

SELECTED DETERMINANTS OF ADOPTION OF IMPROVED SUGARCANE
PRODUCTION TECHNOLOGIES BY SMALL SCALE FARMERS IN MUMIAS
DIVISION OF MUMIAS DISTRICT, KENYA

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DEDICATION

To my beloved wife Mary, my sons Argwings, and Amberg and my daughter, Ansley, for their patience and understanding during my long stay way from home. To my late farther, Ainea Makhandia and late mother, Frida Malala, for educating me. To all sons and daughters of Makhandia family who encouraged me to learn.

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ABSTRACT

Despite the introduction of improved sugarcane production technologies (ISPTs) by Kenya Sugar Research Foundation (KESREF) in Kenya, sugarcane productivity in Mumias sugar zone has been fluctuating on a downward trend with the average yield from 98.0 tons per hectare in 1998 to 6.3 tons per hectare in 2007. There are no study findings about the adoption levels and factors affecting adoption of ISPTs in Mumias district. This made it necessary for me to carry out this study. The two selected ISPTs of main concern that were studied are weed management and fertilizer application. The study analyzed the selected determinants of adoption of the two selected ISPTs and their adoption level by small scale sugarcane farmers in the division. The selected determinants were farmer's age, gender, land tenure, level of income, farm size, level of education, labour availability and frequency of extension contact with farmers. A correlation survey research design with a survey methodology was employed in this study. The target population consisted of 2196 smallholders farmers in the division from which a sample of 120 farmers, whose cane age was between one month and eight months old, was drawn. Mumias sugar company cane field registers formed the sampling frame. Researcher and trained Mumias Sugar Company (MSC) field assistants administered questionnaire and observation schedule were used to obtain data from the sampled small scale sugarcane farmers. Data were summarized by use of descriptive statistics and analyzed using Statistical Package for Social Science (SPSS) for windows, based on the study objectives and questions. Frequencies were used to determine the level of adoption of the two selected ISPTs. Multiple linear regression analysis was used to assess the selected determinants of the adoption of the two selected ISPTs basing on significance level of 0.05. The level of adoption of the two selected ISPTs varied between moderate adoption and very high adoption with over 82.5% of the farmers being very high adopters of the two selected ISPTs. The research revealed that the farmer's adoption of technologies in the study area depended very little on their socio-economic status as well as frequency of extension contact with farmers. For fertilizer application the coefficients were all insignificant, hence relative contribution to ISPTs adoption was also insignificant at 0.05 level of significance. For weed management all the coefficients were insignificant except that of land tenure whose relative contribution was thus significant at 0.05 level of significance. The research also revealed that the fluctuating sugarcane yields in the study area could be due to other factors not studied, but not the adoption levels of ISPTs since over 82.8% of the farmers were very high adopters.

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LIST OF ABBREVIATIONS AND ACRONYMS

BATs	Broker McConnel Agricultural technical Services
COMESA	Common Market for East and Southern Africa
GOK	Government of Kenya
ISPT	Improved Sugarcane Production technology
KARI	Kenya Agricultural Research Institute
KESREF	Kenya Sugar Research Foundation
KSB	Kenya Sugar Board
MoA	Ministry of Agriculture
MOCO	Mumias Out grower Company
MoLFD	Ministry of Livestock and Fisheries and Development
MSC	Mumias Sugar Company
SDL	Sugarcane Development Levy
SPSS	Statistical Package for Social Sciences

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Improved Sugarcane Production Technology (ISPTs) are technologies that were researched and documented by Kenya Sugar Research Foundation (KESREF) for the purpose of improving sugarcane yields as well as quality. Since inception of sugar research in Kenya, there is no documented work on the adoption of ISPTs in Mumias division. The information on factors determining the adoption of the ISPTs and their adoption level is lacking. Despite the introduction of the ISPTs, the sugarcane production in Mumias division has continued to fluctuate on the downward trend for the last 10 years. The basic technologies tested and released for cane production include new varieties, Improved sugarcane production technologies, pest and disease management strategies (Wawire *et al.*, 2006). The technology transfer process was undertaken by Kenya Sugar Research Foundation (KESREF) extension officers through joint extension programmes with millers and out grower companies. The ISPTs that were introduced by KESRE were; land preparation, planting, weed management, fertilizer application and trash management. The two selected ISPTs for this study were; weed management and fertilizer application since they applied to both plant and ratoon sugarcane crop classes. The selected determinants of adoption of these selected ISPTs and their level of adoption among the small scale sugarcane farmers in Mumias division were investigated. During 2001, Kenya Sugar Board Research Foundation (KESREF) was established as a premier provider of research, development and extension services in the sugar industry, in collaboration with the sugar companies and other relevant stakeholders. Improved sugarcane production technologies are technologies aimed at improving sugarcane yields as well as cane quality at harvest time. These technologies were researched and documented by the sugar industry research arm in order to boost cane yields which had declined to a considerable level.

The introduction of sugarcane growing ushered in small scale sugarcane farming in the division. Feasibility studies for growing sugarcane in the region were done by a United Kingdom-based agricultural firm, Booker McConnel Agricultural Technical Services

(BATs). When asked to invest in the project BATs interest was in management rather than investment, and thus suggested quite a new organizational structure of production composed of contract farmers. Presently Mumias Sugar Company (MSC) depends on over 60,000 hectares of sugarcane, 90% of which belongs to small scale farmers while the 10% of the land is Mumias sugar nucleus estate located within the division. Over the years farmers in the division have depended on sugarcane as the major source of household income. However, Kenya sugar research foundation (KESREF), (2007) reports a general decline in sugarcane production, hence resulting in decline in income. This coupled with the long sugarcane growing period of 16-24 months forces farmers to grow food crops besides cane to ensure food security. At the time of inception of MSC, it was envisaged that contract farming would improve general management skills of the farmers and that sugarcane income would be ploughed back into increased maize production (Owour, 1995). However, Odada (1979) reported that the sugarcane crop enterprise had failed to offer sufficient returns to support the cane producing families. Small scale farmers own on average 0.60 ha under sugarcane production.

For any new idea (technology) to be adopted, farmers have to undergo an adoption process. The adoption process has five stages and these are; awareness stage, interest stage, evaluation stage, trial stage and adoption stage. The study was carried out with the assumption that the small scale sugarcane farmers in Mumias division underwent all these stages in the adoption of improved sugarcane production technologies. There are characteristics of adoption of agricultural production technologies and it is hoped that these characteristics applied in the adoption of improved sugarcane production technologies by small scale sugarcane farmers in Mumias division of Mumias district. These characteristics are; relative advantage, triability, observability, compatibility and complexity. The study investigated the selected determinants which were socio-economic status of the farmers as well as the frequency of extension contact with farmers to establish if they had any relationship with the adoption of the improved sugarcane production technologies. The socio-economic factors that were studied are; land tenure, farm size, level of income, level of education, age, gender and labour availability.

Mumias division is one of the four divisions in Mumias District, of Western province. Administratively, it comprises of Ekeru, Township, Nucleus, Lureko, and Matawa sub-divisions. As for sugarcane farming arrangement by Mumias Sugar Company, the division is divided into two cane farming sub-divisions called Ekeru and Lukero. The division has very deep friable loam soils favourable for agricultural production and has adequate rainfall of 1500-2000 per annum that is well distributed. Most of the division's arable land is under sugarcane which is the major economic activities in the area. The Mumias Sugar Company (MSC) is situated in the division. Geographical location of Mumias division is shown on Mumias district map (Appendix III).

1.2 Statement of the Problem

Improved Sugarcane Production Technologies if adopted are supposed to improve sugarcane yields as well as quality. Sugarcane productivity in Mumias sugar zone has been fluctuating on downward trend with the average yield falling from 98.03 tons/ha in 1998 to 63.70 tons/ha in 2007 (Kenya Sugar Board, 2007) in spite of the introduction of the ISPTs developed by KESREF. The two selected ISPTs of great concern in this study were weed management and fertilizer application since they applied to both plant cane and ratoon cane classes. This study sought to investigate the effect of selected determinants such as farmer's gender, age, level of education, labour availability, land tenure, farm size, level of income and frequency of extension contact with farmers on adoption of the two selected ISPTs by small scale sugarcane farmers, since no similar work had been conducted in the division.

1.3 Purpose of the Study

The purpose of the study was to establish the effect of selected determinants on the adoption of the selected ISPTs by small scale sugarcane farmers in Mumias division. The selected determinants such as farmer's gender, age, level of education, labour availability, land tenure, farm size, and level of income and frequency of extension contact with the farmers were investigated to establish if they affected the adoption of ISPTs in order to develop better strategies to enhance their adoption.

1.4 Objectives of the Study

- i. To establish the level of adoption of the selected ISPTs by small scale sugarcane farmers in Mumias division
- ii. To establish whether farmer's age, gender, level of education, labour availability, land tenure, farm size, level of income and frequency of extension contact with farmers are the determinants of adoption of the selected ISPTs by small scale sugarcane farmers in Mumias division.
- iii. To determine the relative contribution of each determinant in the adoption of the selected ISPTs, thereby establishing the determinants that have the greatest impact on technology adoption.

1.5 Research Questions

The study addressed the following questions:

- i. What is the level of adoption of the selected ISPTs by small scale sugarcane farmers in Mumias division?
- ii. Are farmer's age, gender, level of education, labour availability, land tenure, farm size, level of income and frequency of extension contact with farmers the determinants of adoption of the selected ISPTs by small scale sugarcane farmers in Mumias division?
- iii. What is the relative contribution of each determinant in adoption of the selected ISPTs adoption in Mumias division?

1.6 Significance of the Study

By pointing out determinants of adoption of the selected ISPTS, this study provides guidance to the sugar industry administrators, researchers and all the stakeholders for enhancing the program's effectiveness. The added knowledge on which factors have the greatest influence on the selected ISPTs adoption would help administrators make more informed decisions on how to promote ISPTs adoption.

Another benefit from the research would be provision of an explanation of the current state of technologies used by farmers. Moreover, since ISPTs involve a variety of practices that are specific to sugarcane, measuring their adoption may provide a strong case for increasing investment in various ISPTs research.

Also because of the importance of sugarcane in Kenya, this study provides a basis for gauging how policy changes may affect sugarcane farmers. Policy issues that constrain or enhance the provision of inputs that are required to carry out ISPTs practices have a direct effect on how sugarcane farmers react to them. The results provide useful information to enhance the success of the ISPTs and indeed any other related program that attempts to introduce practices for adoption in the settings that are similar to those in the study area. Results of this study thus have implications well beyond the confines of the study area.

In Kenya, KESREF is greatly funded from Sugarcane Development Levy (SDL) contributed by all sugarcane millers and its continued support is dependent on the effectiveness of its programs. Therefore, for continued funding, the research findings must demonstrate benefits. These benefits do not accrue if farmers do not adopt the practices (Wawire *et al.*, 2006). A crucial step therefore seems to be to identify the forces that enhance ISPTs adoption. This research project aimed at fulfilling this important task. Information obtained from the study was expected to be of great significance in enhancing the adoption of ISPTs with a view to improving sugarcane yields among small scale holder farmers in Mumias division.

1.7 Scope of the Study

The study carried out in Mumias Division of Mumias District, Western Province, Kenya. The proposed study covered the aspects related to adoption of the selected ISPTs by the small scale sugarcane farmers in Mumias Division. The selected ISPTs that were studied were weed management and fertilizer application. The influence of farmer's gender, age, level of education, labour availability, farm size, land tenure, level of income and frequency of extension contact with farmers on the adoption of the ISPTs by small scale

sugarcane farmers in Mumias division were investigated. A sample of 120 small scale sugarcane farmers whose cane age lied between one and eight months were studied.

1.8 limitations of the Study

- i. The questionnaire was in English and had to be translated into local dialect for those not conversant with English.
- ii. The study was carried out among small scale sugarcane farmers contracted by MSC in Mumias division, generalization should be done with care because there are certain characteristics that are unique to MSC e.g. free extension services and fertilizer supply on credit.

1.9 Assumptions of the Study

The study was carried out with the following assumptions:

- i. All locations in the study area were considered homogenous in terms of natural soil fertility.
- ii. The weather was assumed favourable to allow the visiting of all the sugarcane plots.
- iii. GoK extension services were accessible to all the farmers in the study area.
- iv. Agro-ecological factors were the same in the whole study area.
- v. Technology characteristics such as relative advantage, triability, observability, compatibility and complexity applied to all the farmers in the study area.

1.10 Definition of Terms

Adoption: This is a mental process through which an individual passes from first learning about new ideas (innovation) to its final use (Rogers, 1983). In this study, adoption referred to continued practicing the ISPTs by small scale sugarcane farmers. It was measured by field observation to ascertain the practices and the length of time during which the technologies had been practiced by the farmers

Determinants: These are factors that either singly or in combination have a direct effect on the dependent variable in any study.

Diffusion: The process of spreading of a new idea from the source of invention or creation to its ultimate users or adopters (Rogers, 1983). In the context of this study, diffusion mean the spread of ISPTs among sugarcane farmers in the research area.

Extension service: The process of passing new information or technology from agricultural research to a farmer and pass feedback from the farmer to the researcher (Wasula, 2000). In this study, it referred to provision of input and technical advice to farmers by the extension providers

Improved Technologies: Are technologies that were researched and found to improve sugarcane yields if applied (Wawire *et al.*, 2006).

Plant crop: Sugarcane crop between planting and first harvest (Wawire *et al.*, 2006). It referred to the sugarcane status right from the time of germination to the time of first harvest.

Ratoon crop: Sugarcane crop that sprouts after harvesting and grows until the next harvest (Wawire *et al.*, 2006). It referred to the sugarcane status between one harvest and the next harvest.

Small scale farmer: Small scale farmer is considered to be one who has farm size of less than ten hectares (Wasula, 2000). In this study, it referred to contracted sugarcane farmers in Mumias division with less than ten hectares under sugarcane farming.

Technology: This can be considered to be the systematic application of scientific knowledge to practical purpose (Amudavi, 1993). In this study, technology referred to the sugarcane production scientific knowledge researched and found that its use improved sugarcane yield. These technologies were land preparation, planting, fertilizer application, weed management and trash management.

Trashlining: Arrangement of trash (dry sugarcane tops and leaves left after harvesting) within cane inter rows (Wawire *et al.*, 2006).

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter highlights the major concepts of the literature reviewed that were relevant to the study. The literature mainly focuses on sugar industry in Kenya, characteristics of technology adoption, technology adoption process, determinants of adoption, theoretical framework and conceptual framework.

2.2 Sugar Industry in Kenya

This section sheds light on challenges facing the sugar industry, sugarcane production and sugarcane production technologies.

2.2.1 Challenges Facing the Sugar Industry

In Kenya sugarcane is grown under rain fed conditions and at high altitude where water and temperatures are the main limiting factors (Odada, 1979). The crop takes two years to mature and yields are low compared to cane grown in low altitude and under irrigation that take one year. The increasing population has resulted in reduced land size due to the continued sub-division into uneconomical units, which render farms mechanization difficult and expensive (Wawire *et al.*, 2006). Over a time, a culture has developed where many sugarcane farmers depend entirely on sugar companies and contractors for their farm operations. This practice has rendered them mere spectators rather than active farmers. This has exposed them to inflated costs by service providers leaving them with negligible earnings (Kenya Sugar Board, 2007). Capital requirements for cane development are heavy and call for specialized financing requirements. Alternative lines of credit to farmers are also limited since cane farming is viewed as a high- risk venture with long payback period. Some farmers have had to develop cane using own resources while other farmers have abandoned cane farming altogether (Wawire *et al.*, 2006). Farmers have had to contend with delayed payments for cane delivered due to financial constraints facing the sugar companies (Kenya Sugar Board, 2007). In addition, delayed harvesting arising from unsynchronized cane development and factory capacities exacerbates this situation. In some instances, farmers have had to wait for cane delivery

payments for several months. The research-extension-farmer linkage is weak and as a consequence, the dissemination of research recommendations are constrained (Wawire *et al.*, 2006). The out grower institutions are poorly managed and many owe the Kenya Sugar Board (KSB) large sum of money under the Sugar Development ^{Fund} Levy (SDF). The institutions no longer play the complementary role to the sugar companies as originally envisaged (Kenya Sugar Board, 2007). However, despite the diminished effectiveness of these institutions, cane farmers still require institutional arrangements through which services to them could be rendered. The research programme and capacity of the Kenya Sugar Research Foundation is limited to agronomic research with little efforts towards industrial and applied research. As a result, research in processing and marketing technologies has lagged behind (Wawire *et al.*, 2006).

2.2.2 Sugarcane Production

Generally, the average sugarcane yields in tons/ha have been fluctuating on the downward trend nationally for the last ten years, between 1998 and 2007, although in some years in between there were some improvements. Figure 1 shows the sugarcane yields for both Mumias Sugar Company and Kenya between 1998 and 2007.

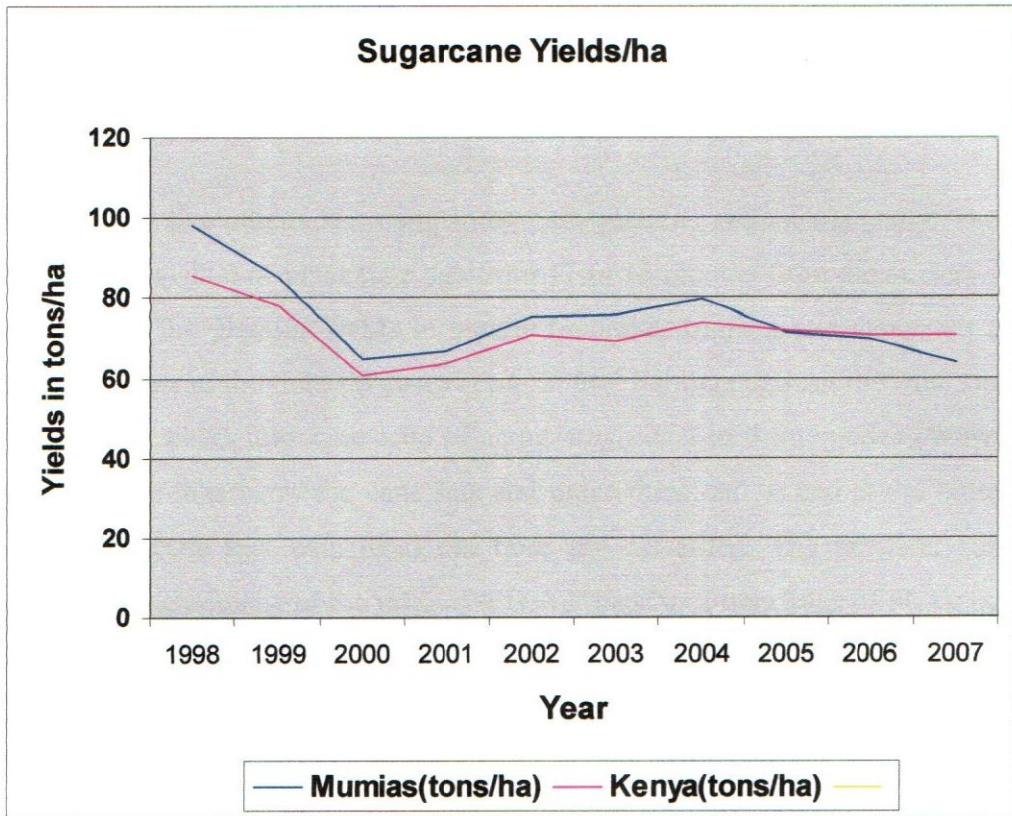


Figure1: Sugarcane yields for Mumias Sugar Company and Kenya for the period 1998-2007 (Source: Kenya Sugar Board Year Book of Sugar Statistics, 2007)

2.2.3 Improved Sugarcane Production Technologies

The improved sugarcane production technologies include those developed for land preparation, planting, fertilizer application; weed management, and trash management.

Land preparation

In Mumias sugar zone, tractors are used for land preparation to make a seedbed for sugarcane planting. Mostly, the disc ploughs and disc harrows are used for ploughing and harrowing respectively while mouldboard furrows are used for furrow opening. The depth of plough achieved in Mumias sugar zone is at least 24cm. Harrowing is done after at least three weeks and immediately furrowing done to a depth of at least 2cm less than the plough depth as a rule of thumb (Wawire *et al*, 2006). Farmers have been encouraged

to develop land on their own, but this has not picked up hence the company has control over land preparation. This technology was therefore not being investigated.

Planting

In Mumias just like other sugar companies, cane planting is done manually. The planting material (cane stalks) of plant cane age from 11 to 15 months from the nursery is usually transported to the planting fields in bundle or basket trainers and deposited at regular intervals of plots in the field (Wawire *et al.*, 2006). Farmers detrash the cane stalks, chop the clean cane stalks into cane setts of about 40cm or 3 to 4 internodes (Wawire *et al.*, 2006). Farmers then carry the cane sets and place them end to end at the bottom of the furrows. The cane sets with dead eye buds are discarded. The fertilizer supplied by Mumias Sugar Company at the ratio of 4 D.A.P bags to 2 urea bags of 50 kg per hectare is then mixed and applied in the furrows (Wawire *et al.*, 2006). After that the furrows are then covered with soil manually to the desired depth (Wawire *et al.*, 2006). Amount of soil cover depends on the weather condition, heavy soil in dry weather and light soil in wet or humid weather. It is recommended that planting should be completed within 3 days from the time seed cane is delivered. When planting procedures and time are followed to the letter and that weather conditions are favourable there is always a high germination percentage which leads to a high plant population that finally translates into high sugarcane yield in tons/ha at harvest time (Wawire *et al.*, 2006). This technology applies to plant crop only but not to a ratoon crop, therefore it was not investigated.

Fertilizer Application

Most farmers in Mumias sugar zone have had their soil sampled and analyzed for plant nutrients. This is because it is a company policy to sample and analyze soil before giving out inputs to farmers, for every new crop cycle (Wawire *et al.*, 2006). Mumias Sugar Company supplies fertilizers to contracted farmers. For plant crop, planting fertilizer rates are 4 DAP bags and 2 urea bags of 50kg per hectare and topdressing at four month at 4 urea bags of 50 kg per hectare. For ratoon crops, 1st topdressing at 4 DAP bags and 2 urea bags of 50 kg per hectare between 1 and 2 months and 2nd topdressing at four month at 4 urea bags of 50 kg per hectare. Fertilizer application is an operation done by farmers

manually and it also requires following of the procedures when mixing and applying. Proper mixing and application, coupled with right timing of the application gives the cane right nutrients at the right time and this makes cane healthy throughout its growing period that translates into high sugarcane yields in tons/ha (Wawire *et al.*, 2006). There is human labour required to accomplish this task which may be dependent on some socio-economic factors and farmers' exposure to extension. Delay in fertilizer application or non-application and non-following of application procedures ultimately lead to low sugarcane yields.

Weed Management

The study sample in Mumias indicate that all farmers use hand weeding (100%) to manage weed on their farms (Wawire *et al.*, 2006). The number of weeding fro plant cane is higher than in ratoon cane in the whole sugar zone. Although the number of weeding are dictated by the prevalence of weeds, an average of five and four weeding are practiced for plant and ratoon cane respectively. The manual weeding using a hoe is the commonly used method and is costly because of the high labour requirement. The labour requirement is provided by either using family members or hiring labour (Wawire *et al.*, 2006). According to Sifundza and Ntuli (2001), most contracted small holdings were established with an assumption that family labour would be available.

Chemical weed control, although having been demonstrated to farmers has not been adopted due to financial constraints of the farmers (Wawire *et al.*, 2006). Delay in weeding or no weeding at all causes a reduction in sugarcane yields at harvest time. Weed management is affected by socio-economic factors as well as the farmers' exposure to extension. This technology was investigated in the study.

Trash Management

Trashlining, where the cane trash and cane tops left after cane harvesting are lined between the cane rows. This is done in all the cane fields in Mumias sugar zones. Trashlining is recommended to be done within one month after transport is completed. This is done to remove trash from the cane stools to allow air and sunlight to reach the stools to enable regeneration of shoots from the cut stools into ratoon crop. Trashlining is

done manually either by family or hired labour. Delayed or improper trashlining leads to low yields in ratoon cane at harvesting time. This technology applies to ratoon crop only and thus was not investigated.

2.3 Characteristics of Technology Adoption

There are five characteristics that affect the technology adoption and these are:

2.3.1 Relative Advantage

This is the extent to which the new farm practice is assessed by farmers as superior to their present practice. It is assumed that the higher the relative advantage of a new idea, the higher the probability of its widespread acceptance and use by farmers. Technologies that produce quick results are more rapidly adopted (Amudavi, 1993; Waghmare, 1989).

2.3.2 Triability

This is the extent to which a new idea can be adopted on a scale for experiment and observation. In the process of adoption the farmer will try out ideas before taking too much risk. The decision to adopt an idea will depend on the level of success achieved in trial stage. Trying on a small scale enables a farmer to develop less uncertainty because of use of little money (Ogal, 1983).

2.3.3 Observability

The degree to which the results of an innovation are visible to potential users. A new idea that has visible results is adopted more rapidly. Farmers are likely not to be concerned with an idea until confronted with an important problem related to the idea (Makindi, 2002).

2.3.4 Compatibility

This is the extent to which the recommended farm practice is seen as consistence with current practices, values and past experience of farmers. An idea in conflict with important beliefs and social values of a community will be rejected (Amudavi, 1993).

2.3.5 Complexity

This refers to the difficulty or ease with which new farm practices can be understood, learned and used. Simple ideas will be adopted more readily than complex ones (Amudavi, 1993).

2.4 Technology Adoption Process

Various authors define the term 'technology' in a variety of ways. Rogers (1995) uses the word 'technology' and 'innovation' synonymously and defines technology as the design for instrumental action that reduces the uncertainty in the cause-effect relationship involved in achieving a desired outcome. A more meaningful definition may be that technology is a set of 'new ideas'. New ideas are associated with some degree of uncertainty and hence a lack of predictability on their outcome. For a technology to impact on the economic system, blending into the normal routine of the intended economic system without upsetting the system's state of affairs is required. This entails overcoming the uncertainty associated with the new technologies. It therefore comes as no surprise that several studies set out to establish what these factors are, and how they can be eliminated (if constraints) or promoted (if enhancers) to achieve technology adoption. Most technologies are termed "labour-saving", "time saving", "capital-saving" or "energy-saving" and so forth.

Farmers take sometime to adopt innovations after they are introduced to them. The decision to adopt takes time (Rogers, 1983). Farmers must undergo an adoption process, a method process through which individual pass from first hearing of an idea to its final adoption. For the purpose of this study, adoption will be taken as the continued practice to the improved sugarcane production technologies. According to Rogers (1983), and Lionberger (1996), adoption is a sequential process of decision making that involves the following stages:

Awareness Stage

It is fist knowledge one has about a new practice or idea. Farmers can obtain the information through mass media, neighboring or any other source, but lack detailed information about the idea (Ogal, 1983). The farmers in the study areas were made aware

of the improved sugarcane production technologies and the same time using similar extension methods.

Interest Stage

An individual becomes interested in the new practice and seeks information about the idea or new technology to determine its usefulness (Otto, 1997). Mass method or group method play important role in providing the necessary information.

Evaluation Stage

The individual or potential adopter weighs the advantage and disadvantage of the new practice in terms of his or her present situation and prospects for future (Ogal, 1983).

Trial Stage

This is the stage when an individual tries the technology on small scale. The farmer tries to validate the decision taken during the evaluation stage (Wasula, 2000). Similar trials on improved sugarcane production technologies were carried out to all farmers.

Adoption Stage

This is the acceptance and integration of the new idea or technology. The farmer is satisfied with the technology's application under existing conditions (Amudavi, 1993).

2.5 Determinants of Adoption

A variety of studies have sought to establish factors underlying adoption of various technologies. These factors are broadly classified as social, economic, cultural, personal and institutional (Wilson and Gallaup, 1995; Mbithi, 1982). The individual factors included in the above broad classification are:

2.5.1 Land Tenure

Ownership of land has been regarded as a major constraint in agriculture and hindrance to farmers to make long-term investments. The constraints have to do with customary rights of various groups and individual members of these groups to made use of different

products grown on the land (Lugo, 2002). In Mumias sugar zone, most of the land is either privately owned or leased. However, it was important to look into the aspect and find out its influence in the adoption of improved sugarcane production technologies among small scale farmers in the study area.

✓ 2.5.2 Farm Size

Much empirical adoption literature focuses on farm size as the first and probably the most important determinant. Farm size is frequently analyzed in many adoption studies (Doss and Morris, 2001; Daku, 2002). The effect of firm size has been found to be positive (Feder *et al.*, 1985). In Kenya, for example, a recent study (Gabre-Madhin and Haggblade, 2001) found that large commercial farmers adopted new high-yielding maize varieties more rapidly than small holders. Farm size affects adoption costs, risk perceptions, human capital, credit, constraints, labour requirements and more. Farm size is positively related to practice of new ideas. Many technological advances require large farm size. Farmers with large farms adopt more advance farm practices than small size holder (Amudavi, 1993). Farmers operating large farms tend to have greater financial resources and chances of receiving credit are higher than those operating smaller firms. In Mumias division sugarcane plots vary between 0.20 hectares and 4 hectares (Wawire *et al.*, 2006). It was interesting to discover how the farm size determined the adoption of improved sugarcane production technologies.

2.5.3 Level of Income

The level of income will determine if a farmer can practice more technologies or not (Chavangi, 1992). In Mumias division the level of income significantly vary among the farmers (Wawire *et al.*, 2006). It was interesting to discover how this variation determined the adoption of the Improved Sugarcane Production Technologies.

2.5.4 Level of Formal Education

Studies that have sought to establish the effect of education on adoption in most cases years of formal schooling. Generally education is thought to create a favourable mental attitude for the acceptance of new practices especially of information-intensive and

management intensive practices (Caswell *et al.*, 2001). According to Rogers (1983) technology complexity has a negative effect on adoption. However, education is thought to reduce the amount of complexity perceived in a technology thereby increasing a technology' adoption. Studies have indicated that education plays a major role in determining the rates of practice of any new technology in developing countries. However, farmers have not always felt that schooling beyond eighth grade is needed for farming, in any case it makes a person impractical (Lionnberger, 1996).

2.5.5 Age of Adopter

Age is another factor thought to affect adoption. Age is said to be a primary latent characteristic in adoption decisions. However, there is contention on the direction of the effect of age on adoption. Age was found to positively influence the adoption of sorghum in Burkina Faso (Adesina and Baidu-Farson, 1995). However, age has also been found to be either negatively correlated with adoption, or not significant in farmer's adoption decisions. In studies on adoption of land conservation practices in Niger (Baidu-Forson, 1999), rice in Gunea (Adesiina and Baidu-Forson, 1995) age was either not significant or was negatively related to adoption. Older farmers seem to have somewhat less inclined to practice new farm practices than young ones (Onguko, 1992). Older farmers, perhaps because of investing several years in a particular practice, may not want to jeopardize it by trying out a completely new method.

In addition, farmers' perception that technology development and the subsequent benefits, require a lot of time to realize, can reduce their interest in the new technology because of farmer's advanced age, and possibility of not living long enough to enjoy it (Caswell *et al.*, 2001). Further more, elderly farmers often have different goals other than income maximization, in which case, they will not be expected to adopt an income-enhancing technology. Highest adoption of practices is found middle age. In Mumias division sugarcane framers are of varying age with majority of the farmers lying within middle to old age bracket.

2.5.6 Gender

Gender issues in agricultural production and technology adoption have been investigated for along time (Wabbi, 2002). Doss and Morris (2001), in their study on factors influencing improved maize technology adoption in Ghana, showed insignificant effects of gender on adoption. Most homes are managed by women as men are always in town in search of jobs (Saito and Splurling, 1992). However, there is still belief in some communities that women are not supposed to make decision on farming. In Mumias division most sugarcane farming contracts are held by men with few being under women. Kidula (2007) has studied the implication of sugarcane contract farming on household food production. These have a bearing on the adoption of ISPTs from a gender perspective.

2.5.7 Availability of Labour

Labour constraints in specialized task can inhibit practice of new technology. Labour shortage has tended to discriminate against categories of farmers. However, availability of affordable skilled labour has led to high rate of new rate of ideas or technology (Wasula, 2000).

2.5.8 Extension Contacts

Good extension programs and contacts with producers are key aspects in technology dissemination and adoption. Most studies analyzing this variable in the context of agricultural technology show its strong positive influence on adoption. Farmers who have frequent contact with the extension usually have higher tendency of adopting a technology than those who have less contact. The extent to which farmers make contact with extension staff determines the adoption of the technology (Feder *et al.*, 1985). In Mumias sugar zone, farmers have contacts with MSC extension staff.

2.6 Theoretical Framework

The theory that was used in study is the Diffusion of Innovation theory by Rogers (1983). Diffusion of innovation proved to be a useful instrument for describing different information processes involved in the adoption of the improved sugarcane production

technologies by small scale farmers in Mumias division. This theory is illustrated by the model of adoption –diffusion process (figure 1) and innovation adoption curve (figure 2) of Rogers which is a model that classifies adopters of innovations into various categories. The innovation adoption curve categories are innovators, early adopters, early majority, late majority and laggards. The theory is based on the idea that certain individuals are inevitably more open for adoption than others. The small scale farmers have different perspectives of the innovations hence some are more open and willingly to adopt new technologies.

Before an innovation is adopted, it has to go through the diffusion process (Rogers, 1983). Diffusion has five elements as contained in this innovation diffusion theory. These elements are:

- i. Characteristics of an innovation which may influence its adoption
- ii. Decision making process that occurs when individual consider to adopt a new idea, product or practice
- iii. Characteristics of individuals that make them likely to adopt an innovation
- iv. Consequences for individuals that make them likely to adopt an innovation
- v. Communication channels in the adoption process.

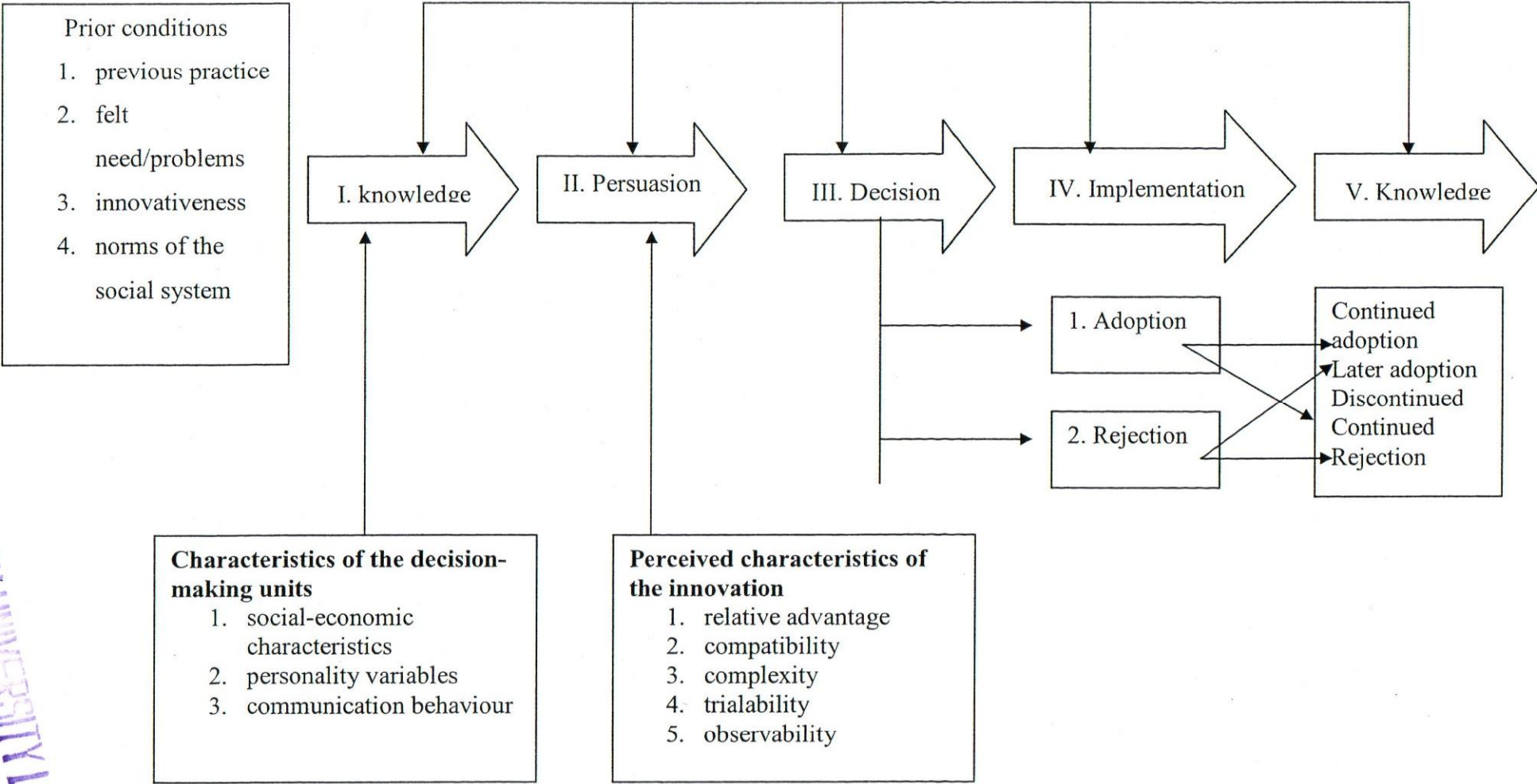


Figure 2: A Model of Stages in the Adoption in the Adoption Process

Adopted from Rogers (1983), pp. 165

2.7 Conceptual Framework

Adoption or non-adoption of the improved sugarcane production technologies by small scale sugarcane farmers in Mumias division of Mumias sugar zone may be associated with social-economic factors and extension contact frequency. The improved sugarcane production technologies that will be investigated are weed management and fertilizer application. Adoption of these technologies affect sugarcane husbandly standards which eventually determine the sugarcane yields at harvest. The main independent variable for this study are socio-economic factors and frequency of extension contact while the dependent variable is adoption of improved sugarcane production technologies. There are also other variable which may interact with the dependent and independent variables on one way or another, these are referred to as moderating variables. These will not be built into study but will be assumed (figure 4)

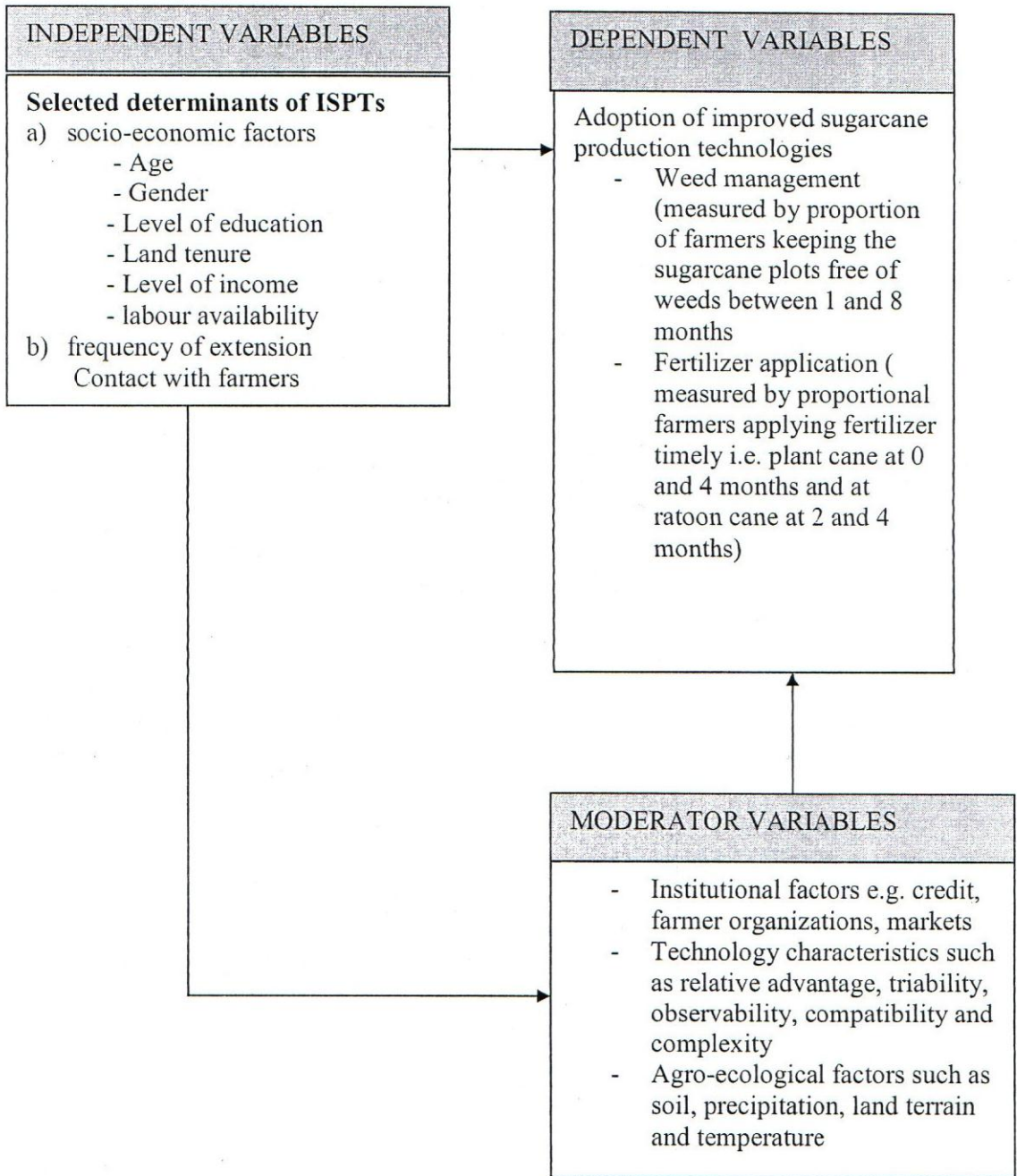


Figure 4: conceptual framework showing socio-economic factors and frequency of extension contact by small scale sugarcane farmers in adoption of improved sugarcane production technologies

Level of adoption of improved sugarcane production technologies (weed management and fertilizer application) were measured by scores of;

- Field observation
- Technology practice
- Period of adoption (in years)

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter discusses the procedures that were used in the research type and instrumentation. It also describes the study location, population, sampling procedure, sample, data collection and data analysis procedures.

3.2 Research Design

This study utilized correlation survey research design. Correlational research involves collecting data in order to determine whether and to what degree a relationship exists between two or more qualifiedly variables (Mugenda and Mugenda, 1999). This research also allows one to analyze how several variables either singly or in combination might affect a particular phenomenon being studied. This was appropriate for the study as it involved collecting data from a sample of small scale sugarcane farmers in Mumias division on determinants of adoption of the selected ISPTs. The study was considered as a survey because it used questionnaires to get data relating to the social-economic status of the study population as well as the frequency of extension contact with MSC extension staff. Observation schedule was used to gather information related to the levels of the adoption of the ISPTs among the study population.

3.3 Location of the Study

The study was carried out in Mumias Division of Mumias District, Western Province. The division was chosen for the study, because of the fluctuating sugarcane yields on downwards trend for the past 10 years in the division. There was also no study about the division on the selected determinants of adoption of the Improved Sugarcane Production Technologies as well as the adoption levels of these technologies. The division lies within the Mumias sugar zone and sugarcane farming is the main economic activity in the area. The division lies between an altitude of 1270-1300m above sea level. It has adequate rainfall of 1500-2000mm per annum, temperature of 24-33⁰C and very deep friable loam soils favorable for agricultural production. Geographical location of Mumias division is as shown in Mumias District Map (Appendix III).

3.4 Population

The target population group consists of all the 2196 small-scale sugarcane farmers in Mumias Division contracted by Mumias Sugar Company. The number of farmers per sub-location was: Ekeru (1005) and Lureko (1191). Some of the farmers own the land on which they grow sugarcane while others have leased land from other farmers (Wawire *et al.*, 2006). Some farmers use family labour to work on those farms while others use hired labour.

3.5 Sample Size

A list of all the small scale sugarcane farmers from the two sub – location in Mumias division whose cane age lied between one and eight months was complied from MSC farmers' registers to form the sampling frame. A total of 377 farmers from Lureko and 356 from Ekeru sub locations formed the sampling frame. Simple random sampling was done to selected 60 framers from each sub-location. Each farmer was assigned a number from 001 to 377 for Lureko sub-location and from 001 to 356 for Ekeru sub-location. These numbers were written on small plain papers which were folded and put in different boxes for each sub-location. 60 papers were randomly picked without replacement from each box and the numbers checked against the farmer's name. In total 120 contracted small –scale sugarcane farmers were selected. This was appropriate as it is recommended that the minimal sample size for each major group in a survey research should be 100 (Kathuri and Pals, 1993). The cane of age between one and eight months was appropriate since it is during this period that all the improved sugarcane production technologies are undertaken.

3.6 Instrumentation

The instruments used to collect the necessary information were household head questionnaire and direct observation score sheet. Each item in the questionnaire was developed to address specific research questions. The items measured the socio-economic status as well as the frequency of extension contact between MSC staff and the small scale sugarcane farmers in Mumias division. The questionnaire was designed with both open-ended and closed-ended items. Direct observation score sheet was used to collect data on the actual practice of selected ISPTs by small scale sugarcane farmers in the study area.

3.6.1 Validity

Validity refers to the degree to which an instrument actually measures the variables it claims to measure (Kathuri and Pals, 1993). To ensure that the data collected in the study accurately represented the variables of the study, each item in the instrument and the score sheet was checked by the colleagues and experts. It was important to note how each of the study objectives was captured in the questionnaire and score sheet. Both content and construct related evidence validity were discussed. Content validation was done to determine if the contents that the instrument and score sheet contained adequate samples of the domains of the contents they were supposed to represent. Experts and colleagues looked at the contents, format of the instrument and score sheet and found they were appropriate. Construct validity ensured that score from instrument and score sheet yielded correct inferences about variables that they purported to measure.

3.6.2 Reliability

Reliability is the extent to which a measuring device is consistent in measuring what it is supposed to measure (Kathuri and Pals, 1993). To measure the degree to which the research instruments yielded consistent results, they were tested using a random sample of twenty contracted small scale sugarcane farmers in Bumula division. The division was appropriate for the piloting since it was within Mumias sugarcane growing zone and there was fluctuating sugarcane yield on downward trend and had no documented study on determinants of adoption of improved sugarcane production technologies by small scale sugarcane farmers. According to Kathuri and Pals (1993), the smallest number that can yield meaningful results on data analysis in a survey research is twenty, thus twenty contracted small sugar farmers were used for the pre-test. After the pilot study, the reliability of the instrument was assessed using split half technique. This approach eliminated chance error due to different test conditions as in the test; re-test technique (Sharma, 1985). A reliability co-efficient of 0.798 was found. A reliability coefficient of 0.8 or more is accepted as this implies that there is a high degree or reliability of the data (Mugenda and Mugenda, 1999). The two divisions were far apart hence there was little chances of contamination through previous exposure to research process.

3.7 Data Collection Procedures

The researcher received letter of approval from Egerton University Department of Agricultural Education and Extension. The researcher took the letter to the Ministry of Education and applied for a permit to carry out the research in the Mumias Division. The permit was given on 2nd October 2008 to carry out research in Mumias division between 2nd October 2008 and 30th November 2008. The researcher met two MSC field assistant in the study area and went through the instruments with them clarifying all items and trained them so that they could assist in administering the questionnaire and filling the observation score sheets. The two field assistants were each given a questionnaire and an observation score sheet to fill in order to ascertain if they had understood. The researcher together with the field assistants went through the filled instrument and confirmed that they were done properly. The copies of list of the sampled farmers with details showing the sub-location, field number and plot number, questionnaires and observation score sheets were given to the two field assistant and allowed to visit individual farmers to collect data while on their normal MSC field operations. During the visit, the purpose of the study was explained and consent sought to include the farmers into the study. The farmers responded positively and those who were absent, arrangements were made and they were visited later. The questionnaires were administered by the trained MSC field assistants on face-to-face basis with each farmer, clarifying items in the instruments which were not clear to the farmer and clearly recorded the respondents. After that the trained MSC field assistant visited the farmer's cane plot with the farmer, inspected the cane and awarded scores for fertilizer application and weed management on the observation score sheets.

3.8 Data Analysis ✓

The data were summarized using frequencies in the statistical package for social science (SPSS) for windows based on the study objectives and research questions. Responses to each category of items in the instrument was coded and scored for purposes of data entry. Each score was assigned a specified weighting for meaningful interpretation as per the research questions. Cumulative frequency table and multiple regression were used to organize, describe and analyze the data. Multiple linear regression equation was used to determine whether farmer's age, gender, land tenure, farm size, level of education, level of income, labour availability and frequency of

extension contact determined adoption of the selected ISPTs in the study area. The eight independent variables were considered together (in one equation);

a) Weed management (weeding)

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \dots + \beta_K X_K + E$$

Where Y – Dependent variable (weeding) – measured in terms of proportion of weeds in the sugarcane plots

β_0 – Is the constant (Y – intercept) -

$\beta_1, \beta_2 \dots \beta_K$ – Regression co-efficient

X_1 – Gender – measured in terms of male:1, female:2

X_2 – Age of the farmer – measured in years

X_3 – level of education – measured in terms of no education, primary level, 'O' level, 'A' level, Diploma and University level.

X_4 – Farm size – measured in terms of hectares under cane

X_5 – Level of Income – measured in terms of Kshs per year

X_6 – land tenure (type of land ownership) – measured in terms of leased or freehold (leasehold: 1, freehold:2)

X_7 – Labour availability – measured in number of adult persons available as labourers

X_8 – Frequency of extension contact with farmers – measured in terms of weekly, monthly, quarter yearly, biannually, annually and none.

E – The error.

b) Fertilizer Application

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \dots + \beta_K X_K + E$$

Where Y – Dependent variable (fertilizer application) – measured in terms of timely fertilizer application i.e. plant cane at 0 and 4 months and ratoon cane at 2 and 4 months.

β_0 – Is the constant (Y – intercept)

$\beta_1, \beta_2 \dots \beta_K$ – Regression co-efficient

X_1 – Gender – measured in terms of male:1, female:2

X_2 – Age of the farmer – measured in years

X_3 – level of education – measured in terms of no education, primary level, 'O' level, 'A' level, Diploma and University level.

X_4 – Farm size – measured in terms of hectares under cane

X_5 – Level of Income – measured in terms of Kshs per year

X_6 – land tenure (type of land ownership) – measured in terms of leased or freehold (leasehold: 1, freehold:2)

X_7 – Labour availability – measured in number of adult persons available as labourers

X_8 – Frequency of extension contact with farmers – measured in terms of weekly, monthly, quarter yearly, biannually, annually and none.

E – The error.

The β coefficient and standard error of determinants were used to establish relative contribution of each factor to the adoption of Improved Sugarcane Production Technologies.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter is presented in four sections, section 4.2 gives the characteristics of the respondents, section 4.3 gives results and discussion of objective one, section 4.4 gives results and discussion of objective two and section 4.5 gives results and discussion of objective three.

4.2 Characteristics of the Respondents

The farmer's characteristics were identified in order to establish the kind of farmers who participated in sugarcane farming. These characteristics are believed to be critical in understanding the nature and the role of farming in an area.

Gender of Household Head

Gender of household heads is an important factor in household decision making. Past studies have indicated that male headed households tend to focus on income generating group production while female headed households focus on food crops (Kidula, 2007). Survey responses were obtained from 120 respondents from Lureko and Ekero sub-location of Mumias Division, Mumias district. 65.8% of the farmers engaged in the study were male while 34.2% were female as shown in table 1.

Table 1: Gender of the Household Head

Gender	Frequency	Percent
Male	79	65.8
Female	41	34.2
Total	120	100.0

Marital status of the Household Head

In Mumias division, unmarried women seldom own land as it is assumed they can be married any time and move to their matrimonial homes while the unmarried men own land. 89.2% of the farmers engaged in the study were married while 10.8% were widowed or never married as shown in table 2.

Table 2: Marital Status of the Household Head

Marital status	Frequency	Percent
Never	1	0.8
Married	107	89.2
Widowed	12	10.0
Total	120	100.0

Age of Household Head

Age is said a primary latent characteristic in adoption decisions. Age was found to positively influence the adoption of sorghum in Burkina Faso (Adesina and Baidu – Forson, 1995). It is also argued that the age of the household is crucial for his or her decision making, especially in determining what to produce on a given piece of land in a given season. 75% of farmers engaged in the study were aged between 33 and 60 years while 15.8% were aged above 60 years and 2.5% aged less than 18 years as shown in table 3.

Table 3: Age Range in Years of Household Head

Range in Age	Frequency	Percent
Less than 18	3	2.5
18-32	8	6.7
33-45	36	30.0
46-60	54	45.0
Above 60	19	15.8
Total	120	100.0

Occupation of Household Head

Another occupation of the farmer apart from sugarcane farming meant there was an additional source of income which would enable the farmer to adopt new technologies. 78.3% of the farmers engaged in the study did farming as a sole occupation while 20.9% did formal jobs or business alongside farming as shown in table 4.

Table 4: Occupation of the Household Head

Occupation	Frequency	Percent
Teacher	5	4.2
Civil servant	1	0.8
Trader	9	7.5
Farmer	94	78.3
Employee of private sector	10	8.3
No response	1	0.8
Total	120	100.0

Level of Education of Household Head

Evidence from most literatures has proved that education and new technology use are directly correlated (Hassan et al., 1998). Research of the study indicated that out of 120 farmers involved in the study, 25% of them were illiterate, 57.5% had primary education, 12.5% had secondary education and 4.2% had completed college education as shown in table 5. Therefore, this showed about 75% of the farmers had required education to adopt the technologies.

Table 5: Level of Education of household head

Level of education	Frequency	Percent
None	30	25.0
Primary level	69	57.5
O level	14	11.7
A level	1	0.8
Diploma	5	4.2
No response	1	0.8
Total	120	100.0

Farm Size of Household Head

Land as a major factor of agricultural production has been used in several studies. Farmers with large farms adopt more advanced farm practices than small size holders (Amudavi, 1993). The results of the study indicated that 87.5% of the farmers owned 2.5 hectares and below, 9.2% owned between 2.6 and 5 hectares while 2.4% owned above 5 hectares as shown in table 6.

Table 6: Size of Land Owned by Household Head

Range size in Hectares	Frequency	Percent
2.5 and below	105	87.5
2.6 to 5	11	9.2
5.1 to 7.5	1	0.8
7.6 to 10	1	0.8
Above 10	1	0.8
No response	1	0.8
Total	120	100.0

Type of Land Ownership of Household Head

Land ownership had been regarded as a major constraint in agriculture and hindrance to farmers to make long-term investments (Lugo, 2002). 84.2% of the farmers engaged in the study owned land under freehold while 15.% had leasehold type of land ownership as shown in table 7.

Table 7: Types of Land Ownership of Household Head

Types of land ownership	Frequency	Percent
Leasehold	18	15.0
Freehold	101	84.2
No response	1	0.8
Total	120	100.0

Size of Land under Sugarcane Farming of Household Head

The size of land under sugarcane farming has a bearing on the adoption of technologies. The effect of farm size has been found to be positive (Feder *et al.*, 1985). 83.3% of the farmers engaged in the study had land under sugarcane farming not exceeding 1.0 hectare per contract while 14.1% had individually contracted above 1.0 hectare as shown in table 8.

Table 8: Size of Land under Sugarcane Farming of Household Head

Size of land under cane in hectare	Frequency	Percent
1 hectare and below	100	83.3
1.1 to 2	16	13.3
3.1 and above	1	0.8
No response	3	2.5
Total	120	100.0

Availability of Labour

Labour constraints in specialized tasks can inhibit practice of a new technology. Availability of affordable skilled labour has led to higher rate of new ideas or technology (Wasula, 2000). As for the number of adult persons available for labour on the farm, 80.8% of the farmers engaged in the study had at most 4 persons while 12.5% had above 4 persons as shown in table 9.

Table 9: Number of Adult Persons Available for Labour on the Sugarcane farm

Number of persons available for labour	Frequency	Percent
2 and below	46	38.3
3 to 4	51	42.5
5 to 6	12	10.0
7 and above	3	2.5
No response	8	6.7
Total	120	100.0

Source of Labour

Most of the work on sugarcane plots is done manually. Source of the manual labour is either hired or family labour. 51.7% of the farmers engaged in the study used both family and hired labour, 10% used hired labour and 38.3% used family labour as shown in table 10.

Table 10: Source of Labour for Sugarcane Production

Source of labour	Frequency	Percent
Family	46	38.3
Hired	12	10.0
Both family and hired	62	51.7
Total	120	100.0

Sugarcane Cycle

It was important to know the sugarcane cycle as it helped in envisaging the activities anticipated. 45% of the farmers engaged in the study had plant cane while 55% had ratoon cane as shown in table 11.

Table 11: Sugarcane Cycle

Cane cycle	Frequency	Percent
Plant	54	45.0
Ratoon	66	55.0
Total	120	100.0

Sugarcane Age

It was important to know the age of the cane as it helped in ensuring that the required ISPTs are applied. 30.8 % of the farmers engaged in the study had cane aged between 1 and 5 months while 69.2% had cane aged between 5.1 and 8 months as shown in table 12.

Table 12: Sugarcane Age

Cane age (months)	Frequency	Percent
1 - 3	6	5.0
3.1 - 5	31	25.8
5.1 - 8	83	69.2
Total	120	100.0

Sources of Sugarcane Farming Information

It was important to know the source of information to farmers about ISPTs as the information from the extension staff was pure and free from distortion. 90.8% of the farmers engaged in the study received advice about adoption of ISPTs from MSC extension workers while 0.8% received advice from fellow farmers and 1.7% received advice from both MSC staff and fellow farmers as shown in table 13.

Table 13: Source of Information about Adoption of Improved Sugarcane Production Technologies.

Source of information	Frequency	Percent
MSC extension Staff	109	90.8
Fellow farmers	1	0.8
MSC staff and fellow farmers	2	1.7
No response	8	6.7
Total	120	100.0

Frequency of Extension Contact with Farmers

It was important to know the frequency of extension of contact with farmers as this would have an effect on the adoption of ISPTs in the study area. 94.2% of the farmers engaged in the study received extension services monthly, 5% received weekly and 0.8% received quarterly as shown in table 14.

Table 14: Frequency of Extension Contact with Farmers

Period	Frequency	Percent
Weekly	6	5.0
Monthly	113	94.2
Quarter yearly	1	0.8
Total	112	100.0

Effectiveness of Extension Services

Results in table 15 indicated that 93.3% of the farmers engaged in the study rated MSC extension services as very effective while 5.8% rated it as moderately effective and 0.8% rated the extension services as not effective.

Table 15: Effectiveness of Extension Service

Extension service effectiveness	Frequency	Percent
Very effective	112	93.3
Moderately effective	7	5.8
Not effective	1	0.8
Total	1120	100.0

Membership to out grower Institutions

90.8% of the respondents were members of Mumias Out growers Company as shown in table 16.

Table 16: Membership to out grower Institutions

Type of organization	Frequency	Percent
MOCO	109	90.8
No response	11	9.2
Total	1120	100.0

Main Factors Influencing the Adoption of Improved Sugarcane Production Technologies (ISPTs)

When it came to respondents pointing out what in their opinion were the main factors influencing the adoption of selected ISPTs, better returns ranked 1st with 22.5%, both high yields and better returns ranked 2nd with 11.7%, high yields ranked 3rd with 10.%, both MSC input and extension services ranked 4th with 6.7% and lastly both high returns and timely services with 0.8% as shown in table 17.

Table 17: Main Factors that Influence the Adoption of Improved Sugarcane Production Technologies by Small Scale Farmers.

Main factors in respondents opinion	Frequency	Percent
Better return	27	22.5
High yields & better returns	14	11.7
High yields	12	10.0
MSC input & extension service	8	6.7
High return & timely services	1	0.8
No response	58	48.3
Total	120	100.0

4.3 Objective 1

The first objective was to establish the level of adoption of the selected ISPTs by small scale sugarcane farmers in Mumias Division. The data was collected from the respondents using questions: C7i, C7ii, C8i, C8ii and the observation score sheet (Appendix II). Question one required knowing the level of the adoption of the selected ISPTs by small scale sugarcane farmers in Mumias Division. The data were analyzed using frequencies on SPSS for windows (tables 18 and 19).

Adoption Composite Score

Adoption was measured as a score composed of the observation score, technologies practice score and duration of practice score which were reflected as a composite score.

Field Observation Score

Score was assigned to each observation recorded indicating the practice of ISTPs within a continuum 0-5 where, 0 means no practice and 5 indicates highest degree of practice of the technology (Appendix II).

Technology Practice Score

The score was done on a yes or no scale, where no was 0 and yes was 1. These were captured from section C7(i) and 8(i) of the questionnaire (Appendix 1).

Duration of Practice Score

The scoring were done on C7(ii) and C8(ii) and scores awarded as shown below:-

Duration (in years)	Score
Less than 1	1
1.1-3	2
3.1-5	3
Above 5	4

The composite score was the sum of all the score and varied between 0-10. This formed the Y score in the multiple regression equation. The Y score had the scale classifies using equidistant linear interpolation. The classification was as follows: -

Scale range	Classification
0	None adopter
0.1-2.5	Low adopter
2.6-5	Moderate adopter
5.1-7.5	High adopter
7.6-10	Very high adopter

Table 18: Level of Adoption of Fertilizer Application

Adoption level	Frequency	Percentage
Moderate Adopter	5	4.2
High Adopter	16	13.3
Very high adopter	99	82.5
Total	120	100.0

Table 19: Level of Adoption of Weed Management

Adoption level	Frequency	Percentage
Moderate Adopter	6	5.0
High Adopter	14	11.7
Very high adopter	100	83.3
Total	120	100.0

The results showed 82.5% and 83.3% of the farmers engaged in the study were very high adopters of fertilizer application and weeding technologies respectively. There were no non-adopters and no low adopters in the study area. Moderate adopters constituted 4.2% and 5.0% for fertilizer application and weeding technologies respectively while high adopters constitute 13.3 %and 11.7% respectively. This means majority of the farmers in the study area were very high adopters of the selected ISPTs.

4.4 Objective 2

The second objective was to establish whether farmer's age, gender, level of education, labour availability, land tenure, farm size, level of income and frequency of extension contact with farmers were the determinants of adoption of the selected ISPTs by small scale sugarcane farmers in Mumias Division. Data were collected from the respondents using questions: B1, B3, B6, B8, B10, B11 and C4 (Appendix I). Question two required knowing whether farmer's age, gender, level of education, labour availability, land tenure, farm size, level of income and frequency of extension contact with farmers were the determinants of adoption of the selected ISPTs by small scale sugarcane farmers in Mumias Division. The results were analyzed using standardized beta coefficients in the multiple linear regression equation for the selected ISPTs (tables 20 and 21).

For fertilizer application the constant and standardized data coefficients of gender, age, level of education, farm size, level of income, land tenure, labour availability and frequency of extension contact with farmers were 7.179, -0.100, 0.095, -0.028, -0.123, 0.027, 0.217, -0.100 and 0.016. For weed management constant and standardized beta

coefficients of gender, age, level of education, farm size, level of income, land tenure, labour availability and frequency of extension contact with farmers were 5.373, -0.123, 0.129, 0.171, -0.135, 0.079, 0.269, -0.084 and 0.086. Basing on significance level of 0.5 all these factors were not determinants of adoption of ISPTs except land tenure which was a determinant of weed management adoption.

Table 20: Regression of Fertilizer Application Adoption (Dependent Variable) and Socio Economic Factors and Frequency of Extension Contact with Farmers (Independent Variables)

Independent Variables	Unstandardized		Standardized		
	Coefficients		coefficients		
	B	Std Errors	beta	t	sig.
(Constant)	7.179	1.460		4.919	.000
1. Gender (male: 1, female: 2)	-0.239	0.235	-0.100	-1.019	0.310
2. Age (in years)	0.120	0.146	0.095	0.820	0.414
3. Level of education (None, primary, 'O' level, 'A' level, diploma, university)	-0.040	0.159	-0.028	-0.250	0.803
4. Size of farm (in hectares)	-0.091	0.076	-0.123	-1.196	0.234
5. Estimated income from off-farm activities (Kshs per year)	0.037	0.178	0.027	0.207	0.837
6. Land tenure (leasehold:1, Freehold:2)	0.682	0.357	0.212	1.911	0.059
7. Number of adult Persons available as labour	-0.075	0.093	-0.100	-0.805	0.423
8. Frequency of extension Contact (weekly, monthly, Quarterly, biannually, annually, None)	0.076	0.461	0.016	0.164	0.870

Table 21: Regression of Weeding Adoption (Dependent Variable) and Socio Economic Factors and frequency of extension contact with farmers (Independent Variables)

Independent Variables	Unstandardized		Standardized		
	Coefficients				
	B	Std Errors	beta	t	sig.
(constant)	5.373	1.453		3.699	.000
1. Gender (male:1, female:2)	-0.299	0.233	-0.123	-1.279	0.204
2. Age (in years)	0.165	0.146	0.129	1.130	0.261
3. Level of education (none, Primary, 'O' level, 'A' level, Diploma, university)	0.244	0.159	0.171	-1.536	0.128
4. Size of farm (in hectares)	-0.101	0.075	-0.135	-1.339	0.184
5. Estimated income from off-farm activities (Kshs per year)	0.107	0.178	0.079	0.605	0.547
6. Land tenure (leasehold: 1 Freehold: 2)	0.879	0.355	0.269	2.474	0.015
7. Number of adult Persons available as labour	-0.064	0.093	-0.84	-0.687	0.494
8. Frequency of extension Contact with farmers (Weekly, monthly, quarterly Biannually, annually, none)	0.399	0.459	0.086	0.869	0.387

4.5 Objective 3

The third objective was to determine the relative contribution of each determinant in the adoption of the selected ISPTs thereby establishing the determinants that have the greatest impact on technology adoption. The data was collected from the respondents using questions: B1, B3, B6, B8, B10, B11 and C4 (Appendix I). Question three required knowing the relative contribution of each determinant in adoption of the

selected ISPTs in the study area. The results were analyzed using beta coefficients of the multiple linear regression equation for the selected ISPTs. Tables 20 and 21 gave the beta coefficients for determinants in the adoption of both fertilizer application and weeding technologies. These beta coefficients are the relative contributions of each determinant towards the adoption of selected ISPTs.

Multiple linear regression equation for the adoption of the selected ISPTs were thus found to be;

$$\text{i) Fertilizer application} = 7.179 - 0.1X_1 + 0.095X_2 - 0.028X_3 - 0.123X_4 + 0.027X_5 \\ + 0.212X_6 - 0.1X_7 + 0.016X_8$$

$$\text{ii) Weed management} = 5.373 - 0.123X_1 + 0.129X_2 + 0.171X_3 - 0.135X_4 + 0.079X_5 \\ + 0.269X_6 - 0.084X_7 + 0.086X_8$$

Where: gender, age, level of education, size of the farm, level of income, land tenure, labour availability and frequency of extension contact with farmers are $X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8$ respectively. The coefficient of each selected determinant is the indicator of its relative contribution to the adoption of the ISPTs. For fertilizer application the coefficient were all insignificant, hence relative contribution to ISPTs adoption was also insignificant at 0.05 level of significance (table 20). For weed management all the coefficient were insignificant except that of land tenure whose relative contribution was significant at 0.05 level of significance (table 21).

The overall contribution to the adoption of the selected ISPTs in the study area by these combined determinants was 6.9% for the adoption of fertilizer application and 10.4% for the adoption of weeding. This was represented by R square which was 0.069 and 0.104 for fertilizer application and weeding respectively (tables 22 and 23). This meant 93.1% contribution in the adoption of fertilizer application and 89.6% contribution in the adoption of weeding come from unknown factors.

Table 22: Models summary for weeding

R	R Square	Adjusted R square	Std Error of the Estimate	change Statistics				
				R Square Change	F change	df1	df2	Sig. F change
0.322	0.104	0.033	1.13892	0.104	1.458	8	101	0.182

Table 23: Models summary for fertilizer application

R	R Square	Adjusted R square	Std Error of the Estimate	change Statistics				
				R Square Change	F change	df1	df2	Sig. F change
0.263	0.069	-0.004	1.14447	0.069	0.940	8	101	0.488

Question C11 in the questionnaire required knowing what in respondent's opinion, were the main factors influencing the adoption of fertilizer application and weeding technologies. This was open-ended question where respondents were free to list all the factors they considered. As observed earlier from regression analysis, the independent variables contributed 6.9% and 10.4% to the adoption of fertilizer application and weeding respectively while 93.1% and 89.6% contributions came from unknown factors. Some of the unknown factors were to be analyzed using frequencies on SPSS for windows shows in table 24. 22.5% of the farmers engaged in the study indicated better returns, 11.7% indicated both high yields and better returns, 10% indicated high yields, and 6.7% indicated both MSC input and extension service and 0.8 % indicated both high returns and timely service. This confirmed that high farm income is often associated with high adoption levels (Rogers, 1996) as shown in table 24.

Table 24: Main factors, in Respondents Opinion, That Influence the Adoption of Improved Sugarcane Production Technologies by Small Scale Farmers

Main factors affecting adoption in Respondents opinion	Frequency	Percent
Better returns	27	22.5
High yield & better returns	14	11.7
High yields	12	10.0
MSC input & extension service	8	6.7
High returns & timely services	1	.8
No response	58	48.3
Total	120	100.0

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter is presented in four sections: section 5.2 Summary, section 5.3 Conclusion, section 5.4 Recommendations and section 5.5 Further Research.

5.2 Summary

Levels of adoption of fertilizer application and weed management in the study area were found to be very high with 82.5% of the farmers engaged in the study being high adopters of fertilizer application and 83.3% being very high adopter of weed management. Farmer's age, gender, level of education, labour availability, land tenure, farm size, level of income and frequency of extension with farmers were found to have insignificant contribution to adoption of fertilizer application. For weed management all the above mentioned selected determinants were found to have insignificant contribution to its adoption except land tenure whose relative contribution was found to be significant.

5.3 Conclusion

Based on the findings of the study, the following conclusions were made;

- i. Level of adoption of fertilizer application and weed management technologies is very high among small scale sugarcane farmers in Mumias division.
- ii. Farmer's age, gender, level of education, labour availability, land tenure, farm size, level of income and frequency of extension with farmers are not determinants of adoption of fertilizer application and weed management except land tenure which is a determinant in adoption of weed management.
- iii. Farmer's age, gender, level of education, labour availability, land tenure, farm size, level of income and frequency of extension with farmers do not contribute towards adoption of fertilizer application and weed management except land tenure which has a significant contribution to weed management.

- iv. Adoption of Improved Sugarcane Production Technologies in the study area is mainly determined by farmers' perceptions about the benefit associated with the new technologies.
- v. Sugarcane yield decline in the study area is not associated with adoption levels of ISPTs as majority of the farmers are very high adopters yet there is a decline in sugarcane yields.

5.4 Recommendations

- i. Due to high level of technology adoption in the study area, Kenya Sugar Research Foundation should endeavor to develop more technologies to enhance sugarcane productivities. This should be more frequent as demand arises.
- ii. Sugarcane technologies should be developed on farmers' plots for farmers to appreciate their values and own the technologies outcome. This will make them feel part of the technology.
- iii. Economic benefits of any new technology should be evaluated and communicated to farmers since this has been found to have a profound effect on adoption of technologies in the study area irrespective of socio- economic status of the farmers.

5.5 Further Research

- i. Further studies to be carried out in the study area to determine the real cause of sugarcane productivity decline since over 82.5% of the farmers are high adopters of the ISPTs.
- ii. Studies to be carried out to determine the economic benefits of adopting the ISPTs in the study area.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE FOR HOUSEHOLD HEADS

You have been randomly selected to represent the other farmers in this area to provide information on sugarcane production as part of my MSc study at Egerton University. Your complete, honest and comprehensive responses to the questions in this questionnaire will be highly appreciated. The responses you give will be treated with utmost confidentiality and for the purpose of this study. No information provided will be linked to your identity.

A. PERSONAL INFORMATION

1. Farmer's account: _____
2. Sub location: _____
3. Field No. _____
4. Plot: _____

B. SOCIO – ECONOMIC INFORMATION

1. Gender of the respondent

- Male
 Female

2. Marital Status of the respondent

- Never Married
 Married
 Widowed
 Other (specify _____)

3. Age of respondent (in years)

- Less than 18
 8 -32
 33 – 45
 46 – 60
 Above 60

4. Household Size.

- 1-5
 6-10
 Over 10

5. Occupation
- Teacher
 - Civil servant
 - Trader
 - Farmer
 - Private sector
 - Others
6. Level of formal education
- None
 - Primary level
 - 'O' Level
 - 'A' Level
 - Diploma level
 - University Level
7. What is the size of your farm (ha): _____
8. Estimated earnings from off-farm activities Kshs per year
- Less than 20,000
 - 20,001 – 50,000
 - 50,001 – 100,000
 - Above 100,000
9. What is the type of your land ownership?
- Leased
 - Freehold
10. What is the size of the land under sugarcane in hectares? _____
11. What is the number of adult persons available as labour for your sugarcane farm? _____
12. What is your source of your farm labour for sugarcane production?
- Family
 - Hired
 - Both family and hired

C: ADOPTION OF IMPROVED SUGARCANE PRODUCTION TECHNOLOGIES

1. What cycle is your cane?
 - Plant
 - Ratoon
2. What is the age of the cane? (In months)
 - 1-3
 - 3, 1-5
 - 5, 1-8
3. From whom do you receive advice as far as adoption of improved sugarcane production technologies is concerned?
 - MSC extension staff
 - Fellow farmers
 - Other
4. How often do you receive agricultural extension services concerning improved sugarcane production technologies?
 - Weekly
 - Monthly
 - Quarter yearly
 - Biannually
 - Annually
 - None
5. How effective are the MSC extension personnel in influencing you to adopt improved sugarcane production technologies?
 - Very effective
 - Moderately effective
 - Not effective
6. For the number of times you have come in contact with MSC extension staff, which extension method were used?
 - Home visits
 - Method demonstration
 - Result demonstration
 - Barazas
 - Shows
 - Field days

7. i) Do you weed timely? (At least 5 times for plant cane and times for ratoon cane)?
- Yes
- No
- ii) If yes, how long have you been weeding timely? (in years)
- less than 1
- 1-3
- 3.1 - 5
- Above 5
- iii) If no, why? _____
8. i) Do you apply fertilizer timely? (plant cane-1st application during planting time and 2nd application at 4 months while for ratoon cane -1st application at between 1-2 months and 2nd application at 4 months)
- Yes
- No
- ii) If yes, how long have you been applying fertilizer timely? (in years)
- less than 1
- 1-3
- 3.1 - 5
- Above 5
- iii) If no, why? _____
9. i) Do you belong to any farmer's organization?
- Yes
- No
- ii) If yes, which organization?
- MOCO
- Other (specify _____)
- iii) If no, give reason why _____
10. i) Have you received credit for sugarcane farming within the past 5 years?
- MSC
- MOCO
- MOSACCO
- Commercial Banks
- Other (specify _____)

ii) If no, give reasons why

11. What in your opinion, are the main factors influencing the adoption of the improved sugarcane production technologies of weeding and fertilizer application among the small – scale farmers in this area?

APPENDIX II: OBSERVATION SCORE SHEET

Improved Sugarcane Production Technology	Score	% out of 5 points
Fertilizer application	_____	_____
Weed Management	_____	_____

Guide to scoring

Max ----5

Min ----0

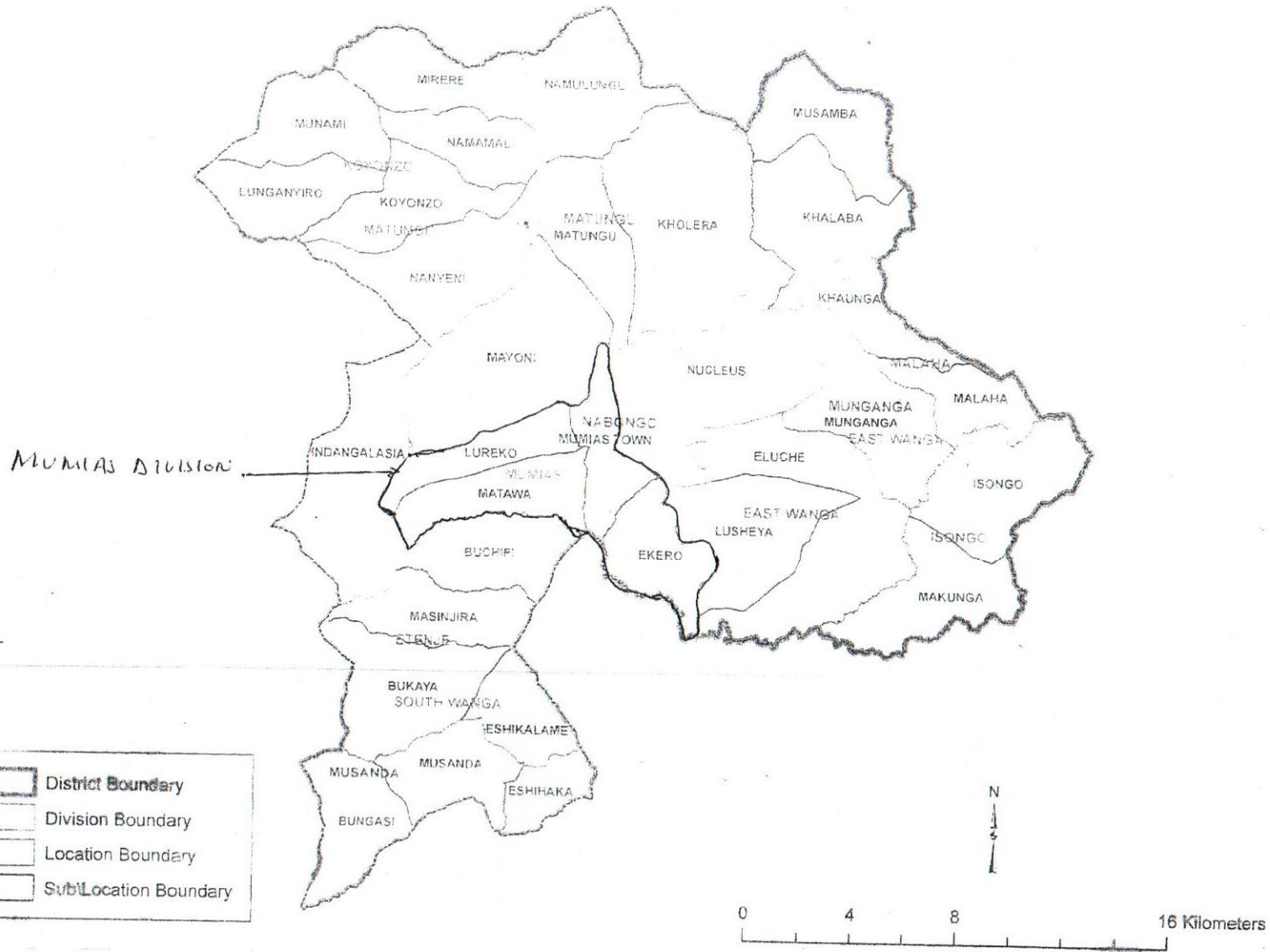
Fertilizer Application

Evidence of timely applied fertilizer, depicted by very green cane leaves and high vegetative growth earns 5 points while presence of very yellow cane leaves and nil or very low vegetative growth earns 0 points

Weed Management

Very clean plot without any weeds earns 5 points while very weedy, por and non weeded plot earns 0 points.

APPENDIX III: MUMIAS DISTRICT MAP



APPENDIX IV: RESEARCH PERMIT

CONDITIONS

1. You must report to the District Commissioner and the District Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit.
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, fitting and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two (2) four (4) bound copies of your final report for Kenyans and non-Kenyans respectively.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice.



REPUBLIC OF KENYA
RESEARCH CLEARANCE
PERMIT

CPK 6045-240-102003

(CONDITIONS—see back page)

PAGE 2

PAGE 3

THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss BONIFACE SHIKUKU
MAKHANDIA

of (Address) BOERTON UNIVERSITY
P.O. BOX 556 KJORO

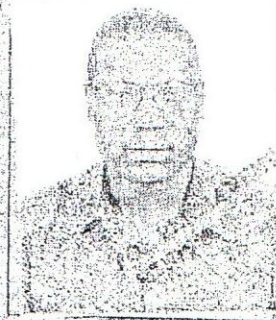
has been permitted to conduct research in

MUMIAS Location
WESTERN District
WESTERN Province

on the topic DETERMINANTS OF ADOPTION
OF IMPROVED SUGARCANE PRODUCTION
TECHNOLOGIES BY SMALL SCALE FARMERS
IN MUMIAS DIVISION OF MUMIAS
DISTRICT, KENYA

for a period ending 30TH NOVEMBER 20 08

Research Permit No. MOEST15/001/280 KTB
Date of issue 2.10.08
Fee received KSHS - 500



M. O. ODIERU
Applicant's FOR Permanent Secretary
Signature Ministry of
Science and Technology