LUND UNIVERSITY

International Master's Programme in Environmental Science

Farmers' Knowledge and Perception towards a Sustainable Adoption of Sugar Beet in Kenya

A Thesis Submitted in Partial Fulfillment for the Award of a Master of Science Degree in Environmental Science at Lund University, Sweden

Author:
Sosu Edward Mawusi
LUMES
P.O. Box 170
SE-221 00 Lund
Sweden
Email: skudzoe@yahoo.co.uk
edward.sosu.357@student.lu.se

Supervisor:
Bodil Elmqvist
MICLU
P.O. Box 170
SE-221 00 Lund
Sweden
Phone: +46 46 222 0512
Email: Bodil.Elmqvist@miclu.lu.se

November 2004

Table of Contents

List of Figures

List of Plates

List of Tables

Abstract

Poverty is a major issue in Kenya. Like most developing countries, majority of the rural poor depends on agriculture. In order to reduce poverty, the agricultural sector must be revitalized and one of the possible solutions is the introduction of new technologies like sugar beet. The research considers the possible path of diffusion of this innovation in respect to Hägerstand and Rogers's innovation diffusion theories. Rogers's innovation decision process is used as the theoretical argument that knowledge and perception of the farmers is relevant for a sustainable adoption of the crop. Structured interviews were used for data collection among three groups, Nyandarua sugar beet trial farmers, Nyandarua farmers and Butere/Mumias farmers. The results show farmers' knowledge on sugar beet to be low. Findings also reveal differences in knowledge on sugar beet among farmer categories studied. Overall, farmers have a good perception about new technologies and are willing to adopt the crop. Economic factors rank highest as the characteristics that farmers want to see in sugar beet in order to adopt it. Since, the sustainability of the crop in Kenya depends on this factor, it should be carefully considered especially in view of the current complexity in the world market of sugar. Trial projects with educational programmes that incorporate farmers' knowledge and perception is a good way of introducing the crop to farmers in Kenya.

Acknowledgements

This work is the result of the efforts of a considerable number of individuals to whom I owe gratitude. Unfortunately, only a few can be named here.

My most sincere thanks go to my supervisor Bodil Elmqvist of the Centre of Environmental Studies-MICLU, for being two steps ahead all the time and always being there for me.

I would also like to express special thanks to Syngenta Seeds AB-Sweden for providing me with the funds and materials for the study. I am particularly indebted to Flemming Yndgaard for his interest, encouragement and insightful comments before and during the writing of the thesis. I also thank Professor Bengt Bentzer, Maria Nihlgård and Staffan Nilsson.

The farmers of the Nyandarua and Butere/Mumias Districts of Kenya have played a substantial role in providing the needed information for this work. I would like to express my sincere thanks to Mr. and Mrs. Wilfred Geita and members of Kiriita Agriculture Self Group, Ndiangui Githahi and officers of the Ministry of Agriculture, Nyandarua, whose kind help and patience made it possible for me to locate sugar beet trial farmers. I also thank the Agronomists at the Mumias Sugar Company for their information, discussions and hospitality.

I am especially grateful to all the staff at MICLU and LUMES for having the patience and time to guide me when the going gets tough. Thanks to Dr. Jonas Åkerman of the Department of Physical Geography for his help with information.

I also thank Mrs. Elizabeth Munyori, Patrick Maina, Grace Gitau of the Kenya Agricultural Research Institute (KARI) Headquarters, Nairobi, for providing me access and information from the library during my literature review.

Special thanks to Nicodemus Mandere Mandere for serving as my research assistant and for spending extra time to critique my work. Special thanks to Mr. and Mrs. Bernard Mandere and the entire Mandere family of Kenya for taking me as a family member and giving me a head start in a foreign land.

I am particularly grateful to my family whose love and resources has brought me this far.

My life in Sweden would have been boring and difficult without the help of my friends who provided me the much needed family. To Christina Andersson, I say you are a real princess. Thanks go to my African brethren and sisters in Sweden for being instrumental in my survival. Special thanks to Martin Ugander, Johannes Nebel and members of FN choir, Sweden, for their great friendship.

For my LUMES friends, you have really shaped my life and will continue to live in my heart.

List of Abbreviations

ACP	African Caribbean and Pacific Countries
BM	Butere/Mumias
CLD	Causal Loop Diagram
CMS	Cytoplasmatic Male Sterility
EBA	Everything But arms
EU	European Union
FTC	Farmers Training Centre
GDP	Gross Domestic Product
GIS	Geographic Information Systems
LDC	Least Developed Countries
N	Nyandarua
NSBT	Nyandarua Sugar Beet Trial
OECD	Organization fro Economic Co-Operation and Development
TSB	Tropical Sugar Beet
USA	United States of America
WCED	World Commission on Environment and Development
WTO	World Trade Organization

1. Introduction

Growth in agriculture has been linked to development in other sectors which invariably contributes to poverty alleviation (Khan, 1999). In the two decades following independence, Kenya's economy grew at an average rate of 6% per annum. This growth was realized due to tremendous performance of the agriculture sector. However, the last two decades has witnessed an overall stagnation in economic growth following a dramatic decline in agriculture growth (Ministry of Agriculture and the Ministry of Livestock and Fisheries Development (MAMLFD), 2004). Out of the 56% of Kenyans thought to be living below the poverty line, 80% live in the rural areas and depend on agriculture for their livelihood (MAMLFD, 2004). Thirtle, Lin and Piesse (2003) observed that development in the agricultural sector has a powerful impact on poverty because it helps majority of poor people compared with development in other sectors like industry or services. To break the poverty cycle will thus require unearthing the productive potentials of people by making agriculture more productive and lucrative through broad based growth and development of the sector. In otherwords, drawbacks to the realization of poverty reduction through agricultural transformation especially among rural farmers must be seriously tackled in order to improve the well being of the populace.

The desire to reduce poverty through agricultural activities led to frequent introduction and research into new varieties of crops such as early maturing and high yielding seeds of maize, wheat and seed cane (Kaumbutho, Karuri & Odhiambo, 1996; United Nations Centre for Regional Development (UNCRD), 2003). Plans to diversify cash crop production and to encourage the growing of high value crops are also among various strategies to reduce poverty (Ministry of Finance and Planning, 2001). It is this same need to create wealth and reduce poverty that encouraged the Kiriita Agriculture Self Help Group in the Nyandarua district of Kenya to experiment with sugar beet to see its viability so as to adopt it as cash crop whose byproducts will also serve as animal feed for their livestock. The successes of this trial at Nyandarua prompted Mandere (2003) to research into the possibilities and challenges of introducing sugar beets as a sustainable solution to the sugar deficit in Kenya. Mandere's findings indicated that over ¾ of the studied areas, in the Nyandarua and Kakamega districts of Kenya had a good potential for large scale sugar beet production when he overlaid the biophysical, social and economic potentials. He however observed some biophysical, social and economic challenges which if not resolved through farmer education could hinder a sustainable sugar beets production. Access to cheap and disease resistant varieties, knowledge of required agronomic practices and ready markets was observed as issues that should be resolved before sugar beet is introduced on a large scale (Mandere, 2003). Also, about 75% of the farmers he interviewed expressed a desire for sugar beets but with the condition that it brought with it certain characteristics.

Sugar is an important commodity in most countries providing about 7% of the world's calorie supply whiles contributing to over 10% of total export earnings of 12 developing countries from 1995-2000 (Mitchell, 2004). In Kenya, the sector contributes about 34% to the Gross Domestic Product (GDP) and serves as a major source of employment both

directly and indirectly (Sugar Campaign for Change (SUCAM), 2002). Thus, it is a major engine of growth to Kenya's economy through the promotion of industrialization and agriculture hand in hand. The sector also supports over 2.6 million Kenyans and serves as a major source of income for over 100,000 small-scale farmers (Kenya Sugar Board Bulletin, 2002). In terms of direct employment, the sector covers over 300,000 people serving as a check on rural-urban migration (Kenya Sugar Board Bulletin, 2002). These contributions have implications for majority of the poor who depends on agriculture.

The agriculture sector in general except for horticulture has however witnessed a decline with regards to export earnings, employment creation, food security and household farm incomes over the years (Government of Kenya, 2003). The growth rate of 4.4% experienced in 1996 decelerated to 1.5% in 1999 and to a -2.4% in 2000. Growth in 2002 remained at a weak rate of 0.7% (Government of Kenya, 2003). The sugar sector which is the third largest contributor to agricultural gross domestic product was not spared in this decline. The Kenyan Sugar Board in its (2001) report has observed a generally declining trend in sugar yield. This has led to large sugar deficit which is catered for through importation. For example, sugar import to Kenya amounted to about 300,000 metric tones as at the year 2000 (Kenyan Sugar Board, 2001). Though imports have reduced to 182 225 metric tonnes in 2003 and 39,977 metric tonnes in the first quarter of 2004 representing a 23% decrease, the sector continues to be plagued with myriads of problems (Kenya Sugar Board, 2004). The 1.2% increase in total area under cane at the end of the first quarter of 2004 for instance, was only attributed to the South Nyanza sugar belt while all the other areas experienced a diminishing cane area (Kenya Sugar Board, 2004).

In enumerating the reasons for the decline in agricultural productivity in Kenya, "poor access to farm credits, high cost of farm inputs, and insecurity in certain parts of the country, and taxation of farmers through local authority cess and other levies" were among the major factors (Government of Kenya, 2003). Another problem that was of critical concern was the absence of appropriate technology that is responsive to variations in agro-ecological zones and the lack of funding research and extension services (Government of Kenya, 2003). Specifically, the sugar industry is plagued with the problem of long maturing sugar cane variety (SUCAM, 2002; Kaumbutho et al., 1996). The sugar produced in Kenya is from sugar cane. Cane production in Kenya takes 20-24 months to mature and to complete a one plant crop cycle whiles taking 18-24 months each in reaching maturity for two ratoon crops. In total, a whole crop cycle which starts from planting to removal of stools for new planting takes about six years (Kaumbutho et al., 1996). Thus, while cane takes a minimum of 18 months to mature in Kenya, it takes only twelve months to reach maturity in Guyana (SUCAM, 2002). The absence of research into early maturing varieties coupled with other problems makes sugar cane farming very unprofitable for farmers (Kaumbutho et al., 1996). What this means is that most farmers will have to wait for long periods before getting some income and this has negative effect on sustaining their family's livelihood and education of their children. The introduction of new technologies could thus be of help in alleviating these problems.

Innovations usually bring with it some degree of benefit to its potential adopters but it equally creates some kind of uncertainties in the mind of adopters (Rogers, 1995). This uncertainty is however reduced by the information embodied in the innovation itself in the form of the possible abilities of the innovation to solve individual's perceive problems. Hillbur (1998) contended that agricultural development result from the introduction of new ideas, practices or materials into the production process. The introduction of sugar beet in Kenya can help alleviate poverty through job creation by serving as a cash crop as well as an early maturing complementary crop for sugar production that will bring regular flow of income to farmers. This innovation or new technology has advantages as well as some challenges which need to be carefully examined to ensure that it benefits the poor farmers. The question to be addressed then is whether sugar beet as a new technology has the ability to solve individual Kenyan farmers' perceived problems and alleviate poverty. For the project to be sustainable, it is equally important to consider the knowledge and perception of the farmers who are the potential adopters of this new crop.

Wossink and Boonsaeng (2003) observed that farmers' perception and knowledge is crucial for successful research and development strategies. They further stated that many promising agriculture policies have failed because they were inappropriate to farmer's needs and perception. Perception generally refers to how people select, organize and interpret information gained through the senses or experience (Encyclopaedia Britannica, 2004). Sustainability of agricultural production is largely dependent on the action of farmers and their decision making abilities given the level of knowledge and information that is available to them (Rahman, 2003). However, the role of perception has received very limited attention in studies regarding farmers' adoption of a new technology (Wossink, de Buck, Niejenhuis & Haverkamp, 1997; Adesina & Baidu-Forson, 1995). Also, there has been a general failure of programmes to address situations where farmers' knowledge is lacking and inadequate (Nyeko, Edward-Jones, Day & Raussen, 2002). Thus to prevent failure with sugar beet and ensure a sustainable adoption of this new technology, a good understanding of the knowledge, needs and perception of the farmers is required in order to devise a systems approach of introducing the crop to them. The study also complements the few scientific studies available on the sustainability of tropical sugar beet. An assessment of farmers' perception and the problems will equally be carried out to eliminate any pro-innovation bias that might otherwise unknowingly characterize the research (Rogers, 1995).

1.1 Significance of the Study

The study will help provide scientific information on the necessary social and psychological factors that would influence the acceptability of the new crop and any large scale sugar beet production in Kenya. This would be instrumental in bridging the current social and psychological knowledge gap on tropical sugar beets. It will also form the basis for understanding the psychological and social factors underlying the adoption of a new crop by farmers. Psychological factors represent the uncertainties created in the minds of adopters of this innovation, as well as the opportunity it provides to reduce uncertainty through solving the individual farmers' perceived problems (Rogers, 1995). Social factors on the other hand are related to the extent to which other farmers will be

dependent on the subjective evaluation of the innovation by individuals they consider to be more like themselves, thus farmers who have previously adopted the innovation (Rogers, 1995).

Furthermore, it will help promote sustainable large scale sugar beet production in order to ensure reliable income for farmers and invariably reduce poverty levels in Kenya. Also, important is the fact that unearthing the potential ability of Kenyan farmers to sustainably produce sugar beet on a large scale will provide policy makers and investors the necessary information regarding the viability of such a project.

Finally, the study will be instrumental in designing appropriate educational programs to fill in the gap in farmers' knowledge as well as predispose them to having an objective perception of the crop before and during its introduction. This is paramount because sugar beets is new and require special care that is otherwise absent in sugar cane cultivation and as a new crop it is only proper that farmer's have adequate knowledge about it so as to ensure a sustainable cultivation.

1.2 Objectives of the Study

Generally, the study will examine the extent of diffusion of knowledge and perception among farmers towards the adoption of sugar beet in Kenya.
Specifically it will seek to;

- Diagnose the problems that Kenyan farmers' face with their crops.
- Determine the kind of typical characteristics that farmers require in a new complementary crop in order to be committed to the innovation decision process.
- Find out the extent of farmers' awareness of sugar beet and their knowledge about its cultivation process in order to evaluate a possible knowledge gap of farmers on the sugar beet crop.
- Compare the knowledge and perception of sugar beet trial farmers and non sugar beet trial farmers on the adoption of innovations.
- Analyze their perception on the introduction of sugar beet as a sustainable new complementary crop both in terms of sugar production and as cash crop and
- Make recommendations for effective farmer educational programs prior to a large scale introduction of sugar beet.

1.3 Scope and Limitations of the Study

The research considers the place of knowledge and perception and how that will influence adoption decisions among Kenyan farmers. It is not a complete analysis of all the factors that influence the adoption of a new technology. The findings also apply mainly to the study areas and cannot be said to reflect the view of all farmers in Kenya since the factors that influence the perception and acceptability of new things might differ between communities based on previous experience and other circumstances. The short time period available for the research to be carried out did not allow for an in-depth analysis of all variables such as the world market sugar conditions, gender, Hägerstrand's (1967) "distance bound neighbourhood effect", those who have stopped the trials etc.

Also, information on Tropical Sugar Beet was accessed from very few books and journals because of limited documented work done in the area.

Despite these limitations, the study is a further step in the scientific analysis of sustainable adoption of sugar beet in the tropics and the role of perception and knowledge in adoption decisions.

2. Background

In order to ensure that technologies arising from crop research do not increase the deterioration of agricultural systems, it is important to understand the larger view of sustainability before taking practical steps to apply the concept to any agricultural project. Thus the sustainability of sugar beet in Kenya will be of primary focus. The chapter examines the idea of sustainability with regards to sugar beet in the tropics. It also looks at the importance of knowledge and perception with respect to Hägerstrand (1967) and Rogers's (1995) innovation diffusion theory and more specifically Rogers (1995) "Innovation Decision Process". Causal Loop Diagrams (CLDs) will be used for illustrating the various systems.

2.1 Sustainable Agriculture

The word sustainability has become a buzz word over the decades. Apart from the potential difficulties encountered in finding data to determine which production practices are sustainable, there is an absence of agreement on the appropriate definition of sustainability (Herdt & Steiner, 1995). The Bruntland commission defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development (WCED), 1987).

Sustainable agriculture is "concerned with the ability of agricultural systems to remain productive in the long run" (Herdt & Steiner, 1995). It involves determining whether particular crop production systems are productive by examining systems that have been operating for a long period on long-term experimental research stations. This information is useful in determining variability of production over the period as well as draw suggestion on its sustainability based on the record (Herdt & Steiner, 1995). Thus, suggestions regarding sustainability of sugar beet can only be made with regards to long term data accumulating from long period trial projects in Kenya.

The dimensions of sustainability are biological/physical, economic and social which can be analysed in different but interrelated ways (Herdt & Steiner, 1995). The biological dimension reflects the level of output which is dependent on physical quantity of inputs and biological growth processes. Degradation of this resource base such as erosion, waterlogging and destruction of soil structure can result in falling quantity of output over time. Changing climatic conditions or introduction of new plant diseases and pest can also cause similar effect. The economic dimension is based on the value of output, that is, the quantity times a price that represents value. Although, output of the system might be constant over time, falling commodity prices, increased input costs or other economic changes can result in the system's failure. The systems ability to effectively support farming communities represents the social dimension. Agricultural production may fall if the communities and institutions on which it depends deteriorate. For instance, poor agricultural policy, insecure land tenure, war, social disruption, and changing labour conditions can lead to non-sustainable agriculture. While economic performance greatly affects farmer's decisions, it is dependent on biological performance modified by costs

and prices. Social performance is dependent on both biological and economic performance (Herdt & Steiner, 1995).

2.2 Sugar Beet and Sugar Cane

Sugar beet (*Beta vulgaris saccharifera*) is a fleshy root crop processed for sugar production and usually associated with temperate regions. During the first year of growth, it produces sugar in order to see it over the winter while flowering and producing seeds in the second year (Cooke & Scott, 1993). Sowing is done in spring with harvesting in the first autumn or early winter.

Though sugar is thought to have first been used by man in Polynesia and discovered by western Europeans in the 11th Century, sugar beet was only first identified as a source of sugar in around 1750 (Food and Agriculture Organization/European Bank for Reconstruction and Development (FAO/EBRD), 1999). Sugar beet only replaced sugar cane as the main source of sugar by 1880 in continental Europe (FAO/EBRD, 1999). Since its discovery, the beet has spread all over the world and is cultivated in all of the continents except Australia (Cooke & Scott, 1993). Sugar beet and sugar cane serve as the major sources of sucrose with sweetening and preservative properties used in a wide range of foods, beverages and pharmaceuticals (Cooke & Scott, 1993). Sugar beet contributes about 30% of the world's sugar supply mainly produced in industrialized countries with sugar cane (*Saccharum officinarum)* contributing the remaining 70% mainly produced in developing countries under tropical conditions (FAO/EBRD, 1999).

2.3 Tropical Sugar Beet (TSB)

The idea of Tropical Sugar Beet (TSB) was developed as a result of the analysis of the future of sugar production from the late 90's (Chatin, 2004). The 2% increase in sugar production per year to meet increasing annual demands was catered for by sugar cane due to its lower cost of production than sugar beet (Chatin, 2004). According to Chatin (2004), this cost competitiveness is due to low labour cost in sugar cane producing countries whereas beet sugar produced mainly in Europe and USA has to battle with expensive labour, equipment, and land cost. Based on these realities, Syngenta Seeds, one of the three major actors in the beet seeds market, set as a goal to revitalize its market (Chatin, 2004). In 1997 first sugar beet seeds were drilled in the Pune research station outside Bombay in India to test the adaptability of beet sugar to the prevailing condition. The results indicated the beets growing well within five months with a sugar yield equivalent to that of sugar cane which takes twelve months to mature (Chatin, 2004). With the outcome encouraging, trials were carried out in many other countries like Sudan, Pakistan, Kenya, Thailand, Bolivia and Malawi.

According to (Yndgaard, 2004), since the ancestors of sugar beet originated from the Middle East and the coasts of the Mediterranean Sea, it should be practical for the beet to be adapted to more hot/ dry climates. Geita (2004) also stated that sugar beet (*Beta vulgaris saccharifera*) share the same botanical characteristics with fodder beet (*Beta vulgaris rapa*) and red beets (*Beta vulgaries crueta*) both of which have been introduced 60 years ago by the white settlers in Kenya, thus, biophysically it should be possible to

grow sugar beet in Kenya. Plate 1 show a picture of sugar beet and Plate 2 is a sugar beet trial farm in Kenya.

Plate 1: Sugar beet plant

Plate 2: Sugar beet trial farm in Kenya

2.3.1 Characteristics of TSB

Chatin, Gokhale, Nilsson & Chitnis (nd.) stated that results from trials in tropical regions show 60 to 80 tonnes of beet per hectare with a sugar content of 14% to 19% (10 tonnes of white sugar per hectare) can be produced within 5 or 6 months. This means it can be used as a good rotational crop and farmers can grow other crops before the next planting season. Water requirement has also been found to be about 30% to 50% compared to cane and it can withstand long period of drought at the end of its cycle without negative effects on the yield. With respect to soil chemistry, it can survive in both saline and alkaline conditions (above 8 EC and pH).

Chatin et al. (nd.) further observed that sugar beet needs lots of oxygen, tight control of water requirement during germination to avoid root diseases and limited nitrogen fertilization to avoid sugar impurities as well as stimulate sugar accumulation in the root at the end of the growing period. They stated that these limitations should be carefully considered.

Another characteristic of sugar beet that has an implication for economic sustainability is the buying of seeds every planting season by farmers. Sugar beet is usually strongly self sterile (Bosemark, 1993). Known as "cytoplasmatic male sterility[1] (CMS)", it was first discovered and studied in the 1940's (Bosemark, 1993). The problem is that their offspring of sugar beet are sterile and farmers must buy seeds every planting season for growing. This characteristic is thus different from most existing crops that produce fertile seeds which can be cultivated by farmers. It is acknowledged that farmers most of the time buy seeds for planting although they produce fertile seeds. However, the economic implications of this feature is important in a poor country like Kenya where incomes are low and farmers might not be in a position to afford buying seeds. The possession of

[1] For extra reading on CSM consult Bosemark, N.O, (1993) Genetic and Breeding in Cooke, D., A. & Scott, R., K. (Eds.). The Sugar Beet Crop: Science into Practice. Chapman & Hall, London

economic means to acquire an innovation has been found to be instrumental in the adoption of innovations by individuals (Yapa & Mayfield, 1978). The notion of having to buy seeds every planting season also has significant implications in terms of farmers' perception towards the new technology which will affect the extent of adoption.

2.4 World-Market Sugar Conditions

The sugar market has been branded one of the most policy distorted of all commodities with the EU, USA and Japan identified as the worst offenders (Mitchell, 2004; Oxfam, 2002). Government guaranteed prices, import control and production quotas have resulted in producers in these countries receiving more than double the world market price for their product although comparatively, they have a higher cost of production than most developing countries producers. For instance, government support or transfers from consumers account for over halve the value of sugar production in OECD countries, averaging $6.4 billion per year during 1999-2001 (Mitchell, 2004). This amount almost equals the $6.3 billion annual sugar exports of developing countries and more than half of the $11.6 billion world sugar trade within the same year. EU alone provided $2.7 billion to its sugar producers within the period (Mitchell, 2004). As a result these countries have become net exporters instead of importers dumping their surplus sugar in the world market at subsidized prices thereby denying developing countries like Kenya export opportunities and earnings. This also distorts the domestic prices of sugar in developing countries leading to low prices for the poor farmers.

Mitchell (2004) point to estimates of global welfare gains of $4.7 billion per year, employment of nearly one million workers in developing countries and an increase of 40% in world market price if trade protection by OECD countries is removed. According to Oxfam (2004), the current ruling by the WTO[2] regarding EU sugar subsidies may result in some kind of reforms that might be beneficial to some developing countries depending on the priority of the changes. They further state that only few countries will benefit from the result of the ruling with majority of very poor countries deprived the opportunity of foreign exchange earnings. The EU announced that it was going to reform the sector few months before this ruling in line with the expiration of the current EU sugar policy in June 2006 (Mitchell, 2004; EU 2004). These proposed reforms have however been criticized by African, Caribbean and Pacific (ACP) countries, stating that it will be devastating to their sugar industries with severe socioeconomic consequences (ACP, 2004). Similarly, Least Developed Countries (LDC) sugar exporting countries have criticized the reforms saying this will frustrate their legitimate expectations from the "Everything But Arms (EBA)[3]" initiative (ACP, 2004)

The complexity of the entire sugar market is crucial for the sustainability of sugar beet in Kenya as this influences market and price which are influential in farmers' perception formation and subsequent adoption decisions.

[2] Interim ruling of the dispute settlement committee following a complaint by Brazil, Thailand and Australia that EU sugar rules contravene WTO rules

[3] The EBA grants duty-free access to imports of all products (including limited amount of sugar) from LDCs without any quantitative restrictions, except to arms and munitions.

2.5 Causal Loop Diagrams (CLDs)

CLDs can be used to capture hypotheses about the causes of dynamics, elicit and capture mental models of individuals or teams and to communicate important feedback that one believes are responsible for a problem (Sterman, 2000). They have been employed in this study to capture the feedbacks of relevant variables that influence the diffusion of innovation and to serve as visual illustration of the dynamics involved in the pathways of innovation diffusion.

Variables are usually connected by arrows to denote the causal influences among variables. Each of these causal links is assigned a positive (+) or negative (-) polarity to show how the dependent variable changes when the independent variable changes. Important loops are shown with loop identifiers which can be a positive (reinforcing) or negative (balancing) feedback. According to Sterman (2000), a positive link means that an increase or decrease in cause will result in a more than proportionate increase or decrease. Negative links means that increase or decrease in cause will result in more than proportionate decrease or increase respectively[4].

However, CLDs are never comprehensive and final, but always provisional (Sterman, 2000). The aim is to present a simplified representation of a system leading to lots of assumptions being made in constructing the CLD. Most variables are thus left out. The use of the CLD in this study is simplistic because human behaviour which is the focus is much more complex.

2.6 Innovation Diffusion Theories

The relevance of knowledge and perception in influencing decisions regarding the adoption of innovations has been clearly stated by many researchers (Yapa & Mayfield, 1978; Rogers, 1995; Negatu & Parikh, 2003). However, to understand the importance of knowledge and perception in the adoption of sugar beet in Kenya, it is important to briefly examine innovation diffusion theories because they consider the relevant variables that influence the diffusion and adoption of an innovation.

Basic tenets underlying Hägerstrand and Rogers's theory will be reviewed in order to gain an understanding into how innovation spreads overtime. Hägerstrand's theory is chosen because it is one of the classical studies of the innovation diffusion process which provided the basis for the development of other theories in diffusion studies. Also his idea about the influence of distance and its relationship with respect to the diffusion of innovation is of interest to this study. The choice of Rogers's theory is influenced by the fact that apart from being one of the most comprehensive works on innovation diffusion research (Hillbur, 1998) his innovation decision process discusses the place of knowledge and perception in innovation adoption which is the focal interest of this study.

An innovation can be construed as an idea, practice or object which is perceived as new by individuals or other units of adoption (Rogers, 1995). As far as human behaviour is concerned, it does not matter whether the idea per se is new as measured by the time

[4] See Sterman (2000) for more reading on CLDs.

since its first discovery. It is the perceived newness of the idea that determines the individual's reaction to it. Thus newness does not only involve the presence of new knowledge but the development of either a positive or negative disposition towards the innovation (Rogers, 1995). The words "innovation" and "technology" can mostly be used as synonyms. Technology as observed by Rogers (1995) "is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome". Technologies usually consist of two components, that is, a *hardware* aspect made of the tools which represents the technology as a material or physical object and the *software* aspect that is made up of the information base for the tool (Rogers, 1995). Viewed in this sense, the sugar beet seeds can be described as the hardware aspect while the knowledge needed for a sustainable adoption will be the software part. Technology however is always thought of in hardware terms but in other cases it may be composed entirely of information like a political philosophy, a religious idea, a news event, rumor, assembly-line production, and quality circles (Rogers, 1995).

Diffusion however, is "the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 1995). It is also considered as a gradual process by which firms or individuals adopt successful innovations (Jaffe, Newell & Stavins, 2000). Diffusion is thus a special type of communication mainly pre-occupied with the spread of ideas perceived as new. The four main elements in this process are; the innovation, communication channels, time and the social system which according to Rogers (1995) are identifiable in every diffusion study, campaign or program.

Communication channel is the means through which information is passed from one person to the other. This can be either through the mass media (effective in creating knowledge of innovation) or interpersonal channels (which are more effective in forming and changing attitudes toward a new idea). Hägerstrand (1967) in a series of diffusion studies came out with the proposition that the spread of innovation is the result of *learning* or *communication* process (Brown, 1981). He explained that although a 'strict spatial sequence from farm to farm' was non-existent, an influential distance-bound 'neighbourhood effect' was continuously evident as the central feature of the innovation process (Gregory, 1987). Reasoning from this, he espoused that private rather than public, that is, person-to person 'pairwise tellings' was the most fundamental push factor responsible for innovation diffusion (Gregory, 1987). The limiting factor to the diffusion of innovation is when individuals perceive the innovation as not meeting their social economic or psychological needs (Brown, 1981). This discrepancy is likely to result in conflict within the individual.

In evaluating the diffusion of information on sugar beet, it is useful in finding out if there is a significant "neighbourhood effect" with respect to distance regarding knowledge among the non sugar beet trial farmers. This will provide an understanding of the best and possible pathways in which knowledge on sugar beet should be diffused. It is also important to look at previous post adoption behaviour to evaluate factors that are likely to limit the diffusion of sugar beet among Kenyan farmers. Figure 2.1 is a simple illustration of the innovation diffusion process.

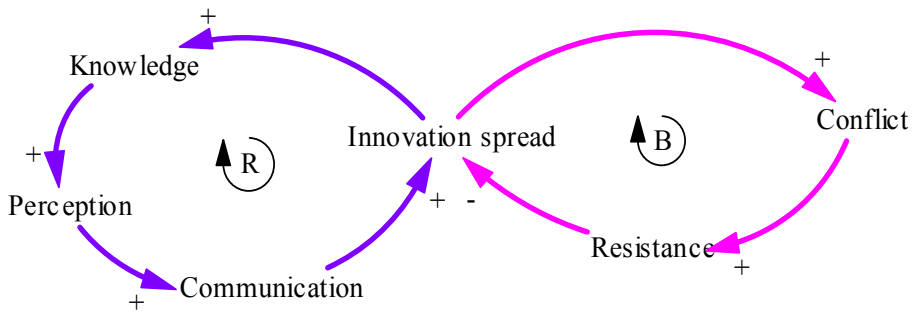

Figure 2.1: CLD of innovation diffusion

The Causal Loop Diagram (Figure 2.1) above illustrates the reasoning of Hägerstrand and Rogers's innovation diffusion theory (Refer to more detail in figure 2.1 & 2.3). The more an innovation spreads, the more knowledge will be acquired by adopters. More knowledge will result in a positive perception which will be communicated to others who have not adopted the new idea. The non-adopters will then try it leading to more spread of the innovation. This represents a reinforcing system of the diffusion of an innovation. With time, adopters may come to analyze the level of similarity between the innovation and their social, economic and psychological characteristic needs (Brown, 1981). If the characteristics of the innovation do not meet the needs of the potential adopters, it will create a sense of conflict or dissonance which results in resistance that limits the spread of the innovation. This aspect of the loop represents a balancing effect.

2.6.1 The Innovation- Decision Process

The innovation-decision process is a process in which "an individual (or other decision-making unit) passes from knowledge of an innovation to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation and use of the new idea, and to confirmation of this decision" (Rogers, 1995). Individual's decision to adopt an innovation is not immediate but follows a process made up of sequences of actions and decisions which occurs over time (Rogers, 1995). The basic of the processes is knowledge and persuasion, synonymous to perception. The five main steps in the innovation-decision process are: Knowledge, Persuasion, Decision, Implementation, and Confirmation. Yapa and Mayfield (1978) mention similar conditions; availability of sufficient information, existence of favourable attitude towards the innovation, possession of economic means to acquire the innovation and the physical availability of the innovation as necessary conditions to satisfy before individuals adopt an innovation. These factors however vary in terms of importance depending on the character of the innovation under discussion (Yapa & Mayfield, 1978). The stages in the innovation-decision process are however not distinctive and autonomous but overlap (Rogers, 1995) due to the complexity of human behaviour.

Knowledge

Knowledge has varied meanings based on its own epistemology, i.e. its own theory of what knowledge is. What knowledge is depends on who does the interpretation and the

purpose for which it is done (Hillbur, 1998). According to Rogers (1995) it is when individuals (or other decision-making unit) learn about the existence of an innovation and seek understanding of how it operates. He postulated that individuals mainly look for software information embodied in the innovation by seeking to know what the innovation is, how it works and why it works. He however contended that individuals actively engage in selective exposure and attend to messages consistent with their pre-existing attitudes and beliefs (Rogers, 1995). In otherwords, individuals are selective in terms of the information they attend to and they give preference to messages that agree with the attitudes and believes.

The definition of knowledge in this study encompasses this software knowledge as well as local knowledge of farmers which until recently has not been considered and treated as relevant (Hillbur, 1998). Though this idea of local knowledge has been subjected to several opinions, what it focuses on and refers to in this research is farmers' awareness of sugar beets, the extent to which they engage in problem diagnosis as well as evaluate the compatibility and differences between their other crops and sugar beet based on experience. Jaffe et al. (2000) observed that adoption of an innovation is a risky business that requires lots of information on the attributes and use of the particular innovation. They stated that since it takes time for information to be properly diffused, an innovation's diffusion is limited by this process of information diffusion. The adoption of sugar beet therefore depends on whether farmers have the adequate software knowledge of what it is, how the beet is cultivated as well as their perception of the extent to which it is similar or different from their already existing crops. The process of knowing is however a social process that involves talking to others like change agents or gaining information through the mass media (Rogers, 1995).

Rogers characterized knowledge into three levels. The *awareness-knowledge* is information that an innovation exists and it is this knowledge that motivates individuals to seek *how-to knowledge* and *principles knowledge*. The *how-to knowledge* is the information that one needs to properly adopt an innovation. It involves the understanding of how much of the innovation to use and how to use it correctly. This can be likened to the software knowledge. The absence of this knowledge before trial and during adoption of an innovation is likely to result in conflict and resistance. *Principles- knowledge* is information regarding the functioning principles that underlie how the innovation operates. The knowledge regarding the biology of plant growth for instance underlies the adoption of fertilizers by farmers. Although this kind of knowledge is not always necessary for adoption, the absence of it may lead to a greater chance of misusing the innovation which may later result in conflict (Rogers, 1995). One important variable that influences knowledge acquisition is experience. In their study of Ugandan farmers, Nyeko et al. (2002) found out that farmers' awareness of Alnus pest was significantly influenced by their length of experience in cultivating the species. Thus, since farmers rely on their own experiences as a source of knowledge, variation in knowledge is likely to occur between farmers who have an experience with sugar beet cultivation and those who have never cultivated it. Accurate knowledge about an innovation has been identified as the necessary condition for adoption (Yapa & Mayfield, 1978). In their work on farmer perceptions of weed control techniques in sugar beet, Wossink et al. (1997)

concluded from their survey data that knowledge required, labour requirements and risk were important determinants in the selection of a weed control technique. It is for instance crucial for an individual to be aware of the existence of an innovation before he or she tries it. Obviously if an individual is not aware that an innovation exists in the first place, there will be no effort made to try or adopt it.

Knowing about an innovation may not necessarily result in its adoption especially when individuals do not consider it as relevant to their situation, and as useful (Rogers, 1995). The perception that the individual holds about the innovation is more relevant in determining his or her passage through the innovation-decision process (Rogers, 1995). Yapa and Mayfield (1978) have observed that although knowledge is a necessary condition for adoption decisions, it is not a sufficient condition in itself. Evidence points to access to land and security of tenure, access to credit, and access to inputs such as fertilizer, seeds and water as the most important factors affecting adoption decisions (Yapa & Mayfield, 1978).

Persuasion

The persuasion stage is when people develop favourable or unfavourable beliefs toward the innovation. This involves innovation evaluation where individuals seek to know the advantages and disadvantages of the innovation and its applicability to their own situation. This reduces the level of uncertainty about the innovation's expected consequences. During this stage, individuals become psychologically involved with the innovation by actively seeking information about the new idea, the messages they have received, and interpret the information received (Rogers, 1995). Gurung (2003) acknowledged that it is relevant to include people's perception in the analysis of innovation adoption decisions. He maintained that an individual's background, cultural context and social rules influence his or her decision to a large extent and farmer's perception differs from those of researchers and extentionists.

Assessment of deciding factors that influence farmers' decision to adopt new agricultural technology to old or alternative ones shows it as dependent on the perception of the characteristics of the new crop in comparison to existing ones (Negatu & Parikh, 1999; Adesina & Baidu-Forson, 1995). An analysis of the perception of sugar beet trial farmers with respect to the characteristics they perceive in sugar beet and how they compare the crop to existing crops is thus needed.

The importance of perception in adoption decisions has been confirmed by various research findings. In a study of a sample of Ethiopian farmers, it was realized that perception about modern varieties of grain had a significant effect on its adoption (Negatu & Parikh, 1999). A study by Adesina and Baidu-Forson (1995) also show a demonstrable impact of farmers' perception of the characteristics of new crops on adoption decisions. Analysis of their data on modern sorghum and rice varietal technologies in Burkina Faso and Guinea respectively showed that farmers' subjective preferences of characteristics like yield, food quality, tillering capacity etc had a significant effect on farmers' adoption of these varieties. Concluding from their analysis Adesina and Baidu-Forson (1995) reasoned that varieties that farmers judge as possessing

better yield performance over local varieties tend to be those that are adopted. Wossink et al. (1997) for instance, found demonstrable evidence showing that farmers' subjective preferences for characteristics of new weed control techniques were important determinants of adoption behaviour. They further argued that the focus on improving agronomic characteristics was too narrow and that farm organization (labour requirement and labour balance), management (knowledge) and risk characteristics were the decisive factors in adoption decision.

Since perception differs among individuals, awareness of factors that influence its formation would aid in the development and transfer of appropriate technologies. In determining factors that influences farmers' perception on new crops, Negatu and Parikh (1999) mentioned among other things the relevance of knowledge and experience in growing the new crop. The significance of experience in influencing knowledge and perception was subsequently confirmed by the findings of Nyeko et al. (2002).

One important consideration at this stage is the influence of near-peers based on the fact that individuals feel a need for social reinforcement of their belief or attitude toward the new idea. The subjective opinion of peers (based on their personal experience with the innovation) is most convincing because "when someone who is like us tells us of their positive evaluation of a new idea, we are often motivated to adopt it" (Rogers, 1995).

Decision

Decision is when individuals engage in activities that lead them to either adopt or reject the innovation. "*Adoption* is a decision to make full use of an innovation as the best course of action available", while "*rejection* is a decision not to adopt an innovation" (Rogers, 1995). Individuals will mostly adopt only after a probationary trial to determine its usefulness in their own situation, however, "trial-by-others" may provide some form of vicarious trial for some adopters (Rogers, 1995). It has been acknowledged that the knowledge-persuasion-decision process does not always follow in the logical manner as proposed by the innovation-decision process but could sometimes follow from knowledge-decision-persuasion (Rogers, 1995).

Implementation

Implementation is when individuals put the innovation into use. Individuals at this stage want to find answers to questions as, "Where do I obtain the innovation?" "How do I use it?" "How does it work?" and "What operational problems am I likely to encounter and how do I solve them?" (Rogers, 1995).

Confirmation

The final stage of confirmation is when individuals seek to reinforce the innovation decision that they have already made, but people may descent their decision when they experience conflicting information regarding the innovation (Roger, 1995). Individuals at this stage seek to avoid a state of dissonance or try to reduce it if it thus occurs. Thus as to whether farmers who have had trials with sugar beet are eager to adopt it on a large scale or not is instrumental for understanding a long term adoption by other farmers.

Figure 2.2-2.3 illustrates the innovation decision process which is an expansion of the reinforcing loop of Figure 1. This represents the place of knowledge and perception in the diffusion of sugar beet.

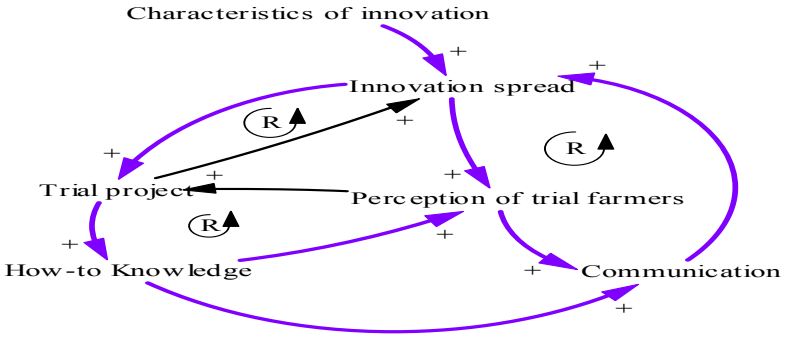

Figure 2.2: CLD of diffusion of knowledge and perception among trial farmers

The diffusion of knowledge and perception on sugar beet among trial farmers is likely to follow the path illustrated by the Figure 2.2 above. The diffusion process will be influenced by the characteristic of beet. Thus the more innovation spread that occur, resulting from good characteristics of beet, the more positive perception they will have towards it. This will lead to more communication among farmers about the crop which will promote the spread of the innovation. This represents a reinforcing loop and the thick arrows shows a dominating system. Consequently, the spread of sugar beet will lead to setting up more trial projects which will increase their *how-to knowledge*. Increase in *how-to knowledge* leads to more perception of the crop as well as more communication which will inevitably lead to increase in the spread of the innovation.

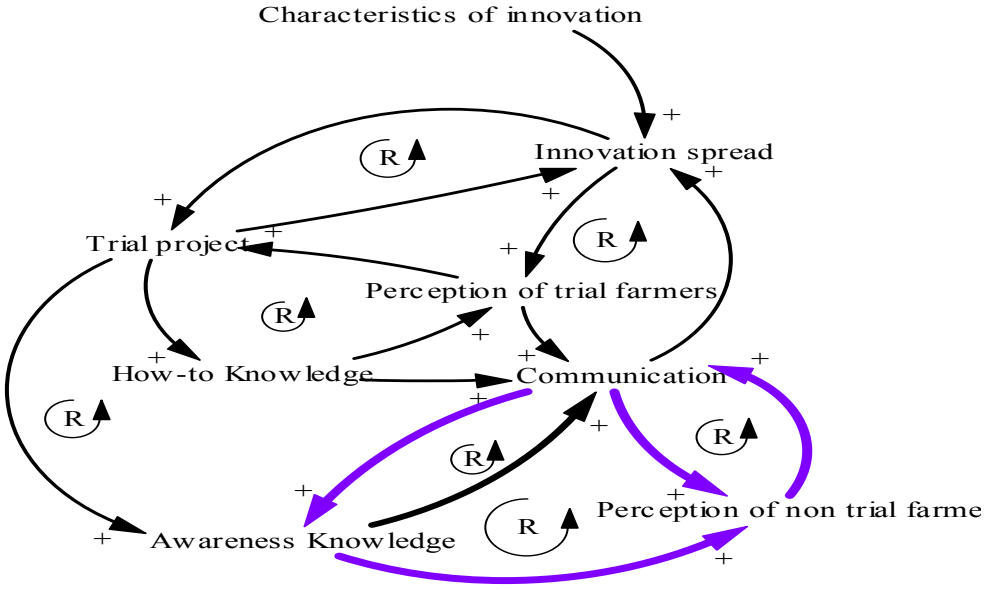

Figure 2.3: CLD of diffusion of knowledge and perception among non trial farmers

Figure 2.3 shows how information will be diffused among non trial farmers. More communication about sugar beet by trial farmers resulting from more positive perception

and *how-to knowledge* will lead to more *awareness knowledge* about the crop. This will lead to more perception of the crop by non trial farmers who will also talk about it to others thereby leading to the diffusion of beet. The communication by farmers who have tried beet will also strongly influence the perception of the non trial farmers.

2.6.2 Criticism of Innovation Diffusion

The adoption of an innovation should not be assumed as something that is necessarily desirable since these innovations might not be desirable for either the individual or the social system (Rogers, 1995). Additionally, a particular innovation may be pleasing to one adopter in one situation, but prove to be undesirable for another potential adopter in a different situation (Rogers, 1995).

The notion that diffusion and adoption of innovation has positive impact upon individuals' welfare and subsequently economic development and social change has received myriads of criticisms. The assumption of an equal opportunity for everyone in the adoption of innovation has been flawed. Evidence point to the fact that disparities in access to resources, interest, societal rules and norms results in inequalities and that innovation tends to widen the socioeconomic gap between the higher and the lower status segments of the system (Hillbur, 1998; Rogers, 1995). Although the disparities can occur in all social systems, it has been found that apart from not leading to any significant development and improvements in individual welfare, innovation diffusion has greatly increased regional inequalities, widens the disparities between social and economic classes and only creates more advantages for the rich in Third World countries (Brown, 1981).

Another criticism rests on Pro-innovation bias of most diffusion studies which inevitably results in conclusions that the adoption of a particular innovation should be rapid and should not be rejected (Rogers, 1995). Although, seldom is this bias stated directly in findings, it is mostly assumed and implied. The reasons for this has been adduced to the fact that most researches regarding diffusion of an innovation is sponsored by a change agency whose primary concern is not whether the innovation will be beneficial or not, but to promote its rapid diffusion (Rogers, 1995). Subsequently, most documented works of innovation shows successful cases and little attention is paid to unsuccessful cases. It is thus suggested that diffusion studies should examine the adopter's perceptions of the innovation and of his or her own situation, problems and needs (Rogers, 1995).

2.7 Areas of Study

Kenya like many other developing countries has agriculture as the main support of its economy. The sector directly contributes 26% to the gross domestic product (GDP) and 60% of all export earnings (MAMLF, 2004). About 80% of the Kenyan population resides in the rural areas and earn their livelihood from agriculture with majority of the urban poor also living on agriculture related activities (MAMLFD, 2004). The three main contributors to agriculture GDP are tea, coffee and sugar respectively (Kenya Sugar Board Bulletin, 2002).

The information presented on the study areas is derived from the Nyandarua district regional development plan 2001-2030 (UNCRD, 2003) and the Butere/Mumias district development plan 2002-2008 (Ministry of Finance and Planning, 2001). The main reason that influenced the choice of these districts was that Geographic Information System (GIS) overlays show them to provide a potential for sugar beet production (Mandere, 2003).

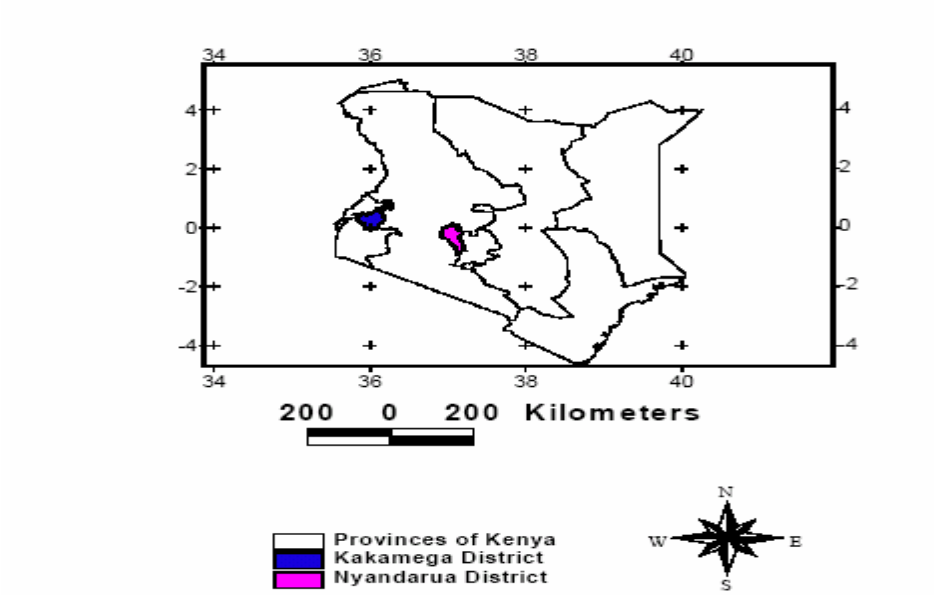

Figure 2.4: Geographical location of study areas (Nyandarua and Butere/Mumias[5]) Source: Mandere (2003) Modified from Mud Spring Geographers Inc.

Nyandarua

This district is located in the Central Province. It covers an area of 3,528 square kilometres. The area has rich volcanic soils which vary in both fertility and distribution presenting a high potential for crop production. Soil types ranges from well drained deep soils to shallow, rocky and poorly-drained soils. The annual rainfall within the district is 979 mm but ranges from 700 mm to 1,620 mm. Temperatures within the district are moderate with an average of 21.5 degrees Celsius and the highest is lower than the national average. Rainfall quantity has delineated different potentials for crop production, the kinds of crop produced and type of animal reared. The very low temperatures results in the formation of night frost almost every month. This affects agriculture activities and makes the cultivation of certain crops like maize hazardous.

Nyandarua is principally an agrarian region where 85% of the people derive their livelihood from this sector. The crops cultivated include maize, wheat, barley, potatoes, cabbages, carrots and pears. The main cash crop in the region is Pyrethrum which is grown by small sector holdings throughout the district. Problems facing the agricultural sector in the district include poor road conditions making it difficult to market farm produce, poor marketing, collapse of institutions concerned with marketing and farmer

[5] Butere/Mumias District was curved out of Kakamega District. No other updated map existed.

assistance, and low productivity resulting from use of inappropriate farming techniques and land subdivisions.

The choice of Nyandarua was not only influenced by Mandere's (2003) result but also by the fact that sugar beet trial by Kiriita Agriculture Self Help Group has been taking place for some time now. The knowledge and perception of these farmers is instrumental because they have an experience with the crop. Hägerstrand (1967) in explaining the spatial diffusion theory argued that the times at which individual's learn about an innovation is dependent on their relative location vis-à-vis earlier adopters. Rogers (1995) explained this as homophilous communication in which there is an effective communication of new ideas between two or more individuals who are similar. Thus the importance of the perception of those farmers who have tried sugar beet cannot be underestimated in evaluating the future adoption of the crop by other farmers. This falls in line with the objective of the study to compare the knowledge and perception of farmers who have cultivated sugar beet on trial basis and those who have never cultivated it.

Butere/Mumias

The district which was curved out of the larger Kakamega district on March 2, 1998 covers an area of 939.3 square kilometres. The predominant soil type is loamy soils. Rainfall is high almost all year ranging from 1,597 to 2,873 mm per year. Temperature is equally high all year with a mean of 29 degrees Celsius.

Agriculture is the most important sector contributing of 65% of the total earnings in the district. Crops cultivated include sugar cane, pulses, cereals, tea and cotton.. Source of raw materials come from both contracted farmers and the company's nuclear estate. Poor farming methods due to absence of extension services, over dependence on one cash crop (sugar cane), poor infrastructure and illiteracy have been identified as some of the problems facing agriculture in the district.

Additional factors influencing the choice of this district is that Mumias Sugar Company, one the largest sugar manufacturing companies in Kenya is located here and they are likely to find sugar beet a complementary crop for sugar production. The sugar company has also carried out preliminary trials of sugar beet. The area is also a major sugar cane farming area and a shift in raw material use like sugar beet by the company has implication for the large number of sugar cane farmers as well.

3. Methodology

3.1 Sample and Sampling Method

The target population comprised of all farmers in the Nyandarua and Butere/Mumias Districts in Kenya. Sixty participants were selected from the chosen population. Purposeful sampling was used in choosing participants for the study. This is a type of sampling procedure in which samples are selected with the aim of identifying information-rich cases in order to allow for an in-depth case study (Merters, 1998). Specifically, stratified purposeful sampling was used. This combines different sampling strategies such that subgroups are selected based on specified criteria. Sample of cases are then selected within those strata (Merters, 1998). Thus the chosen population was divided into 3 strata; Nyandarua Sugar Beet Trial (NSBT) Farmers, Nyandarua (N) Farmers and Butere/Mumias (BM) Farmers. Snowball sampling which helps identify samples with information important for the study was also applied (Merters, 1998). Here, key informants such as the Chairman of the Kiriita Agricultural Self Help Group and the District Agricultural Research Liaison Officer were first contacted regarding sugar beet trials. They further recommended other people who are trying sugar beet. A similar strategy in addition to moving from one household to the other in different locations was used in identifying non sugar beet trial farmers in Nyandarua and Butere/Mumias.

Forty participants were selected from the Nyandarua district. Twenty were sugar beet trial farmers from both the Kiriita Agricultural Self Help Group and other trial farmers under the supervision of the district agricultural office. The rest twenty were non sugar beet trial farmers in the district. It is assumed that they would have heard of the crop due to their proximity to trial fields. This is to control for the situation in Butere/Mumias where farmers might not have heard of sugar beets before. Some of the areas visited include Miharati, Ndaragwa, Olkalou, Farmers Training Centre (FTC) in Latimo Location, Nyahururu.

Twenty participants made up of both sugar cane and non sugar cane farmers were drawn from the Butere/Mumias district. This represents farmers who have no prior experience with the sugar beet crop. Their knowledge and perception will be compared to those of Nyandarua farmers to determine whether a previous association with the crop results in perceptual differences and if so in what way, and if distance from trial site has an effect on farmers' knowledge. Some areas visited include Ekero village, Mumias Sugar Company, Ekama Village.

3.2 Questionnaires

The study employed both primary and secondary data. The primary data was acquired through a self-designed questionnaire based on literature review to collect information on farmers' knowledge and perception. It was made up of 56 items divided into various sections. Refer to appendix.

Section A was used to collect background information (farmers' age, sex, education and district) and information on the size of farms as well as year of farming experience.

Section B was to help ascertain their knowledge on sugar beets to help evaluate their knowledge gap whiles *Section C* looked at their perception towards new technologies. This also helped to assess the perceptual differences towards new technologies of people who have tried sugar beet and those who have never. *Section D* evaluated the conditions necessary for the adoption of new technologies while *Section E* (basically for those in Kirrita Agricultural Self Help Group) evaluated perceptions towards sugar beet. It also considered the environmental perspectives of sugar beet cultivation. *Section F* looked at the economic viability. Economic analysis is helpful in identifying behavioural factors and problems at the farm level that influence adoption of a new idea (Wossink & Boonsaeng, 2003). Section G is basically control questions that helped to double check some of the answers provided earlier on.

Secondary data basically consisted of information regarding needed agronomic practices for sustainable sugar beet cultivation. This involved literature search on tropical sugar beet cultivation and was compared with farmer's knowledge of sugar beet cultivation to determine the gap in their knowledge. This also involves the collection of background information for the study.

3.3 Procedure

The questionnaires were administered in the form of a structured interview. The researcher familiarized participants with the purpose of the study as well as built confidentiality and anonymity which help to allay fears that will enhance cooperation and honesty in response. The original questionnaires were in English and the language used was English and where needed the Field Assistant translated it into either Swahili or the appropriate language of the respondent. The interview technique is useful as it will allow for more in-depth assessment of farmers' knowledge and perception and how it has impacted their adoption decisions over the years (Wossink et al., 1997). The period of interview ranged from thirty minutes to one hour. During the survey, time was allocated from each survey day for checking and clarifying completed questionnaires and correcting wrong descriptions while they were fresh in memory.

3.4 Critique of the Methodology

Since non probabilistic sampling was used it is not easy to mathematically analyse the possible bias and likely error from the result of the research (Merters, 1998). The disadvantage of this is that the sample cannot be claimed to be representative of the larger population (Bailey, 1987). It is therefore wrong to generalize the findings of the research to the larger Kenyan population.

Possible sources of error in response of participants include:

- difficulties in understanding of some questions by farmers due to language barrier and reliance on interpreters most of the time
- short time duration leading to difficulties of building confidentiality, anonymity and trust among respondents and
- absence of opportunity for respondents to consult records, family or ponder his or her reply

The coding and categorization of open ended questions was based on the subjective evaluation of the researcher and this could be a possible source of error in the result.

4. Results and Discussion

4.1 Farmers' Socio-Economic Background

The key socio-economic characteristics of surveyed farmers are summarized in Table 4.1. Age of the sampled farmers ranges from 28-72 years with the average being 47 years. Age of farmers is said to influence farmer's maturity and decision making ability (Rahman, 2003). More males (37) than females (23) were interviewed. This however includes situations where both couples were present and provided answers together. In such situations, the couples agreed on who should be the principal interviewee.

The gender gap can be explained by the fact that some women will not like to take the interview if their husbands are not around. This clearly demonstrates the relevance of gender consideration in agricultural development as reported by many researches (Von Billow & Sorensen, 1993; Valdivia, 2001; Doss, 2002). Research shows that it is with labour intensive crops and particularly cash crops that gender division of labour and gender relation of production plays a pivotal role in the adoption of new production systems and its integration into the farming system (Von Billow & Sorensen, 1993). For instance, difference in labour allocation for agricultural purposes has been found between men and women (Valdivia, 2001). These findings shows that the Kenyan women saw themselves as playing one role while their husbands played another and as such they might not be able to provide all the relevant information needed. Also, the perception of threat by husbands to their dominant position in the household could account for the refusal of the women to take the interview alone (Von Billow & Sorensen, 1993). In a survey on Kenyan tea outgrower schemes, Von Billow and Sorensen (1993) found that conflict between spouses accounted for one-third of all the tea plots to be partly or completely neglected and that, low productivity of tea was intimately linked to the prevailing gender relations a factor ignored by other studies that tend to rather focus on technical, economic and institutional factors. Subsequently, the finding that differences exist in the kind of crops preferred by both men and women (Valdivia, 2001), and that women mostly give priority to food crops rather than cash crops based on their role as the main providers of food (Von Billow & Sorensen, 1993) should serve as a guiding principle in the introduction of sugar beet if it should gain acceptance from both couples. Although, Doss (2002) did not find any crops or crops of major importance grown exclusively by either men or women in Ghana, for sugar beet to be introduced in the household and be sustained, it is necessary that both partners are present, understand factors affecting its production and accept it.

Most of the farmers have formal education. 22 of the respondents have secondary education, followed by 20 primary and 12 with college education. Only 6 of the sampled farmers did not have any formal education but have had some form of apprentice training or have been into farming all their lives. Education level influences farmers' access to information as well as their ability to understand technical aspects of innovations which largely affects crop production decisions (Rahman, 2003). Thus, the high level of education among the farmers is likely to result in a better understanding of the sugar beet crop.

Subsistence pressure, measured by family size, ranges from 1-16 with the average being 7. According to Rahman (2003), the chayanovian theory of the peasant economy contends that higher subsistence pressure increases the tendency to adopt new technology.

Total landholding averaged 5.6 acres but varied markedly from 0.4 to 60 acres. On average, most of the farmers have had long experience with farming (22 years), with the least being 1 year and the longest 60 years.

Table 4.1: Socio-economic background of surveyed farmers

Variable	**Total Response**	**Range**	**Average**
Age (Years)	60	28-72	47
Gender Male Female	 37 23	-	-
Education Primary Secondary College Other	 20 22 12 6	-	-
Subsistence Pressure (family size)	60	1-16	7
Total Landholdings (Acres)	60	0.4-60	5.6
Years of Farming Experience	60	1-60	22

Maize was one of the major crops among all the farming groups. Most farmers said it was because maize is the main staple crop used in preparing one of the major dishes known as "Ugali". Differences however exist among the various cohorts in terms of the main crop and variability of crops cultivated. Among Nyandarua Sugar Beet Trial (NSBT) and Nyandarua (N) farmers, maize was stated as the main crop while Butere Mumias (BM) farmers have sugar cane as the main crop. NSBT farmers have a wider spread of types of crops cultivated mentioning as many as nine different crops, while N farmers had five types with BM farmers having only three types. Spread of crops cultivated has been found to be related to risk management strategies in poor household and developing countries as a response to climatic and market uncertainties (Valdivia, 2001). This is known as the hedging strategy in the form of diversification. Thus the spread of crops among the groups represented their diversified portfolios meaning that NSBT farmers have more diversified portfolios that N and BM farmers.

4.2 Problem Diagnosis

Wide range of factors was identified by farmers as problems facing their current crop (Figure 4.1). Economic factors dominate their problems with low payment (prices) and high cost of inputs ranking highest. The social problems include administrative bottlenecks or political interference and the absence of transparency in pricing. Pests and diseases, and drought ranked highest on the environmental problems.

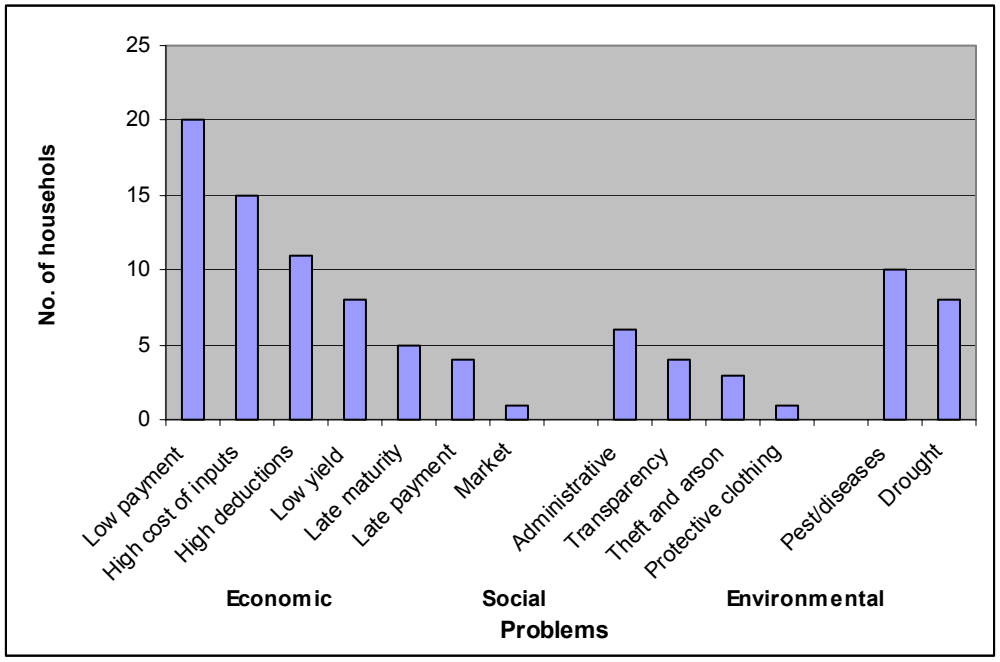

Figure 4.1: Problems farmers face with their current crop

However, specific problems resulting from either type of major crop cultivated or geographical location was identified (Table 4.2). Peculiar to NSBT and N farmers is drought leading to crop failure. Rainfall variability plays an important role in defining risk for the farmer in terms of attainment of food sufficiency for the household and sustaining income for its members (Mortimore, 1998). This they respond to through diversifying type of crops cultivated, technologies and strategies equivalent to the limit of their resource endowment (Valdivia, 2001; Mortimore, 1998). In otherwords, the drought experienced by these farmers is one of the factors influencing the variability in terms of crops cultivated by NSBT and N farmers. N farmers said they experience low yield because of soil infertility and absence of good seeds. Administrative bottlenecks or political interference was also mentioned by NSBT and BM farmers.

BM farmers mentioned late maturity of sugar cane (20-24 months for main crop and 18-24 months for ratoon) as a major problem. Most stated that they only continue to grow sugar cane because there is a factory in the town and that no alternative cash crops exist. This coincides with the Ministry of Finance and Planning's (2001) statement that overdependence on one cash crop was a contributing factor to poverty in the district. Thus to the farmers, an introduction of a new crop will be a good idea. It is equally in this

vein that sugar beet can play a useful role as a complementary cash crop that will help alleviate poverty.

The Mumias Sugar Company supplies BM farmers with all the inputs for cane production including harvesting and transportation with the farmers managing the farm. After the harvest, the company deducts all the cost involved and the rest is given to the farmers. Most farmers however said that the deductions were too high, lacks transparency (example, they are not present during weighing) and input cost were high. Most of them said they end up getting nothing at the end of the six years of cropping season (one main crop and two ratoons) a phenomenon they termed "dr" (debit). Theft and arson, and low yield were also problems to them.

Table 4.2: Problems farmers face with their current crops in their specific districts

Problems	**BM Farmers**	**NSBT Farmers**	**N Farmers**
Economic Factors			
Low payment	8	7	5
High cost of inputs	4	6	5
High deductions	11	0	0
Low yield	5	0	3
Late maturity	5	0	0
Late payment	3	0	1
Market	0	0	1
Social Factors			
Theft and arson	3	0	0
Transparency	4	0	0
Protective clothing	1	0	0
Administrative	3	3	0
Environmental Factors			
Pests/diseases	2	4	4
Drought	0	3	5

Farmers' ability to diagnose their problems shows that they have local knowledge of the farming system and their strategy to manage these problems is a resource. Mortimore (1998) calls it an *internal resource* which should be strengthened and incorporated for the successful introduction of any new crop and not undermined. Subsequently, these problems should be carefully considered if sugar beet is to be a sustainable crop to the farmers. This is relevant in eliminating any pro-innovation bias (Rogers, 1995) by considering carefully if sugar beet can help solve the farmers' problems.

4.3 Characteristics Required by Farmers in a New Crop

Availability of markets, financial aid, education on cultivation, high yielding, availability of factory, good prices and early maturing featured prominently on farmers desired characteristics that a new crop should come with before they will adopt it (Table 4.3). Overall, economic factors dominate their characteristic needs. These findings agree with those of Negatu and Parikh (1999) that marketability of product and grain yield are the two most important ingredients affecting adoption decision. Fernandez-Cornejo and

McBride (2002) pointed out that an innovation's profitability (yield, input cost and cost of adoption relative to current management practices) is considered as the main motivation behind adoption. One economic consideration is the availability and affordability of seeds. The Farmers indicated that they are used to buying seeds every planting season for their current crop and are prepared to buy seeds for cultivating sugar beet as well. The problem however is the affordability of the seeds to farmers as stated by most farmers. Prices of the seeds must therefore be set taking into consideration the economic situation of the farmers as this will determine farmers' ability to continue cultivating the crop.

Table 4.3: Characteristics that farmers desire in a new crop (multiple responses)

Total Response (%)	**Conditions for Adoption**	**NSBT Farmers**	**N Farmers**	**BM Farmers**
	Economic Factors			
29	Market	13	16	12
11	Financial Aid (Subsidies)	6	2	7
9	High yielding	0	5	8
9	Factory	8	2	1
6	Good prices	3	0	6
5	Early maturing	0	0	7
4	Availability of seeds	3	1	1
3	Supply of inputs	1	1	2
2	Transport provision	3	0	0
1	Availability of By-products	2	0	0
	Social Factors			
11	Education	2	4	9
4	Transparency (Management)	3	0	2
	Physical/Environmental Factors			
4	Agronomically favourable	0	2	4
1	Pest/disease resistant	0	0	2
1	Less environmental effect	0	1	0

This economic demand forms one of the great challenges to the sustainability of sugar beet in Kenya due to the fact that farming systems dependent on the world market are plagued with unpredictable fluctuation (Mortimore, 1998). Domestic markets in Africa are also not spared price fluctuations as they continue to wrestle with inflation and policy change (Mortimore, 1998). Subsequently the complexity in the world market of sugar resulting from the subsidies provided by OECD countries to their farmers (Oxfam, 2002) is likely to undermine any possible benefits that might otherwise have accrued to the farmers in Kenya. Consequently it might lead to farmers looking for new options as displayed by their post adoption behaviour in Table 4.5.

Although variations exist between the different groups regarding their peculiar characteristic needs, the issue of market ranked first for all of them and economic factors dominated their characteristic needs. This also compares with the problem that farmers face with their major crops in which economic factors (Low prices, high cost of input,

high deductions) ranked as major factors (Figure 4.1). The differences in characteristic requirements can be favourably compared with the peculiar problems of the farmers regarding their current crops (Table 4.2). Among NSBT farmers, availability of a factory and financial aid ranked as the next most important while N farmers and BM farmers perceive high yielding and education about the crop as next most important. For sugar beet to be sustainable in Kenya, these perceived needs of farmers should be seriously considered.

4.4 Farmers' Knowledge of Sugar Beet

Farmers' knowledge, which comprises of *awareness knowledge* and *how-to knowledge*, is displayed in Figure 4.2 and Figure 4.3 respectively. NSBT farmers have high knowledge regarding the existence of sugar beet in Kenya. This is followed by N farmers who live in the vicinity of beet growing where 5 out of the 20 farmers surveyed reported hearing of sugar beet. Only 3 BM farmers reported ever hearing of beet with the rest 17 having no awareness of the existence of beets. The trend displayed by the findings points to Hägerstrand's (1967) "distance bound neighbourhood effect" which he observed in his study of diffusion of innovation in Sweden was at play. Thus "pairwise tellings" might have led to the greater awareness knowledge among N farmers than BM farmers due to proximity of N farmers to trial fields. The factors involved in Hägerstrand's theory are however more complex than those considered in this research.

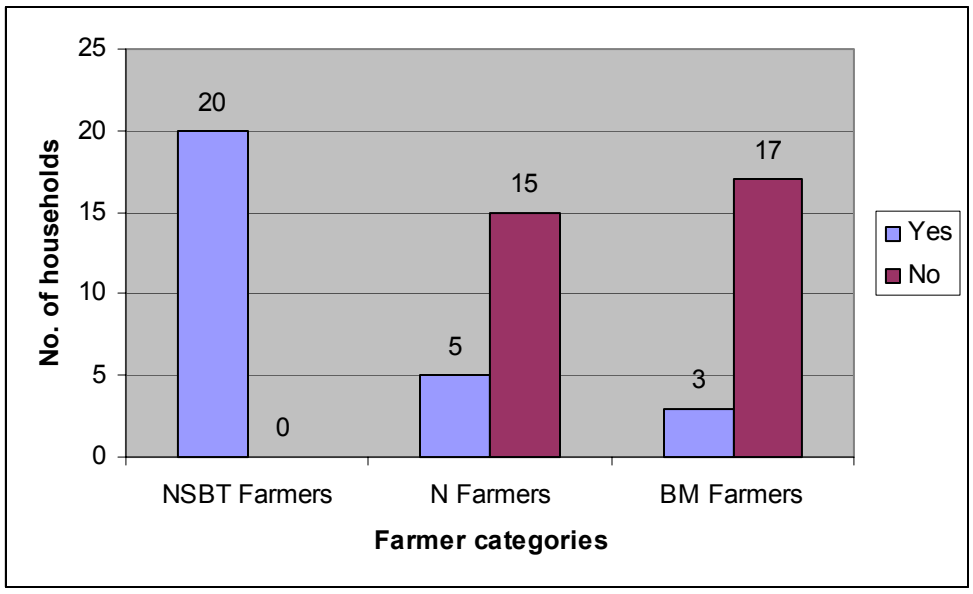

Figure 4.2: Farmers' "awareness knowledge" of sugar beet

Figure 4.3 displays farmers' *how-to knowledge* on sugar beet. In all, NSBT farmers were able to describe the processes involve in sugar beet farming. Common to all their answers is land preparation (seedbed preparation), planting, weeding, caretaking (chemical and fertilizer application) and harvesting. They were equally able to explain details regarding required distance between seedlings, drilling, thinning and sometimes transplanting. However, only 10% of N farmers (2 out of the 5 who have heard of beet) were able to explain a similar process while none of BM farmers were able to do so. They claimed

that although they have heard of beet, they have not seen it let alone knowing how it was cultivated.

The results clearly demonstrate that both *awareness and how-to knowledge* are high in NSBT farmers. This is because both kinds of knowledge were diffused almost at the same time through setting up of trial projects and education and monitoring by both opinion leaders and Agricultural extension officers. The trend displayed by N farmers and BM farmers indicate that while awareness knowledge might spread quickly, it takes much more time for the acquisition of how-to knowledge. This confirms Rogers's (1995) assertion that one moves from *awareness knowledge* to *how-to knowledge*, which indicates that *awareness knowledge* spreads faster than *how-to knowledge*. The findings also indicate that "trial by others" as described by Rogers (1995) have provided a form of vicarious learning for the N farmers in order to acquire the necessary knowledge on cultivation processes.

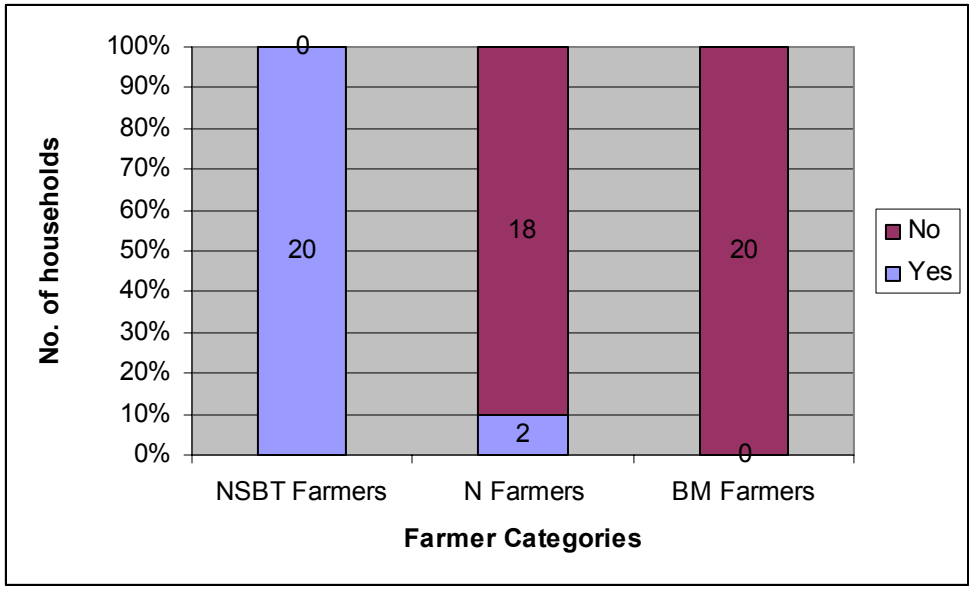

Figure 4.3: Farmers "how-to knowledge" of sugar beet

The results above shows that while NSBT farmers have some necessary knowledge needed for beet cultivation this is lacking in both N and BM farmers. This equally indicates that there has been little communication of the new idea by NSBT farmers to other farmers. Also, the difference in knowledge is due to the experience that NSBT farmers have had with the crop which is likely to predispose them to having a better perception as well as knowledge when it comes to determining the necessary variables for evaluating the sustainability of the project in Kenya. The lesson to be learnt from the above observation is that, it is better to set up trial projects as a means of diffusing *awareness knowledge* so that as in the case of NSBT farmers, how-to knowledge will equally be acquired at the same time. However, since the trials are on small scales, it is not possible to tell if NSBT farmers have all the necessary knowledge required when it comes to large scale production and management.

4.5 Farmers Perception on Adoption of Innovation

Since sugar beet is a new crop, it was necessary to determine the farmers' perception towards new crops/varieties and their experiences with these new technologies. In answer to the question as to whether they have adopted new crops or crop varieties before (Table 4.4), 95% of the NSBT farmers claimed they have adopted either a new crop or crop variety, followed by 60% of N farmers while in the case of BM farmers 45% had adopted a new crop or variety.

The result shows that farmers have had an experience with new crops and are open to new technologies in their area. This indicates that the farmers might be receptive to new ideas such as trying sugar beet. The trend displayed however shows that, NSBT farmers could be classified as 'early adopters' in accordance with Rogers's (1995) adopter categorization since they have had much more experience with other crops and subsequently sugar beet. This also shows that one of the major ways of NSBT farmers' strategy for managing risk is hedging through diversification of crops cultivated (Valdivia, 2001; Mortimore, 1998). Furthermore, the knowledge and perception of these early adopters will be paramount in the adoption decisions of other farmers.

Table 4.4: Farmers' response to whether they have adopted a new crop/variety before

Groups	**Yes**	**Percentage (%)**	**No**	**Percentage (%)**
NSBT Farmers	19	95	1	5
N Farmers	12	60	8	40
BM Farmers	9	45	11	55

Table 4.5 is to help determine farmers' post adoption behaviour as well as elucidate their perception through previous experience with either a new crop or venture in the past ten years. In answer to whether they were still adopting a previously adopted crop/variety or venture, 75% of NSBT farmers were still adopting the new crop or in the new venture. This was followed by BM farmers (72%) and N farmers (21%). Although, this revealed somehow ambiguous trend especially among the N farmers and BM farmers, it can be explained by the fact that more BM farmers have adopted new things compared to N farmers and most of the BM farmers adopted new business ventures instead of crops which they are more satisfied with.

Table 4.5: Farmers' post-adoption behaviour (Based on number of 'Yes' responses above)

Groups	**Yes**	**Percentage (%)**	**No**	**Percentage (%)**
NSBT Farmers	15	75	5	25
N Farmers	3	21	11	79
BM Farmers	13	72	5	28

The suggestion to be drawn from this trend is that when the farmers are satisfied with whatever new technology they have adopted, they are likely to hold on to it, but if they feel that it does not meet their needs they will discard it (Rogers, 1995). This was clearly demonstrated when farmers were asked to state their major crop. Thus although the literature states that Pyrethrum is the main cash crop in the Nyandarua district (UNCRD,

2003), only 5 out of the 40 respondents in the district mentioned it as a major crop. In an interview with the District Agricultural Officer, she explained that most farmers have stopped cultivating pyrethrum because of low and late payment. The implication is that when the farmers consider sugar beet to be lacking in meeting their needs after adoption, they are likely to stop cultivation and look for alternatives. This prediction regarding post sugar beet adoption behaviour is given credence by NSBT farmers response to whether they have been cultivating a larger area (29%), constant area (35%) lesser area (7%) of sugar beet or have stopped (29%). The major reason cited for stopping the sugar beet cultivation was that there was no market which presupposes that it does not meet their economic needs.

The positive perception that farmers have about new technologies or ventures was reflected in their answer to the question as to whether they will like to try sugar beet (Table 4.6). The results revealed that they are willing to adopt and try new crops; NSBT farmers (100%), N farmers (90%) and 95% BM farmers. The desire by all the groups to try sugar beet can be explained by their assumption that it will possess better characteristics than their existing crops. Inadvertently, it is based on the extent to which they are dissatisfied with their current crops and the benefits they perceive in the new crop. As stated by Negatu and Parikh (1999), the decision to adopt is based on the assumption of getting a maximum value from the new crop. They further explained that farmers' decision to grow modern varieties in relation to traditional ones is based on their comparison of marginal net benefit of one against the other.

Table 4.6: Farmers' perception on trying sugar beet

Groups	Yes	Percentage (%)	No	Percentage (%)
NSBT Farmers	20	100	-	-
N Farmers	18	90	2	10
BM Farmers	19	95	1	5

4.6 Trial Farmers' Perception towards Sugar Beet

Out of the 20 farmers who have ever cultivated beet, 75% thought it had the qualities they wanted in a new crop while 5% said it did not have the desired qualities with 20% stating that they cannot tell because the crop was still on trial basis. The major qualities mentioned were high yielding[6] (12) and early maturing (7) (Figure 4.4). These perceived qualities might have been influential in their 100% decision to adopt sugar beet (Table 4.6) and agrees with Adesina and Baidu-Forson (1995) findings that better yield has significant effect on farmers' adoption behaviour. Negatu and Parikh (1999) also mentioned perception of yield as one of two most important ingredients affecting farmer's adoption decision. The other qualities mentioned include easy growing (less water requirement after establishment) and this they said was relevant because of the frequent drought experience in the region and the unreliability of rainfall. The farmers also said it was a good prospective cash crop and that it has a multi-purpose use (serving as cash crop and the byproducts serving as fodder).

[6] It should be noted that sugar is not extracted from the trial project since there is no market or factory available

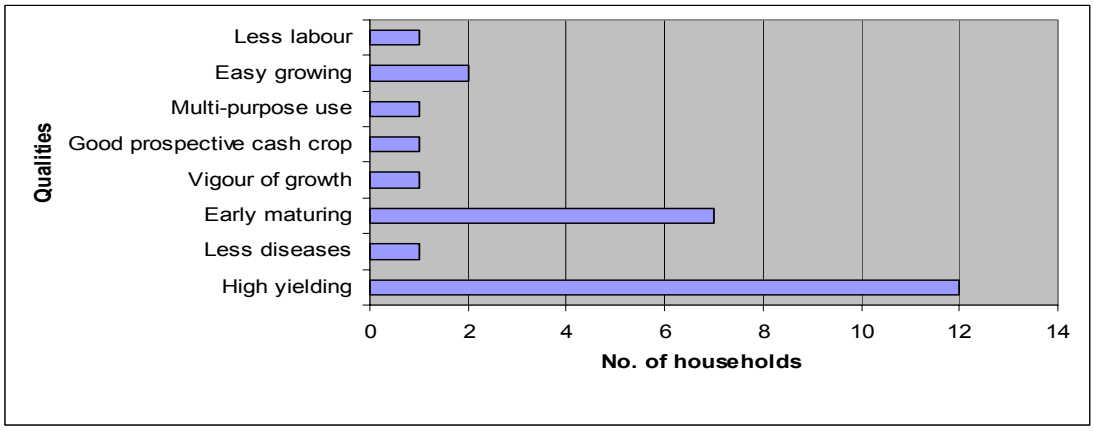

Figure 4.4: Qualities farmers perceive in sugar beet

In comparison to their existing crops, majority (15 out of 20 respondents) stated that it was better. The major reasons stated for this assertion was high yielding, thus confirming Negatu and Parikh (1999), Adesinah and Baidu Forson (1995) findings on the influence of level of yield as well as in line with NSBT farmers assertion that it had a major quality of higher yield (Figure 4.4). Prospective cash crop, and less work compared to pyrethrum were also cited. Only one respondent stated that it was poor because it was not doing well. The remaining farmers (5) stated that they cannot tell because sugar beet was still on trial basis and there was no market available. They stated that, currently the harvested sugar beet is only used as fodder.

NSBT farmers mentioned laborious land preparation, pests and disease attack (aphid, frost and rust), high costs of inputs and high water requirement during germination as the constraints they face growing sugar beet (Figure 4.5). Others include lack of adequate knowledge about the crop in general and the absence of market. Some of them thus suggested that it will be good to factor this laborious land preparation into the pricing of sugar beet.

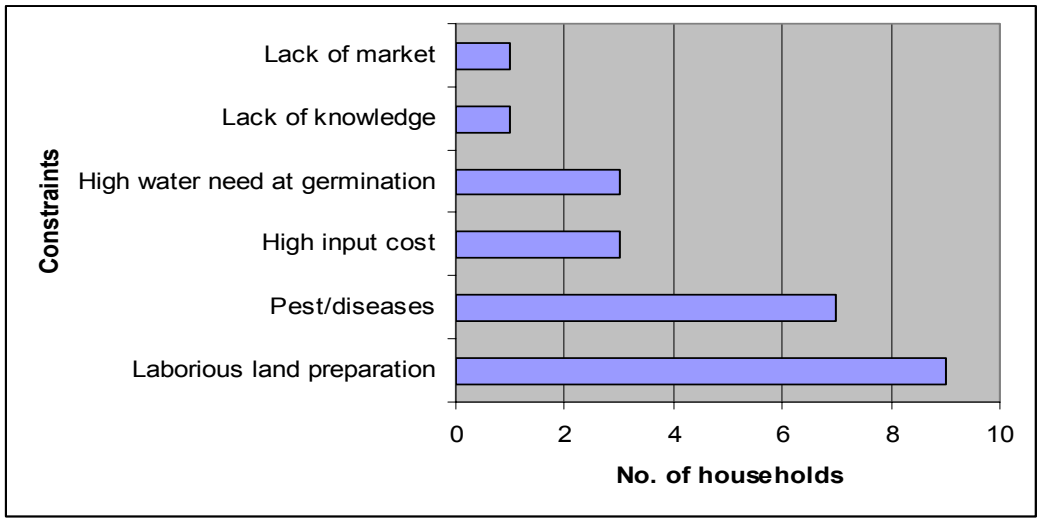

Figure 4.5: Constraints with growing sugar beet (based on 14 'yes' multiple responses)

Overall, NSBT farmers perceive only a 25% difference between sugar beet and their existing crops in terms of agronomic practices. 95% of the respondents claimed sugar beet shared similarity with existing crops in terms or cultivation and other practices. Reference was made to crops like spinach, carrot, cabbage, red and fodder beet, and other vegetables which shared similar characteristics in terms of cultivation to sugar beet. This illustrate that the farmers are knowledgeable in their trade and this knowledge should be considered for a successful introduction of sugar beet. It also implies that when in doubt regarding problems relating to sugar beet, they are likely to fall on their previous knowledge in terms of chemical or fertilizer application. One farmer for instance reported that he applied chemicals used for wheat to sugar beet and this resulted in the death of the sugar beet. It is therefore necessary to educate farmers on the extent to which they can rely on their previous knowledge of similar crops since this might at times be detrimental to sugar beet.

These findings suggest that NSBT farmers generally perceive sugar beet in a positive way which has great implication for subsequent adoption by other farmers. In a nutshell the positive perception of NSBT farmers is likely to positively impact the adoption of sugar beet by other farmers through "pairwise tellings" (personal communication) as stated by Hägerstrand (1967). As pointed out by Rogers (1995) this probationary trial will help to determine the usefulness of the crop in their own situation and may provide some form of vicarious trial for some non trial farmers.

5. Conclusions and Recommendations

This study offers insight into farmers' knowledge and perception on sugar beet and its importance for the sustainability of the crop in Kenya. The principal conclusions and recommendations of this research are;

- Economic factors dominate problems faced by farmers and the major factors mentioned are low payment (prices) and high cost of input. Social problems include administrative bottlenecks or political interference and absence of transparency in pricing while pest and diseases, and drought rank highest on the environmental problems.

- Farmers mentioned economic advantages as vital in influencing whether they will adopt sugar beet. Availability of markets, financial aid, education on cultivation, high yielding, availability of factory, good prices and early maturity featured prominently as factors that will make them committed to the innovation-decision process. These economic factors were also stated as the deciding factor that influenced their previous post- adoption behaviour.

- Farmers' *awareness* and *how-to knowledge* on sugar beet is generally low. Knowledge gap thus exists on sugar beet among Kenyan farmers studied.

- Sugar beet trial farmers have more *awareness* and *how-to knowledge* on sugar beet than non sugar beet trial farmers. This is because both kinds of knowledge were introduced at the same time through trial farms which were monitored. There was some evidence of Hägerstrand's distance-bound neighbourhood effect in knowledge among farmers. Those closer to trial farmers had more knowledge than those farther from trial sites.

- Overall, there was no difference in perception towards new technologies between sugar beet trial and non-trial farmers. They all have a positive perception towards innovation and are willing to adopt sugar beet both as complementary crop for sugar production or as a cash crop. An analysis of their post adoption behaviour however shows that they will not hesitate to stop cultivating sugar beet if they find it is not meeting their needs

- For sugar beet to be sustainable in Kenya it is argued that the findings on their knowledge and perception are incorporated in an educational programme for the farmers prior to a large scale introduction of the crop. Since the domains of sustainability are interlinked rather than distinctive, the social psychological sustainability that has been analyzed by this research can only work if the economic and biological aspects complement it.

- The method of introducing new crops through trial basis as was in the case of trial farmers is very important since it will afford farmers, extension officers and interested parties opportunity to monitor the progress of the project as well as

carrying out effective educational programmes. More trial projects should be established in coordination with the agricultural ministry to build and improve farmers' *awareness* and *how-to knowledge* at the same time as was observed with trial farmers. This should include an educational programme that consider the local knowledge of the farmers and the extent to which they can depend on previous knowledge. Good knowledge will help farmers have the right perception of the crop and this is crucial in influencing the adoption decision of farmers who have not adopted the crop.

- Immediate steps should be taken to establish a market in order for large scale trials since the current trials on small scale cannot bring out all the possible difficulties when it comes to large scale production. Market is crucial for current trial farmers because it determines whether they will continue cultivating it. It will also predispose them to the most important factor that will influence future adoption decisions and will help them to form a conclusive perception of the crop.

- Future research should look at the economic sustainability of sugar beet in Kenya and how the project should be carried out in order to bring benefit to all groups. Other areas to consider for research are the possibilities of setting processing factories in areas where the crop will be cultivated as well as adapting existing sugar cane processing factories to process sugar beet, and the environmental implications of sugar beet in Kenya. It is also relevant to research into why farmers stop adopting a new technology after they have tried it so as to take measures to prevent a similar situation with sugar beet.

References

ACP. (2004). ACP Press Release, Retrieved October 20 from www.acpsugar.org

Adesina, A. A. & Baidu-Forson, J. (1995). Farmers' Perceptions and Adoption of New Agricultural Technology: Evidence from Analysis in Burkina Faso and Guinea, West Africa. *Agricultural Economics*, 13, 1-9.

Bailey, K. D. (1987). Methods of Social Research. New York, USA: The Free Press.

Bosemark, N. O. (1993). Genetic and Breeding. In D. A. Cooke, & R. K. Scott, (Eds.), *The Sugar Beet Crop: Science into Practice*. London, UK: Chapman & Hall.

Brown, A. L. (1981). Innovation Diffusion: A New Perspective. New York, USA: Methuen & Co.

Chatin, P., Gokhale, D., Nilsson, S. & A. Chitnis (nd.) Sugar Beet Growing in Tropical Areas: A New Opportunity for Growers and the Sugar Industry
Email: Philip.Chatin@syngenta.com; Web: www.syngenta.com

Chatin (2004) *Tropical Sugar Beet: From a Business Idea to Sustaining Sugar Production in Tropical Areas*. Compiled by Yndgaard, F. in Summary of Workshop: Globalisation- A Great Opportunity for Sugar Beet in Developed and Developing Countries, 4th February 2004. *Journal of Swedish Seed Association*, 1-2, 12-29

Cooke, D. A. & Scott, R. K. (1993). The Sugar Beet Crop: Science into Practice. London, UK: Chapman & Hall.

Doss, C. R. (2002). Men's Crops? Women Crops? The Gender Patterns of Cropping in Ghana. *World Development*, 30(11), 1987-2000.

Encyclopaedia Britannica Online. (2004). Perception. Retrieved March 12, 2004. From http://www.britannica.com/search?query=perception&ct=&fuzzy=N

EU. (2004). Sugar: EU Commission Proposes More Market-Consumer, and Trade-Friendly Regime. News Releases, No. 112/04

FAO/EBRD. (1999). Sugar Beets/White Sugar Agribusiness Handbooks Vol. 4. Electronic Version. Retrieved June15, 2004.
From http://www.fao.org/tc/tci/sectors/sugar.pdf

Fernandez-Cornejo, J. & McBride, W.D. (May 2002). Adoption of Bioengineered Crops. Washington, D.C. USA: *Agricultural Economic Report*, 810.

Geita, W. (2004). *Tropical Sugar Beet Production Challenges and Opportunity*. Compiled by Yndgaard, F. in Summary of Workshop: Globalisation- A Great Opportunity for Sugar Beet in Developed and Developing Countries, 4th February 2004. *Journal of Swedish Seed Association*, 1-2, p. 12-29.

Government of Kenya. (2003). Economic Recovery Strategy for Wealth Creation and Employment Creation 2003-2007. Nairobi, Kenya: Government Press.

Gregory, D. (1987). The Stasis of Diffusion Theory. In D. Gregory & J. Urry, (Eds.), *Social relations and Spatial Structures*. London, UK: Macmillan Education Ltd.

Gurung, A. B. (2003). Insects- A Mistake in God's Creation? Tharu Farmers' Perception and Knowledge of Insects: A case Study of Gobardiha Village Development Committee, Dang-Deukhuri, Nepal. *Agriculture and Human Values*, 20, 337-370.

Hägerstrand, T. (1967). Innovation Diffusion as a Spatial Process. Translation and with a Postscript by A. Pred (originally Published in 1953). University of Chicago Press.

Herdt, R.W., & Steiner, R. A. (1995). Agricultural Sustainability: Concepts and Conundrums. In V. Barnett, R. Payne & R. Steiner (Eds.) Agricultural Sustainability: Economic, Environmental and Statistical Considerations. John Wiley and Sons Ltd.

Hillbur, P. (1998). The Knowledge Arena: Approaching Agroforestry and competing Knowledge Systems- A Challenge for Agricultural extension. Lund, Sweden: Lund University Press.

Jaffe, A. B., Newell, R.G. & Stavins, R.N. (2000). Technological Change and the Environment, Discussion Paper 00-47. Washington, D.C, USA: Resources for the Future.

Khan, H. A. (1999). Sectoral growth and Poverty Alleviation: A Multiplier Decomposition Technique Applied to South Africa. *World Development*, 27(3), 521-530.

Kaumbutho, P. G., Karuri, E. G. & Odhiambo, M. O. (1996). Study of Sugarcane and Sugar Production Costs in Kenya. Nairobi, Kenya: Kenya Sugar Authority.

Kenya Sugar Board. (2004). Quarterly Bulletin of Sugar Statistics: January to March 2004. Nairobi, Kenya: Government Press.

Kenya Sugar Board. (2002). Bulletin. Nairobi, Kenya: Government Press.

Kenya Sugar Board. (2001). Year Book of Sugar Statistics 2001, Comparative Sugar Production in 2000-2001. Nairobi, Kenya: Government Press.

Mandere, N. (2003). Towards Sustainable Agriculture: Sugar Beets Production in Kenya as a Potential Viable Solution to the Current Sugar Deficit. An Analysis of Possibilities and Challenges. Masters Thesis. MICLU, Lund University.

Merters, D. N. (1998). Research Methods in Education and Psychology: Integrating Diversity with Quantitative and Qualitative Approaches. UK: SAGE Publications Ltd.

Ministry of Agriculture and the Ministry of Livestock and Fisheries Development. (2004). Strategy for revitalizing Agriculture 2004-2014. Nairobi, Kenya: Government Press.

Ministry of Finance and Planning. (2001). Butere/Mumias District Development Plan 2002-2008. Nairobi, Kenya: Government Press.

Mitchell, D. (2004). Sugar Policies: Opportunity for Change. World Bank Policy Research Working Paper, 3222.

Mortimore, M. (1998). Roots in the African Dust: Sustaining the Drylands. Cambridge UK: University Press.

Negatu, W., & Parikh, A. (1999). The Impact of Perception and Other factors on the Adoption of Agricultural Technology in the Moret and Jiru Woreda (District) of Ethiopia. *Agricultural Economics,* 21, 205-216.

Nyeko, P., Edward-Jones, G., Day, R., K. & Raussen, T. (2002) Farmers' Knowledge and Perceptions of pests in Agroforestry with Particular reference to Alnus species in Kabale District, Uganda. *Crop Protection*, 21, 929-941.

Oxfam. (2004). An End to EU Sugar Dumping? Implications of the Interim WTO Panel Ruling in the Dispute against EU Sugar Policies brought by Brazil, Thailand and Australia. Oxfam Briefing Note.

Oxfam. (2002). The Great EU Scam: How Europe's Sugar Regime is Devastating Livelihoods in the World. Oxfam Briefing Paper, No. 27

Rahman, Sanzidur (2003) Environmental Impact of Modern Agricultural technology Diffusion in Bangladesh: An Analysis of farmers' Perceptions and their Determinants. *Journal of Environmental Management*, 68, 183-191.

Rogers, M. E. (1995). Diffusion of Innovations 4th Edition. New York, USA: The Free Press.

Sterman, J. D. (2000). Business Dynamics: Systems Thinking and Modeling for a Complex World. USA: McGraw Hill companies.

SUCAM. (2002). A Comprehensive Background to the Sugar Industry in Kenya. Retrieved March 20 2004 from http://www.kenyalink.org/sucam/documents/eam1_files/frame.html

Thirtle, C., Lin, L. & Piesse, J. (2003). The Impact of Research-Led Agricultural Productivity Growth on Poverty Reduction in Africa, Asia and Latin America. *World Development*, 31(12), 1957-1975.

United Nations Centre for Regional Development. (2003). Nyandarua District Development Plan, 2001-2030. An Integrated plan for Sustainable Regional Development. Nairobi, Kenya: UNON Print-shop.

Valdivia, C. (2001). Gender, Livestock Assets, Resource Management, and Food Security: Lessons from the SR-CRSP, *Agriculture and Human values*, 18, 27-39.

Von Billow, D. & Sorensen, A. (1993). Gender and Contract Farming: Tea Outgrowers Schemes in Kenya. *Review of African Political Economy; March 1993*

WCED. (1987). Our Common Future. New York, USA: Oxford University Press.

Wossink, A. & Boonsaeng, T. (2003). Farmers' Knowledge and Perceptions of Animal Waste Management Technologies: An Explorative Study for North Carolina. ARE Report, No. 29.

.

Wossink, G. A. A., de Buck, A. J., Van Niejenhuis, J. H. & Haverkamp, H. C. M. (1997). Farmer Perceptions of Weed Control Techniques in Sugarbeet, *Agricultural Systems,* 55(3), 409-423.

Yapa, L. S., & Mayfield, R. C. (1978). Non-Adoption of Innovations: Evidence from Discriminant Analysis. *Economic Geography*, 54, 145-156.

Yndgaard, F. (2004) Summary of Workshop: Globalisation- A Great Opportunity for Sugar Beet in Developed and Developing Countries, 4th February 2004. *Journal of Swedish Seed Association*, 1-2, 12-29.

Appendix

Farmers' Knowledge and Perception towards the Sustainable Adoption of Sugar Beet in Kenya

Questionnaire

(A)Background information

1) Age…. ……
2) Gender (M) (F)
3) Education Primary Secondary College Other……
4) District……
5) Do you belong to a farming group? (Yes) (No)
6) What is your family size? .....
7) How many years have you been farming? .....
8) Acres of farmland……
9) What is your major crop…….

Why……

10) Do you have any problems with your major crop? (Yes) (No)
……
11) What changes do you want to see in your major crop?
……

(B) Knowledge (This will help evaluate the knowledge gap)

12) Have you heard of sugar beet before? (Yes) (No)
13) Do you know how it is grown? (Yes) (No)
14) Can you describe the processes involved?
.....
15) Do you know anybody adopting it? (Yes) (No)
16) Have you heard of anyone adopting? (Yes) (No)

(C) Perception towards new technologies

17) Have you adopted a new crop/variety in the last 10 years? (Yes) (No) When?
……
18) If (Yes), what was it? .....
19) Have you tried any new venture in the last 10 years? (Yes) (No)
20) If (Yes), what was it? .....
21) Did you like it? (Yes) (No)
22) Was it successful? .....
23) Are you still adopting it? OR are you still in the new venture?
.....
24) Why? .....
25) Would you try anything new (sugar beet)? (Yes) (No) ……

(D) Conditions that influence adoption of new technologies

26) Under what conditions will you adopt a new crop (sugar beet)? .....
……
27) How long would it take for you before you adopt a new crop?
.....

(E) Perception towards sugar beet (Basically for those who have ever cultivated it)

28) What do you think of it? .....
29) Do you buy the seeds yourself? .....
30) Does it have the qualities you want in a new crop?

If yes, what are they? .....

31) Have you been cultivating sugar beets more or less or constant?
.....

Why ……..

32) How will you compare sugar beet with your other crops in terms of performance?
……..

In what way? .....

33) What do you basically use the crop for? .....

34) Are you eager to adopt sugar beet? (Yes) (No)……
.....

35) Have you observed any environmental changes since adopting sugar beet?
.....
36) What problems (constraints) have you observed growing sugar beet?
……..
37) Is the cultivation of sugar beet different from other crops (Specify)
……
38) Are there any similarities in terms of cultivation with other crops (Specify)
.....
39) What changes (improvements) would you want to see in sugar beet
……..

(F) Economic Viability and Sterility Factor (of sugar beet seeds)

40) What has been the economic impact of trying out sugar beet?
.....
41) Do you think sugar beet production will be economically profitable to you?
.....

42) Do you buy seeds every planting season for your other crops? (Yes) (No)
……..

43) How much is it ……
44) Will you be prepared to buy seeds every planting season? (Yes) (No)
……..
45) What is your average income per year? .....
46) What are the two most important sources of your income?
.....

(G) Controlled Questions

47) Have you heard of any new crop in your district before?
.....
48) Have you known or ever heard of anybody adopting a new crop in your district before?
.....

49) Where did you get your information about sugar beet from?
.....

50) What knowledge (View) did you have about it before you got it?
……
51) What do you think about it now (what knowledge do you have about it now)
……

52) Have you ever talked to others before about sugar beet? .....

53) To what extent has your farming group influenced your views or actions?
.....
54) Is your entire household involved in farming? (Yes) (No) …….
55) What will you grow when you stop growing sugar cane? (Or your major crop)
…….
Why…….

56) Do you have any other comments you would like to make about the issues discussed in this survey? .....