their production (Dasqupta, 1989). This study revealed that majority of the farmers sold their bananas locally, mostly to middle traders who exploited them which concur with what Mbogoh (2001) found out.

**Table 42: Chi-square Results of Adoption of TC Banana Technology by Market**

	Value	df	Asymp. Significant (2-sided)
Pearson chi-square	59.630 (a)	8	0.000
Likelihood Ratio	27.284	8	0.001
Linear-by-linear Association	6.703	1	0.010
N of valid cases	120		

#### 4.6.2 Hypothesis Two

The hypothesis tested stated that “there was no significant relationship between the NYS Yatta Field Unit outreach programme and adoption of TC banana technology among the neighbouring small-scale farmers”. The outreach programme was determined by:

- (a) The distance from the farmer’s homestead to the NYS Yatta Field Unit,
- (b) Farmer’s visits to NYS – Yatta Field Unit for courses/field tours or open days,
- (c) No. of farmers obtaining TC banana planting materials from NYS – Yatta Field Unit,
- (d) Frequency of NYS – YFU staff visits to neighbouring farmers.

The results of chi-square statistic tests are presented in the following sections

##### 4.6.2.1 Distance of Homestead from NYS-YFU and Planting of TC Banana

Table 43 indicates a significant relationship between distance of farmer’s homestead from NYS-YFU and planting of TC bananas ( $\chi^2 = 65.379$ ;  $df = 20$ ;  $p = 0.000$ ). Hence the null hypothesis that, there was no significant relationship between adoption of TC bananas by farmers within the proximity and those living at a distant was rejected. Table 44 shows that majority (71.7%) of the farmers living within 0.5 to 10 kms planted more TC bananas than those (28.3%) farmers living 16 kms and beyond.

**Table 43: Chi-square Tests of the Relationship between Distance of Homestead from NYS-YFU and Planting of TC Banana**

	Value	df	Asymp. Significant (2-sided)
Pearson chi-square	65.379 (a)	20	0.000
Likelihood Ratio	72.691	20	0.000
Linear-by-linear Association	3.351	1	0.067
N of valid cases	120		

#### 4.6.2.2 Distance of Homestead from NYS-YFU and Source of Planting Materials

Table 44 shows that the null hypothesis that there was no statistically significant relationship between the farmer's homestead distance from NYS and the source of planting materials was rejected ( $\chi^2 = 66.534$ ;  $df = 20$ ;  $p = 0.000$ ). These findings could be attributed to the fact that, those farmers living within the proximity of the NYS –Yatta Field Unit (0.5-10 km) obtained their planting materials from the station as compared to those living beyond 10km.

**Table 44: Distance Homestead from NYS-YFU and Source of Planting Materials**

Homestead Distance from NYS	Source of Planting Materials						Total	
	NYS Field Unit	Yatta	Farmer Help Groups	Self-	KARI	JKUAT		Friends/ Neighbours
0.5 – 1 Kms	3		0		0	0	0	3
2 – 5 Kms	12		3		2	1	6	24
6 – 10 Kms	12		4		0	2	14	32
11 – 15 Kms	4		9		1	0	13	27
16 – 20 Kms	3		9		0	0	6	18
21 – 30 Kms	0		16		0	0	0	16
Total	34		41		3	3	39	120

#### Chi-Square Tests

	Value	df	Asymp. Significant (2-sided)
Pearson chi-square	66.534(a)	20	0.000
Likelihood Ratio	239	20	0.000
Linear-by-linear Association	0	1	0.997
N of valid cases	120		

#### 4.6.2.3 Farmer's visit to NYS-YFU for Courses/Open days/Tours

Table 45 indicates that there is a significant influence of farmers' visits to NYS-YFU for courses/open days/tours on adoption of TC banana technology ( $\chi^2 = 16.082$ ;  $df = 4$ ;  $p = 0.003$ ). The null hypothesis was rejected and the alternate hypothesis accepted that there was a significant relationship between the adoption of TC bananas and farmer's visit to the NYS-Yatta Field Unit.

**Table 45: Chi-square Results on Farmer's visit to NYS-Yatta Field Unit for Courses or during Open Days.**

	<b>Value</b>	<b>df</b>	<b>Asymp. Significant (2-sided)</b>
Pearson chi-square	16.082 (a)	4	0.003
Likelihood Ratio	22.189	4	0.000
Linear-by-linear Association	7.158	1	0.007
N of valid cases	120		

The extent to which farmers make contact with institutions for technology transfer influences farmer's consciousness and outlook towards adoption of new agricultural technologies.

#### **4.6.2.4 Frequency of NYS-YFU Staff Visit to Neighbouring Farmers to Disseminate TC Banana Technology**

Table 46 indicates that there is a significant influence of NYS-YFU staff visits to neighbouring farmers to disseminate TC banana technology and adoption of the technology ( $\chi^2 = 70.921$ ;  $df = 4$ ;  $p = 0.000$ ). The null hypothesis was rejected because there was a significant influence of the NYS – Staff visit on adoption of TC banana technology among the neighbouring small-scale farmers. This can be explained by the fact that, although the NYS-YFU staffs visits farmers less frequently, those farmers who are visited show a higher level of adoption than those who are never visited.

**Table 46: Chi-square Results on Frequency of NYS – YFU Staff Visit to Disseminate TC Banana Technology to the Neighbouring Farmers**

	<b>Value</b>	<b>df</b>	<b>Asymp. Significant (2-sided)</b>
Pearson chi-square	70.921 (a)	4	0.000
Likelihood Ratio	70.334	4	0.000
Linear-by-linear Association	33.604	1	0.000
N of valid cases	120		

### 4.6.3 Hypothesis Three

The hypothesis tested stated that “there is no statistically significant relationship between farmer’s perception of the TC banana technology and adoption of the technology”. The findings are summarized on Table 47. The results indicate that there was no relationship between farmers’ perception of TC banana technology characteristics and the adoption of the selected TC banana technologies. The TC characteristics (attributes) surveyed were, relative advantage, compatibility, complexity, observability and trialability against selected TC banana technologies (namely, use of TC seedlings, use of recommended spacing, application of fertilizers or manure, watering, desuckering, propping, pests & disease control, weeding and pruning). This may be because many farmers did not know much about the TC banana varieties as compared the local ones. As a result they were unable to compare the two varieties on the basis of other attributes considered.

This lack of relationship may be also due to the fact that farmers are well aware of the TC banana technology and the accruing benefits but do not adopt because of other factors, for example, cost of inputs. The latter explanation is supported by other authors, Parton (1993); Byerlee and Hesse de Polanco, (1986) that farmers might adopt a certain component of a technology package, while refusing another component or adopting it at a later stage, depending on subjective profitability and risk considerations. For instance, a banana grower may buy TC plantlets without exactly following the recommendations for regular desuckering, or for the amount of manure and fertilizer to apply. These findings are consistent with those of Sachs (1993), KARI, (1999) and Wambugu *et al.*, (2002).

**Table 47: Farmer's Perceptions towards Selected TC Banana Technologies as Related to Adoption**

Variable	X <sup>2</sup> Cal.	df	P-value
1. TC Banana Compatibility			
▪ Use of TC seedlings	15.002	12	0.241
▪ Use of recommended spacing	10.700	12	0.555
▪ Fertilize/Manure application	1.825	9	0.994
▪ Watering	9.358	12	0.672
▪ Desuckering	19.590	12	0.075
▪ Propping	10.451	9	0.315
▪ Pests & Disease control	2.821	6	0.831
▪ Weeding	2.028	9	0.991
▪ Pruning	8.195	12	0.770
2. TC banana relative advantage			
▪ Use of TC seedlings	8.329	16	0.938
▪ Use of recommended spacing	16.484	16	0.420
▪ Fertilize/Manure application	8.168	12	0.772
▪ Watering	10.977	16	0.811
▪ Desuckering	22.160	16	0.138
▪ Propping	11.082	12	0.522
▪ Pests & Disease control	1.651	8	0.990
▪ Weeding	5.381	12	0.944
▪ Pruning	14.834	16	0.537
3. TC banana complexity			
▪ Use of TC seedlings	6.070	8	0.639
▪ Use of recommended spacing	9.762	8	0.282
▪ Fertilize/Manure application	3.544	6	0.738
▪ Watering	5.368	8	0.718
▪ Desuckering	21.387	8	0.625
▪ Propping	7.063	6	0.488
▪ Pests & Disease control	0.935	4	0.919
▪ Weeding	1.479	6	0.961
▪ Pruning	4.962	8	0.762
4. TC banana trialability			
▪ Use of TC seedlings	6.066	8	0.173
▪ Use of recommended spacing	2.674	8	0.953
▪ Fertilize/Manure application	9.120	6	0.167
▪ Watering	8.220	8	0.412
▪ Desuckering	8.347	8	0.400
▪ Propping	7.169	6	0.305
▪ Pests & Disease control	0.291	4	0.990
▪ Weeding	7.111	6	0.311
▪ Pruning	6.870	8	0.551
5. TC banana observability			
▪ Use of TC seedlings	3.146	12	0.994
▪ Use of recommended spacing	10.233	12	0.596
▪ Fertilize/Manure application	5.299	9	0.808
▪ Watering	6.638	12	0.881
▪ Desuckering	9.852	12	0.629
▪ Propping	6.344	9	0.705
▪ Pests & Disease control	6.869	6	0.333
▪ Weeding	4.571	9	0.870
▪ Pruning	20.930	12	0.551

#### **4.7 Summary of the Findings**

The results of the study illustrate that 40% of the farmers adopted the TC banana technology with majority of the adopters (60.8%) using TC banana suckers as opposed to 39.2% using TC seedlings. The farmers practise the selected TC technologies at various levels, where 62.5% used the recommended spacing, 61.7% of the farmers prefer using manure. 99.2% of the farmers irrigate their crop, but only 28.3% use the recommended watering frequency. Desuckering is rarely carried out and the tendency is to find many suckers under one stool. Propping is poorly practised (4.2%). This is because of farmers' preference of the medium and short banana varieties as well as inadequate labour. Majority of the farmers (91.7%) do not control pests and diseases although those growing TC bananas agree that they have few if no pests and diseases. Weeding and pruning are practised at 3.3% and 22.5% respectively with labour inadequacy being a major contributing factor to low levels of these practices.

The socio-economic factors affecting adoption of TC banana technologies were identified as level of education, gender, land tenure, source of income, hired labour, credit availability and market. However, marital status and age were not significant to the adoption of TC banana technology. The results also indicate that the distance from NYS-YFU to the farmer's homestead did influence the adoption of TC banana technology. There was significant influence of the NYS-YFU out-reach programme on the adoption of TC banana technology among the neighbouring small-scale farmers. The farmer's perception of TC banana technology had no significant relationship with the adoption of technology. The lack of credit, information on TC banana technology, small land sizes, inconsistent supply and high prices of TC banana seedlings were identified as the major constraints to adoption of TC banana technology.

## CHAPTER FIVE

### SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Introduction

This chapter summarises the results of the study based on the outlined objectives and the hypotheses as stated in the document. It then draws conclusions and makes recommendations on the possible way forward and interventions for various stakeholders that would enhance adoption of TC banana technologies in the study area and elsewhere.

#### 5.2 Summary

There are several ways that poverty alleviation goals and food security strategies can be achieved in Kenya. One of them is to increase agricultural productivity per unit area of land. Among the agricultural crops that show great potential for increased productivity is the banana (*Musa sp.*). Indeed, the introduction and adoption of tissue-culture (TC) banana technology by small-scale farmers is considered a viable choice towards this end.

However, low levels of adoption or no adoption has led to low land productivity even in TC banana potential areas like Yatta division. The situation threatens food security, employment and income generation in banana producing areas. It is therefore prudent to address the factors affecting the adoption of TC banana technology. An investigation of these factors was the main objective of this study by exploring and analysing selected factors that influence adoption of TC banana technology by small-scale farmers neighbouring NYS-Yatta Field Unit as a response to increasing food production and farm income. The specific objectives of the study were:

1. To determine the adoption levels of the TC banana technology by small-scale farmers neighbouring NYS-Yatta Field Unit;
2. To determine the relationship between adoption of TC banana technology and the socio-economic characteristics of the neighbouring small-scale farmers;
3. To determine the influence of the NYS-Yatta Field Unit outreach programme on the adoption of TC banana technology by the neighbouring small-scale farmers; and

4. To determine the relationship between the perception of small-scale farmers of TC banana technology and their adoption of the technology.

The research adopted an ex- post facto design. The study was conducted in Kithimani location, Yatta Division in Machakos district. The target population included all small-scale farmer households along the three water sources (Yatta Canal, Athi and Thika Rivers) and only those growing bananas within 30 kms from NYS Yatta Field Unit. A total of 120 farmers were sampled using stratified random sampling technique. Data were collected using a questionnaire which was composed of direct questions, dichotomous questions as well as likert scale type with items for measurement of farmers' perceptions. The data was analysed using the Statistical Package for Social Science (SPSS) at a 5% level of significance ( $\alpha = 0.05$ ). Both descriptive statistics (percentages, frequencies, means, and standard deviation) and inferential statistics ( $\chi^2$ ) were used to analyse the data.

As far as adoption levels of TC banana technology is concerned, the results revealed that 39.2% of the respondents used TC banana seedlings and (60.8%) used TC banana suckers. The most important reasons for not using TC banana seedlings were high prices of the seedlings (the cost of one seedling ranged between 40 – 60 Kshs) and lack of a convenient supply of the seedlings. (25.0%) of the farmers did not use the recommended spacing and (38.4%) never apply manure at the recommended rate. Although (64.2%) of the farmers indicated that the fertilizers were too expensive to afford, majority indicated that they preferred to use manure to inorganic fertilizers because fertilizers “affect” the banana fruit, such that, the consumers complained of a “soggy” taste of the fruit.

A very small number (8.3%) indicated they controlled for pests and diseases. Most of the respondents (91.7%) indicated that they did not do so because they saw no pests or diseases on their banana crop. Almost all the respondents weed, irrigate, de-sucker, prune and prop their banana crop. However, the frequencies show various levels of these practices. Some 47.5% of the respondents weed at least once or twice per month and 88.3% of them associate this to inadequacy of farm labour. 99.2% of the respondents water their banana crop but some 46.7% are constrained by inadequate water especially due to distances from the source of water and the occurrence of dry spells which affects the level and volume of water for irrigation. Farmers whose farms are over 1 km face the challenge of declining water volumes

in the canals with distance from the rivers. Only 8.3% do not prune their crop, as compared to (42.5%) who never prop their crop and 11.7% who do not de-sucker at all. Those farmers who do not prop their crop indicated that they prefer planting the medium and short varieties, which rarely requires propping.

The analysis of the socio-economic characteristics of the respondents showed that the mean age was 45 and majority (87%) of the respondents were male as compared to females (33%). About 87.5% of the respondents were married and 85% had attained both primary and secondary education. The average banana farm size was found to be 0.68 acres, an indication that majority of farmers were small-scale (<0.8 acres). Although only 8.3% had freehold tenancy with the title deeds 16% had access to credit and 84% indicated that they did not use credit because they did not have title deeds for collateral as required by lending institutions. However, subsequent evidence showed that many farmers (88.3%) did not use the TC banana technologies fully because they did not have money to purchase inputs (seedlings, fertilizers, manure, pesticides/chemicals, and farm implements). Majority (81.7%) sold their bananas locally while 4.2% sold to the urban markets. Only 11.7% did not employ hired labour while 78.3% of those who hired indicated that it was expensive and inadequate.

The study revealed that the NYS-outreach programme is not having significant impact on TC banana technology adoption although farmers living closer to the unit have adopted more than the others. The results showed that farmers living within the proximity( 0.5 – 15 km) from NYS – Yatta Field Unit benefits in that ,17.5% of them attend open days, 5.8% conduct field tours to the centre and only 0.8% attend on-spot-courses. Also, 80.8% have never been visited by NYS – Staff while 47% obtain planting materials from the centre. The most important reason for not attending courses, or open days was lack of communication about the open days or courses which largely target farmers living closer to the centre. The TC banana technology is perceived as largely observable, compatible, triable, not complex and having relative advantages.

### **5.3 Conclusions**

The following conclusions have been drawn from the findings based on the objectives and hypotheses of the study:

1. The results from this study showed that close to 40% of the farmers in the study area have adopted TC banana technology. Most farmers use TC banana suckers obtained cheaply from friends, neighbours and NYS-Yatta Field Unit. Those who use the seedlings source them from self-help groups, Jomo Kenyatta University of Agriculture and Technology, or KARI – Thika Station. Regardless of the source of TC banana seedlings, the level of its adoption is low.
2. The Chi-square test showed that some of the socio-economic factors influencing adoption of TC banana technology are farmer's characteristics such as the level of education, gender, land tenure, source of income, hired labour, credit and market. However, Age and marital status, have no significant relationship with the adoption of TC banana technology.
3. The distance to NYS – Yatta Field Unit has a significant relationship to adoption of TC banana technology. Those farmers living within the proximity of the centre (0.5 – 10 km) obtain their planting material from the NYS – Yatta Field Unit. Farmer's visit to NYS Yatta Field Unit for courses, during open days or on tours had a significant influence on the adoption of TC banana technology; however, there was no significant influence of the NYS-Staff visit frequency and the adoption of TC banana technology. The NYS Yatta Field Unit outreach programme does significantly influence the adoption of TC banana technology among the neighbouring small-scale farmers.
4. The results indicate that there is no significant relationship between farmers' perception of the TC banana technology and adoption of the technology. This indication may be due to the fact that farmers are aware of the TC banana technology and the accruing benefits but do not adopt because of other factors, for example, cost and availability of inputs. This may be also because many farmers are not aware of new TC banana technologies that replaced the local varieties hence the inability to make a comparison between TC banana and non TC banana varieties.

## **5.4 Recommendations**

From the findings of the study, the following recommendations are therefore suggested:

1. In this study it was observed that the provision of credit enhances adoption. There is need to provide affordable micro-credit to TC banana small-scale farmers to enable them overcome capital related constraints such as irrigation facilities (to make banana

watering easy) and acquisition of fertilizers or organic manures to produce good banana crop.

2. There is need to ensure that there is organized and efficient marketing channels. From the study it was clear that high input prices constrain adoption. If farmers are able to make good profits after sale of their bananas, it follows that the absolute prices of inputs will not be a problem to them. However, for good banana profits to be realised the marketing channels need to be efficient. One way of doing this is by eliminating the middlemen. Also, farmers could be encouraged to form marketing associations that could insulate them against poor and fluctuating prices and also develop proper marketing plans and storage facilities as well as encourage banana value addition to enable them benefit from the increased yields which in turn may lead to enhanced adoption.
3. There is need to strengthen and improve on information flow from researchers, via dissemination channels (schools, NYS, churches, on farm trials, village lenders and linkages with small-scale farmers - end-users). This is important for adoption to occur effectively, the TC technology must be matched with appropriate field management packages and backstopped by strong and active out-reach programmes (both from the mainstream agricultural extension and other extension delivery systems like the one at NYS-YFU).

### **5.5 Suggestions for Further Studies**

The study recommends that further investigations can focus on the following aspects of adoption of TC banana technologies:

1. The effect of other factors other than those considered in this study on the adoption in the study area and other parts of Kenya where banana production is a means of achieving poverty alleviation and food as well as income security.
2. A comparative adoption study of the local banana varieties preferred by small-scale farmers as opposed to the TC banana due to their perceived suitability and superiority according to local level indicators and possibility of improving them for high productivity.

3. Integrated impact assessment of the impact of TC banana technology on the livelihoods of the small-scale farmers as would be measured by poverty, food security and other socio-economic indices.
4. Review of the indicators for monitoring and evaluating the outputs and outcomes of the NYS-YFU outreach programme with regard to TC banana technology dissemination. This would focus on the indicators of the programme's capability, effectiveness, efficiency and impacts.

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## APPENDICES

### APPENDIX A: FARM LEVEL QUESTIONNAIRE

You have been randomly selected to provide information for a study on the factors affecting adoption of tissue culture banana technology by small-scale farmers neighbouring NYS Yatta Field Unit in Machakos district. You are requested to respond to the following questions honestly and comprehensively. Your responses will be treated with utmost confidentiality.

Name of respondent: \_\_\_\_\_

Gender:

- Male  
 Female

Marital status:

- Married  
 Widow  
 Widower  
 Divorced  
 Single

Age (year born) \_\_\_\_\_

Highest Educational level

- Primary Std 1  Std 2  Std 3  Std 4  Std 5  Std 6  Std 7  Std 8   
 Secondary Form 1  Form 2  Form 3  Form 4  Form 5  Form 6   
 College  
 University  
 Other (specify) \_\_\_\_\_

6. Occupation \_\_\_\_\_

### SOCIO-ECONOMIC CHARACTERISTICS

7. What is the size of your family? \_\_\_\_\_

8. What are your main source(s) of income?

- Farm produce
- Others (Specify) \_\_\_\_\_

9. In case you get income from farm produce fill in the given table.

Source of Income (Enterprise)	Approximate Amount (Ksh/year)
Total	

10. What is your total income generated from other sources

Kshs. \_\_\_\_\_ per year

11. Size of farm (acres) \_\_\_\_\_

12. Size of the TC banana farm \_\_\_\_\_.

13. What is the land tenure of your farm?

- Freehold with title deed
- Freehold without title deed
- Leasehold
- Bought
- Rented
- Inherited
- Others (specify) \_\_\_\_\_

14. Do you have labour to assist you on farm work?

- Yes
- No

15. If yes, how many? \_\_\_\_\_

16. How much do you pay hired labour? \_\_\_\_\_

17. Do you get credit? Yes \_\_\_\_\_ NO \_\_\_\_\_

18. If yes, indicate the source of the credit

- Bank
- Co-operative Sacco
- Micro-finance
- Others (Specify) \_\_\_\_\_

19. What is the total amount received

- 49,000 and below
- 50,000 – 100,000
- 150,000 – 490,000
- 500,000 and above

20. Do you irrigate your banana crops?

- Yes
- No

21. If yes, which is your source of water?

- Yatta Furrow
- Athi River
- Thika River
- Others (specify) \_\_\_\_\_

21. What is the approximate distance to your source of water? \_\_\_\_\_

22. Do you sell banana from your farm?

- Yes
- No

23. If yes, where do you sell them: \_\_\_\_\_

24. Indicate the level of availability of the following farm inputs by ticking the appropriate box.

Input	Adequate	Inadequate	Not Available
Fertilizer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Manure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chemicals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Planting Materials	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Labour	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Farm Equipment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (Specify) _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## INFORMATION ON ADOPTION OF TISSUE-CULTURE BANANA TECHNOLOGY

25. Do you grow tissue-cultured bananas?

Yes

No

26. If yes, which planting material do you use?

Tissue-culture seedlings

Tissue-culture suckers

27. What is the source of the planting material?

NYS Yatta Field Unit

Farmer Self-Help Groups

KARI

Jomo Kenyatta University of Agriculture and technology

Other (Please Specify): \_\_\_\_\_

28. How much do you pay per seedling/sucker? \_\_\_\_\_

29. Which varieties have you planted? \_\_\_\_\_

30. Number of tissue-culture bananas planted \_\_\_\_\_

31. When did you first plant them? \_\_\_\_\_

32. To what extent do you use the Tissue Culture Banana Technologies?

Use the following Key: **VHD** – Very High Degree: **HD** - High Degree: **MD** - Middle Degree: **LD** - Low Degree: **VLD** – Very Low degree **DU** - Do not use:

Selected Tissue Banana Technologies	Extent of adoption					
	VHD	HD	MD	LD	VLD	DU
Use of TC seedlings						
Use of recommended spacing						
Application of fertilizer or Farm Yard Manure						
Watering						
Desuckering						
Propping						
Pest and Disease control						
Weeding						

Pruning.						
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**INFORMATION ABOUT NYS-FIELD UNIT OUT-REACH PROGRAMME**

33. How far is your homestead from NYS yatta field unit \_\_\_\_\_

- 0.5 – 1km
- 2 – 5km
- 6 – 10km
- 11 – 15km
- 16 – 20km
- 21 – 30km

34. Have you ever attended any open days/courses organized by NYS-Yatta Field Unit?

- Yes
- No

35. If yes, provide details in the table below.

Course	Date(s)	Topics covered.

36. Does the NYS-extension staff visit your farm?

- Yes
- No

37. If yes, how often do they visit your farm?

- Daily
- Weekly
- Monthly
- Quarterly
- Yearly
- Never

38. What messages does the staff deliver during their visit?

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39. Are there other extension staff who visits your farm?

Yes

No

40. If Yes, specify \_\_\_\_\_

41. How often do they visit your farm?

Daily

Weekly

Monthly

Quarterly

Yearly

Never

42. What message on Tissue Banana Technology do the extension staff deliver during their visit? \_\_\_\_\_

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**ATTITUDE (PERCEPTION) TOWARDS ADOPTION OF TISSUE-CULTURE BANANA TECHNOLOGY**

43. Please indicate your level of agreement with the following statements about Tissue Culture Banana Technology.

	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
1. Farmers prefer to grow tissue-culture banana varieties as compared to local varieties.					
2. The use of tissue-culture banana fits well into farming activities (including intercropping)					
3. Tissue-culture bananas are more marketable as compared to local varieties					
4. Tissue-culture bananas yields are more as compared to local					

varieties					
5. Tissues-culture bananas fetch higher prices as compared to local varieties					
6. Tissue-culture banana seedlings are expensive as compared to local varieties.					
7. Tissue-culture banana plantlets require more management practices as compared to local varieties.					
8. Tissue-culture banana plantlets can be tried on a small scale					
9. The benefits of tissue culture banana technology are more visible as compared to local varieties					
10. Tissue culture banana technology fits well with current socio-cultural practices and beliefs					

**GENERAL INFORMATION**

44. What constraints have you faced in the adoption of tissue cultured bananas

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45. In your opinion what should be done to improve the adoption of Tissue Culture Banana Technology by the farmers neighbouring NYS-Yatta Field unit to its neighbouring farmers?

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**END OF QUESTIONNAIRE  
THANK YOU**

APPENDIX B: RESEARCH PERMIT

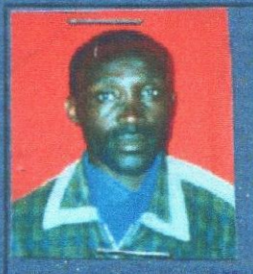
**Page 2** **Page 3**

This is to certify that: Research Permit No. MOEST 13/001/35C 15C  
Prof./Dr./Mr./Mrs./Miss MATHEW MULI WAMBUA Date of issue 20th April, 2005  
Fee received Shs. 500

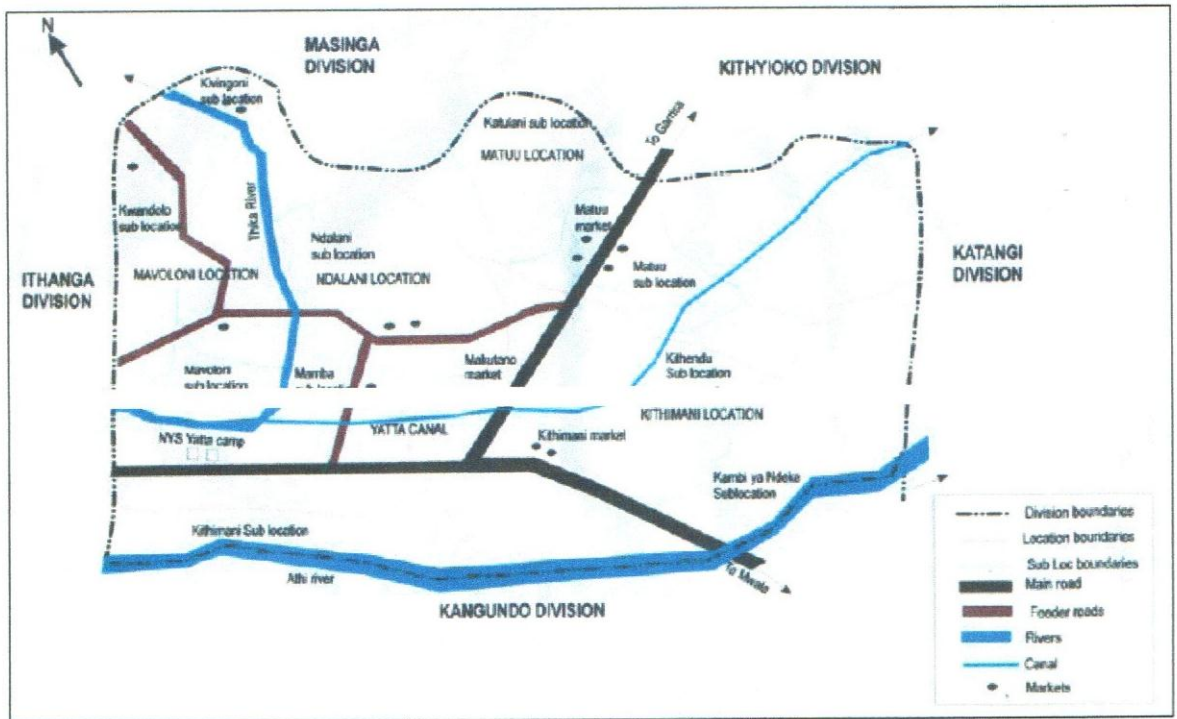
of (Address) EGERTON UNIVERSITY  
P.O. BOX 536, NJORO

has been permitted to conduct research in \_\_\_\_\_  
\_\_\_\_\_ Location,  
MACHAKOS District,  
EASTERN Province,  
on the topic FACTORS AFFECTING ADOPTION OF  
TISSUE CULTURE BANANA TECHNOLOGY BY  
SMALL SCALE FARMERS NEIGHBOURING  
NYS YATTA FIELD UNIT

for a period ending 30th April 2005

  
For PERMANENT SECRETARY  
MINISTRY OF EDUCATION  
SCIENCE AND TECHNOLOGY  
E. O. ONDIEKI  
For: Permanent Secretary  
Ministry of Education  
Science and Technology

# APPENDIX C: MAP OF YATTA DIVISION



ERTON UNIVERSITY LIBRARY