FACTORS AFFECTING ALOE PROPAGATION AND CULTIVATION IN KIENI WEST DIVISION, KENYA

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DECLARATION

Student's Declaration

This thesis is my original work and has not been presented for a degree in any other university or any other award.

Signature……Date……

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Supervisors' Declaration

We confirm that the work reported in this thesis was carried out by the candidate under our supervision.

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DEDICATION

Dedicated to:

My husband Patrick and our children Emmaculate and Grace
My abilities might have failed you
But your encouragement didn't.

ACKNOWLEGDEMENTS

All glory and honor be to the Lord God. Forever am indebted to Him for His love and help.

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To all I say may the grace of our Lord Jesus Christ be with you always.

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ACRONYMS AND ABBREVIATIONS

ADA	Aloe development Authority
ALRMP	Arid Lands Resource Management Project
AMU	Aloe Management Unit
ASALS	Arid and Semi arid Lands
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
EE	Environmental Education
EU-BCP	European Union –Biodiversity Conservation Program
GDP	Gross Domestic Product
GoK	Government of Kenya
IUCN	International Union for Conservation of Nature
KARI	Kenya Agricultural Research Institute
KAWG	Kenya Aloes Working Group
KEFRI	Kenya Forest Research Institute
KFS	Kenya Forest Service
KIRDI	Kenya Industrial Research Development Institute
KWS	Kenya Wildlife Service
LN	Legal Notice
LWF	Laikipia Wildlife Forum

NALEP	Ministry of Agriculture and Livestock Development
NAREDA	Natural Resources Development Agency
NGOs	Non Governmental Organizations
NMK	National Museums of Kenya
PRSP	Poverty Reduction Strategy Paper
SNV-NERTHERLANDS	Netherlands Development Organization
UNDP	United Nations Development Programme

ABSTRACT

The thesis resulting from this study intended to investigate factors affecting aloe propagation and cultivation in Kieni West division, Kenya. The rationale for the study was informed by the fact that aloe propagation and cultivation is one of the identified strategies for aloe conservation and management outside protected areas with both ecological and social-economic benefits. The study was based on the awareness that Kenyan aloe species are listed under Appendix II of Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). This was as a result of unchecked utilizations of the aloe species leading to over-exploitation and wanton destruction of wild aloe population in1980s. The unsustainable harvesting of aloes posed many threats ranging from overexploitation to ecological imbalance and possible loss of some species. In response to the danger of over-exploitation several efforts to improve the aloe sector were initiated. They included a recommendation that CITES parties and the Non Governmental Organizations (NGOs) support the development of community propagation and cultivation schemes for aloe species commonly exploited for aloe bitter gum. The recommendation led to formation of community and private initiatives in aloe enterprises such as Kieni Aloe Plantations and Kamuiga Artemisia Farmers in Kieni West division. However, the local community of the semi arid division of Kieni West has not yet embraced aloe cultivation as would be expected of an economic activity with potential to generate additional income. The investigation was done using a case study research design, a mixture of random and non random sampling methods: and a semi structured interview schedules. The research came up with qualitative data that was: categorized to group frequencies, analyzed using descriptive statistics in the Statistical Package for Social Sciences (SPSS) data editor and presented in frequency tables, percentage frequencies, cross tabulation tables and Chi squired statistic test. The study found out that the respondents (56.6%) were generally aware of aloe propagation and cultivation but the awareness had not resulted in the adoption of the technology with only 2.1% having adopted. The legal requirements of growing aloes was generally unknown even by those who had adopted the innovation. Other factors affecting aloe propagation and cultivation were identified as: lack of information on propagation, management and harvesting of aloe among others classified in this study as driving and restraining factors affecting aloe propagation and cultivation. Arid environmental conditions and financial gains were identified as the major driving factors for adoption of aloe cultivation while lack of clear and favorable market and marketing channels was identified as the major restraining factor. The study concluded that adoption of aloe propagation and cultivation in Kieni West division is related to market information and access. The findings of this study will be useful to the policy makers and promoters of aloe propagation and cultivation in Kenya in assisting them re-orient their methodology of introducing the innovation to include the concerns of the community as discussed in this study

CHAPTER ONE
INTRODUCTION

1.1 Background of the Problem

Aloes are succulent plants in Aloaceae family adapted to arid habitats through their succulent habit. Their reproduction is by seed or suckers. They can be propagated from seeds, suckers, cuttings and tissue culture (Mukonyi and Oduor, 2008). Over 450 species of genus Aloe have been identified all over the world in various habitats from coastal, e.g. *Aloe kilifiensis* to higher altitude, e.g. *Aloe nyeriensis*. Some are widely spread, e.g. *Aloe secundiflora* in Kenya while others have restricted distribution, e.g. *Aloe francombei* in Laikipia Kenya. Although some species are very restricted in distribution, others are widespread and in the absence of competition, may become locally invasive (Mukonyi, 2005).

Majority of aloe species are confined to the African continent, Arabian Peninsula and islands in the Indian Ocean (Reynolds, 1996). Geographically, there is higher concentration of aloes in eastern-southern part of Africa and low in the rainforests where few or none exist. About 83 species of aloes occur in East Africa (Carter, 1994; Wabuyele *et al*., 2006). In Kenya, there are approximately 60 indigenous aloes species and subspecies growing naturally in dry lands of which 23 are endemic (Newton, 2003). Among these species, five namely; *Aloe secundiflora*, *Aloe turkanesis*, *Aloe rivae*, *Aloe calodophila*, and *Aloe scabrifolia* are commonly illegally exploited for aloe bitter gum (Lubia *et al*., 2008). Conservation and management of these five species of aloes outside the protected areas in Kenya can only be done through propagation and cultivation (Lubia *et al*., 2008; Agnew and Agnew, 1994). This is a relatively new and

rare concept among the Kenyan communities where these aloes grow naturally. Accordingly, environmental education has a role to play in: creation of awareness, transferring of the necessary knowledge and skills to the locals for aloe cultivation, changing of values and attitude towards aloe conservation and management, and by ensuring active sustainable participation in aloe propagation and cultivation.

1.1.1 Uses of Aloes

The sap of certain aloes has medicinal or cosmetic applications and has been exploited traditionary and traded internationally for millennia. For instance, *Aloe vera*, an exotic species, whose wild origin is uncertain, is cultivated as a commercial crop in many countries, for example USA, South Africa, Canada and Venezuela for extensive use in the pharmaceutical and cosmetic industries. *Aloe vera* gel has a large market world-wide with a global market value of USD 25 billion (Mukonyi, 2005). The main products from aloe are: aloe gel, aloe bitter gum, aloe dye and aloe live plants produced from different types of aloes and processed differently. *Aloe vera* is the main source of aloe gel. Aloe bitter gum has a growing market with *Aloe ferox)* (Cape Aloe, a South African species), *Aloe turkanensis*, *Aloe secundiflora* and *Aloe scabrifolia* (Kenyan species) being the source of Aloe bitter gum (Mukonyi, 2005).

In Kenya, aloe sub-sector is one of the less known enterprises owing to its size and the number of players involved. It is solely regarded for production of bitters. No gels have been traced within this market, a factor associated with the first-stage processing systems and mechanisms. Though the sector has mixed market and marketing outlets in foreign countries, its contribution in foreign exchange value as well as share in Kenya

Gross Domestic Product (GDP) can not be determined. The sector supports an important segment of population in more than five ASALs districts in the country through wild sap extraction and informal selling employing about 47% of the income earners in the region. Thus, the aloe sub-sector harbors an important potential especially in exports and export earnings (NAREDA, 2003).

Aloes are used by local communities for various purposes: medicine (disease control, skin-soothing lotion), cultural, aesthetic, rangeland rehabilitation, bee forage, livestock fodder in drier conditions, ornamental, fence/demarcations, preparation of traditional brew, superstition e.g. *Aloe desertii* in Kitui while others such as *Aloe ballyi* found in Mwatate and *Aloe ruspoliana)* found in Samburu are poisonous (Mukonyi, 2005; Mukonyi and Oduor, 2008). The local exploitation of aloes in Kenya has not been through value adding trade such as processing of aloe products. But recently there have been local efforts to add value to the aloe sap by making aloe products such as soaps, lotions and creams. However, the aloe products based on well derived aloe gel that are imported in to the country, are expensive and probably not intended for use by the common person. Such products carry certification from the International Aloe Science Council, which none of the locally produced and packaged products bear (NAREDA, 2003).

Industrial uses of aloes include pharmaceuticals, cosmetics, nutraceuticals and dye among others. Some species of Kenyan aloes (mentioned above) are exploited for commercial bitter gum. However, concern has been raised locally and internationally about levels and impact of the exploitation to wild populations. There is currently an increased use of and promotion for use of alternative medicine which is contributing to

commercial utilization of medicinal aloe species by the herbalists. For sustainable utilization of alternative medicinal plants, government and research institutes, private sectors, NGOs, communities and researchers have been identified as stakeholders in this quest (Simiyu, 2003). Empowerment of farmers to guarantee sustainable utilization of medicinal plants has been identified and acknowledged (Mugenyi, 2003).

1.1.2 Kenyan Aloe species and their distribution

There is no detailed scientific study that has been undertaken specifically on inventory to show aloe type population dynamics over a period of time to establish conservation status of each species. However, various researchers (Newton, 2004, Oldfield, 2003 and International Union for Conservation of Nature (IUCN) through literature and observation based on species niche e.g. endemism; have classified conservation status of aloe species in Kenya. Table 1.1 below shows conservation status of Kenyan aloes.

Table 1. 1 Conservation Status of Aloe species in Kenya

Species	**Conservation status global**	**Distribution**
Aloe juvenna		Kenya (R) (Southern Narok) (E)
Aloe myriacantha		Kenya, Tanzania, Uganda
Aloe citrina		Kenya (V), Mandera, Ethiopia, Somalia
Aloe secundiflora		Kenya, Tanzania, Ethiopia
Aloe rivae	V	Ethiopia (R) Kenya (R)
Aloe murina		Kenya (Nguruman) E
Aloe erensii		Kenya (Northern Turkana) – Sudan
Aloe parvidens		Kenya, Ethiopia, Somalia, Tanzania
Aloe wollastonii		Kenya, Tanzania, Uganda
Aloe amudatensis	V	Kenya (Southern Turkana), Uganda
Aloe chrysostachys	V	Kenya (V)-Kitui & Meru (E)
Aloe classenii	V	Kenya (V) (Taita –(E)
Aloe ellenbeckii		Kenya (V) Somalia
Aloe kilifiensis		Kenya (E) (Coast)
Aloe lateritia Engler var. *lateritia*		Kenya (South East)- Tanzania

Aloe lateritia Engler var. *graminicola*		Kenya (E)
Aloe lolwensis		Kenya (E) (Island Lake Victoria)
Aloe macrosiphon		Kenya, Tanzania, Uganda
Aloe massawana	CR (Newton 1998)	Kenya (Coast), Tanzania, Ethiopia
Aloe pirottae	LR/C (Demissew 2003)	Kenya
Aloe ruspoliana		Kenya, Ethiopia, Somalia
Aloe turkanensis		Kenya, Uganda
Aloe tweediae		Kenya, Sudan, Uganda
Aloe ukambensis		Kenya (E) (Kitui/Taita)
Aloe wrefordii	CR (Newton)	Kenya, Uganda, Sudan
Aloe amicorum		Kenya .E. (Marsabit)
Aloe confusa	R/V	Kenya (R) (Taita), Tanzania (V)
Aloe kulalensis	R	Kenya (R, E) (Marsabit)
Aloe powysiorum	(R)	Kenya (R, E) (W. Kenya)
Aloe aegeodonta		Kenya (E) (Kitui District)
Aloe archeri	VCR (Newton 1998)	Kenya (V) (Laikipia, E)
Aloe calidophila	R	Kenya (R) Ethiopia (R)
Aloe carolineae		
Aloe ketabrowniorum		Kenya (E) (Marsabit)
Aloe lensayuensis	V	Kenya (V, E) (Marsabit)
Aloe microdonta		Kenya (Coast), Somalia
Aloe muticolor		Kenya (E) (Marsabit)
Aloe pustuligemma		Kenya (E) (Southern Turkana) (E)
Aloe rugosifolia	V	Kenya (V), Ethiopia (V)
Aloe scabrifolia		Kenya (E) (Laikipia, Samburu)
Aloe tugenensis		Kenya (Baringo) (E)
Aloe vituensis	V	Kenya (V), Sudan
Aloe wilsonii		Kenya (W. Pokot), Uganda
Aloe cheranganiensis	V	Kenya (V), Uganda (V)
Aloe dawei		Kenya, Rwanda, Uganda, Congo
Aloe deserti	V	Kenya (V) –(Nairobi-Taita)-Tanzania
Aloe elgonica	V	Kenya (V) (Eldoret-Mt. Elgon (E)
Aloe fibrosa	V	Kenya (V), (Machakos)- Tanzania (V)
Aloe francombei		Kenya (Laikipia) – (E)
Aloe kedongensis		Kenya (Kiambu, Naivasha) (E)
Aloe morijensis		Kenya (Kajiado), Tanzania
Aloe ngongensis		Kenya, Tanzania
Aloe nyeriensis	V	Kenya (V, E) (Laikipia & Nyeri)
Aloe penduliflora		Kenya (E) – (Taita)
Aloe rabaiensis		Kenya, Tanzania, Somalia

Aloe ballyi	V+CR	Kenya (I), Tanzania
Aloe elata		Kenya- (Nguruman)- Tanzania
Aloe volkensii Engler ssp. Multicau*lis*		Kenya, Tanzania, Uganda, Rwanda
Aloe volkensii Engler ssp. *volkensii*		Kenya, Tanzania
Aloe spp. A. Incompletely Known species from western Kenya Aloe sp. B Incompletely known from two localities in Western Kenya		
KEY: *V-Vulnerable, R-Rare, CR-Critical risk, E-Endemic*		

Source: (Lubia *et al*., 2008).

1.1.3 History of Aloe Enterprises in Kenya

Commercial aloe growing in Kenya has been limited with a lot of emphasis placed on harvesting of wild aloe population without regard to depletion of the resource. Thus, Aloe trade in Kenya was conducted informally for over five decades with aloe bitters finding their way to the international market without regulation. NAREDA (2003) reported that, aloe products were probably trading under disguised brands and names such as vegetable products, natural gums and essential oils and concentrates. Due to the lack of regulatory framework then, the trade and markets for the aloes was impenetrable by formal players while the resource owners and harvesters were exploited by illegal traders (Kihara, 2005). In response to the danger of over-exploitation, the following efforts to improve the aloe sector were initiated:

i. Formation of corporate initiatives towards regulation of Aloe utilization in Kenya promoted by the Kenya Aloe Working Group (KAWG) a consortium of organizations and individuals with interest in sustainable conservation and management of aloe species in Kenya;

ii. Baringo Aloe Bio-Enterprise Project supported by European Union- Biodiversity Conservation Programme (EU-BCP);

iii. Aloe resource inventory and mapping supported by Netherlands Development Organization (SNV-Netherlands);

iv. Research work undertaken by Kenya Forest Research Institute (KEFRI) culminating to various reports on commercial utilization of aloes in Kenya. Among these reports are guidelines for growing aloes. (Guides for farmers and extension officers);

v. The development of a subsidiary legislation on aloe, the Wildlife (Conservation and Management) Aloe Species Regulations, 2007;

vi. Community and private initiatives in aloe enterprises such as Kieni Aloe Plantations and Kamuiga Artemisia Farmers in Kieni West division among others; and

vii. Development of strategy for conservation and management of commercial aloe species in Kenya by Kenya Wildlife Service (KWS) to provide a framework for implementation of the Wildlife (Conservation and Management) Aloe Species Regulations, 2007.

Various players such as the CITES, Kenya Forest Research Institute (KEFRI), National Museum of Kenya (NMK), Laikipia Wildlife Forum (LWF) and individuals have undertaken various studies to establish the status of aloe resources in the country. LWF using USAID grant commissioned Natural Resources Development Agency (NAREDA) Consultants in 2003 to undertake a market survey of Kenya aloes. KEFRI and NMK in 2001 undertook a research on aloe resources with a specific focus on

utilization and scope for commercialization while the CITES Secretariat in 2003 commissioned a desktop study of significant trade review of East African aloes. Other studies done on various topics of aloe conservation, management and marketing are detailed in the literature review section in this thesis. From these studies, it was concluded that:

i. The aloe sector is an active and a viable commercial enterprise and needs formalization for best practice to thrive;
ii. The sector should operate in an environment with rules and procedures taking cognizant of the national and international protocols on trade in the resource; and
iii. There should be an emphasis on value adding of products to increase benefits accruing from the utilization of the resource (Kihara, 2005).

1.1.4 History of Aloe Conservation and Management in Kenya

All species of aloes except *Aloe vera* are listed under Appendices I and II of the CITES which Kenya is signatory. Kenyan aloe species are listed under Appendices II of CITES. The international trade in aloes of Kenya is therefore subject to CITES guidelines and procedures. Therefore, in Kenya harvesting aloes from the wild is only acceptable when:

i. National non-detrimental findings have been done; and
ii. Only after acceptable quota that will not be detrimental to the survival of the aloe species in the wild is allocated. (Lubia *et al*., 2008).

However, aloe propagation and cultivation is encouraged for commercial exploitation and is not subject to non-detrimental findings. The harvest depends on quantities

cultivated and management regime of the species. This qualifies aloe propagation and cultivation as an excellent method of aloe conservation and management outside the protected areas.

CITES makes it obligatory for each country to designate and register one or more management and scientific authorities, to coordinate, manage, administer and advise on the utilization, trade and transactions of all CITES listed species. KWS is the designated management authority and NMK is the scientific authority for Kenya government for the purpose of the implementation of the provisions of CITES. Kenya signed the CITES convention in March 1978, but enforced it in 1979 when the Kenya Wildlife Service became the custodian of the protocol. Recently KWS has facilitated the legislation to regulate aloe trade in Kenya.

Prior to the Wildlife (Conservation and Management) Aloe Species Regulations 2007, Kenya lacked adequate regulations and mechanisms to oversee or regulate the protection, conservation and management of aloes outside protected areas. The unclear provisions for regulation for use of aloes species within the wildlife legislation framework saw the unchecked utilizations of the aloe species in the 1980's resulting in over-exploitation and wanton destruction of aloe species in the wild. The unsustainable harvesting of aloes posed many threats ranging from over-exploitation to ecological imbalance and possible loss of the species. This prompted CITES to impose restrictions on Kenyan aloes, and prompted Presidential Decree in November 1986. The Presidential Decree prohibited harvesting of aloe species from the wild for commercial purposes and instead called for establishment of aloe plantations for commercial

exploitation. However, the Presidential Decree was not translated into law through gazettement and was largely ignored (Lubia, 2005).

Under the Wildlife (Conservation and Management) Amendment Act of 1989, the KWS is mandated to formulate policies governing the conservation, management and utilization of all types of fauna and flora. Unfortunately, it took long for these policies to be developed (GoK, 1989). As a result of these inadequacies in the national law, considerable illegal trade in specimens of aloes continued unabated threatening the resource base in the wild (Lubia, 2005). The illegal trade compromised the premiums of the resource and the recognition that Kenya's aloe bitter gum is of superior quality. However, the recent gazettement of a subsidiary legislation on aloes, the Wildlife (Conservation and Management) Aloe Species Regulations, 2007 (LN 403) will streamline the aloe sub sector through promoting cultivation of the aloe species and certification of harvesting operations dependent on the wild aloe resource base (GoK, 2007)

1.2 Problem Statement

Various studies and efforts have been previously undertaken e.g. the gazettement of Wildlife (Conservation and Management) Aloe Species Regulations (2007) and the establishment of community based institutions to promote aloe cultivation. However, the community in Kieni West division of Nyeri North District, where Kieni aloe plantations and Kamuiga Artemisia Farmers institutions are based have not yet embraced aloe cultivation as would have been expected of an economic activity with a potential to increase household income in a semi arid area. The farmers have continued

with the old economic activities of agro-pastoralism that have failed to alleviate the perennial social economic and ecological problems in the area such as crime, poverty, insecurity and soil erosion . Based on the problems stated, the purpose of this study was to investigate factors affecting aloe propagation and cultivation in Kieni West division of Nyeri North District, Central Province, Kenya.

1.3 Research Justification

The rationale for the study was informed by the fact that aloe propagation and cultivation is one of the identified strategies for aloe conservation and management in Kenya with both ecological and social-economic benefits. The ecological benefits include; reduction of unsustainable utilization of the wild aloe populations and enhancement of rangeland rehabilitation while socio-economic benefits include; economic diversification and poverty reduction leading to improved livelihoods in the ASALs .

The choice of the study area was influenced by: need for conservation of Kenyan indigenous aloes; need to diversify economic activities in an area that is food insecure; and the fact that aloes grow naturally in the area.

The study identified and analyzed factors affecting aloe propagation and cultivation. It provides information to the policy makers, CITES parties, NGOs interested in communities' aloe cultivation schemes, the arid and semi arid resource managers and all other aloe stakeholders in Kenya.

1.4 Research Questions

i. Is Kieni West Division Community aware of Aloe propagation and cultivation as a commercial enterprise?

ii. What strategies are used by the local institutions promoting aloe propagation and cultivation to create awareness and communicate essential knowledge and skills to the community?

iii. What are the limitations /concerns affecting adoption of aloe propagation and cultivation in Kieni West division?

1.5 The Research Hypotheses.

i. Awareness of Aloe propagation and cultivation increases acceptance and adoption of the practice at the community and individual levels.

ii. Adoption of Aloe propagation and cultivation is dependent on membership to local institutions promoting the innovation

iii. Engagement in other economic activities besides farming is diversionary and lack sufficient returns for meeting basic needs of the community.

1.6 Research Objectives

i. To assess the state of awareness, knowledge and skills of aloe propagation and cultivation in the community.

ii. To determine strategies used by the local institutions to create awareness and transfer essential knowledge and skills in aloe propagation and cultivation.

iii. To assess the limitations /concerns affecting adoption of aloe propagation and cultivation Kieni West division.

1.7 Significance of the Research Output

The findings of this study will help the policy makers and promoters of aloe innovation in Kenya re-orient their methodology of introducing the technology to the community. The study provides information on the community concerns that can be integrated to the public training program providing a framework for allocating resource to activities that are more relevant to the needs of the community.

1.8 Conceptual Framework

Figure 1.1 shows the current state of aloe cultivation in Kieni West division. The community have not adopted aloe cultivation. To shift the current equilibrium towards the desired state, a multifaceted process is required. Environmental Education (EE) was identified in this study as a process that can shift the equilibrium to the desired state. Without EE process, ignorance would continue and people would be forced to adopt the innovation at a slower rate as the arid environmental conditions become harsher. This adoption would not be sustainable as it would not be based on removing barriers (retraining factors) but desperation as the alternative economic activities become unreliable.

EE as a process of recognizing values and clarifying concepts will be vital in developing skills and attitudes necessary to help the policy makers and the community understand and appreciate that they have similar goals i.e. (the community's desire to gain financially and the policy makers desire to eradicate poverty in the community while conserving the aloe species). Since both goals are similar, it is the duty of all the

stakeholders to remove the barriers (restraining factors) of aloe propagation and cultivation by:

i. Seeking to acquire knowledge and skills required in aloe production;

ii. Changing attitudes and values towards aloe conservation, management and environment because of the associated benefits; and

iii. Actively participating in sustainable aloe propagation and cultivation. This is the desired state (UNESCO, 1978).

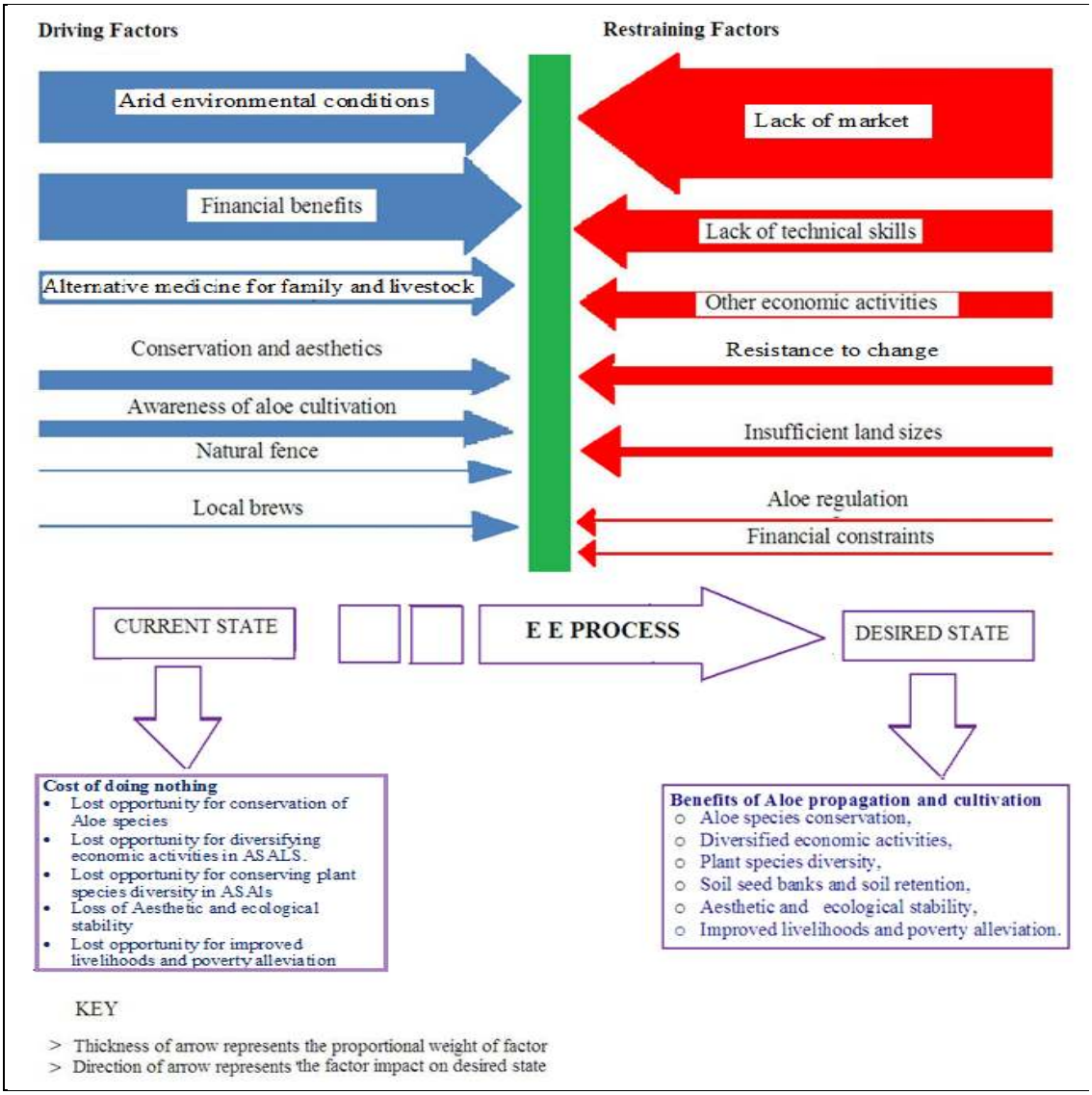

Figure 1.1 Conceptual framework
Source Author

1.9 Operational Definition of Terms

For the purpose of this study, the meaning of the following terms has been stated as:

1.9.1 Artificial Aloe propagation

Artificial Aloe propagation means domestication or growing aloe species to establish a population either by use of seeds, suckers or callus tissue culture material either in a controlled environment or in the wild.

1.9.2 Aloe Propagation and Cultivation

Aloe propagation and cultivation has been used in this study as a single process which involves establishment of aloe populations and all the other sub-process culminating to establishment of the aloe farm, management of the aloes in the farm and harvesting.

1.9.3 Wild population

Wild population of aloe means those populations of aloe species that have not been planted by man and are growing naturally without human manipulation.

1.9.4 Unprotected areas

Unprotected area means a parcel of land that is legally registered under an individual or a group of individuals as defined by the Kenya Land Act.

1.9.5 Aloe Management Unit (AMU)

Aloe Management Unit means area delineated for the purposes of sustainable controlled harvesting of aloes from the wild.

1.9.6 Non detrimental findings

Non detrimental findings mean assessment of impacts of aloe species exploitation to the wild population.

1.9.7 Aloe sap: The yellow liquid found in the outer coating of aloe leave.

1.9.8 Bitter aloe gum

The product produced after boiling aloe sap. The product varies in colour depending on aloe species and is packed and sold for further processing or use.

1.9.9 Aloe gel

The product obtained from the inner part of the aloe leaves extracted through carefully removing the outer skins of the leaves. The process requires specialized leaf stabilization to ensure quality of the product.

1.9.10 Aloe Farming

Used in place of Aloe propagation and cultivation in some parts of this report

1.9.11 Aloe Enterprises

The term is used as a wider term encompassing aloe propagation and cultivation and the subsequent activities such as value addition and trade.

1.10 Scope and the Limitations of the Study

The study identified the factors affecting aloe propagation and cultivation in Kieni West division, the direction and the proportional weight of impact for each identified factor. The study further examined the relationship between community awareness and adoption of aloe propagation and cultivation.

However, the study was limited to only one division yet aloes grow naturally in other divisions. Therefore, there is need to increase scope to Nyeri North District and the surrounding districts where aloes grow so as to enhance benefits from aloe conservation and propagation.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews relevant literature to the study in order to bring the problem of investigation in to appropriate perspective. The reviewed literature shows that sustainable utilization of aloes for commercial purposes is useful for conservation and management of aloes, rehabilitation of dry lands ecosystems and improved livelihood for the local communities. However, effective dissemination of the knowledge accumulated through research is indispensable for aloe propagation and cultivation. Environmental education has a role to play in informing the aloe stakeholders of the knowledge generated for sustainable aloe propagation and cultivation.

2.2 Review of Previous Research

2.2.1 Background Information

Kenya's drylands support 28% of the total human population in the country and occupy 80% of the land area (GoK, 1999). Though endowed with the natural resources, the areas remain underdeveloped due to use of inefficient and unsustainable methods of resource extraction. These areas frequently experience prolonged drought, erratic and uneven rainfall distribution and the local communities have limited alternative livelihoods though nomadic pastoralism is the mainstay economic activity. Population increase and the simultaneous increase in livestock have led to widespread rangeland degradation compromising the livelihoods of hundreds of thousands of pastoralists (Doyo, 2003).

Thus, there is a pressing need for environmental conservation and economic diversification in these areas as spelt out by the government of Kenya elaborate programmes in Poverty Reduction Strategy Paper (PRSP), the Economic Recovery Strategy and Vision 2030 for renewed growth (GoK, 2003; GoK, 2007). Pursuant to these policies government agencies responsible for conservation and management of natural resources in collaboration with other stakeholders have initiated programmes to encourage alternative pastoral projects in drylands and utilization of aloes is one such project that has been identified as a potential community-based natural resource enterprise that will achieve such goals (Lubia *et al*., 2008).

2.2.2 Aloe Conservation, Ecological Management and Marketing

Various studies and reports in relation to conservation and management of genus aloes for various reasons have been carried out. One such initiative is the Plant Conservation Project of the East African Herbarium initiated as a conservation project in 1996 to conserve a range of succulent species including *Aloe archeri, Aloe ballyi, Aloe juvenna, Aloe masaswana, Aloe microdonta, Aloe parvidens, Aloe tugenensis,* and *Aloe wrefordii.* The eight aloe species selected were considered to be succulents of highest conservation concern. The project aimed to carry out field studies to verify the extant populations of the selected species and their conservation status, to document threats, collect stocks for *ex situ* conservation purposes and collect herbarium specimens for further research. This project also intended to inventory protected areas and support enforcement of CITES. The project identified threats to the selected aloe species as habitat destruction, grazing and direct exploitation (Oldfield, 2003)

Other studies done to establish the conservation status of wild aloes in Kenya include Oldfield, (2003), Newton (2003) and Wabuyele *et al*., 2006). Nevertheless, it is the recent work to establish the status of commercial aloe spearheaded by KWS and KEFRI that has given impetus to the aloe conservation work. Efforts to conserve aloes in Kenya have been both *in-situ* and *ex-situ. In-situ* conservation of aloes is done in their wild habitats while *ex-situ,* conservation is done through establishment of demonstration plots, botanical gardens and gemplasm preservation in gene banks. Nairobi Botanical garden situated in National Museums of Kenya is a present example with substantial collections of Kenyan aloes on display (Lubia *et al*., 2008).

Naturally occurring aloes benefit grassland ecosystems ecologically. This was established and demonstrated by a study in a heavily overgrazed Kenyan grassland which found that naturally occurring *Aloe secundiflora* were associated with higher surrounding vegetation cover, plant species diversity, soil seed banks, and soil retention (King, 2003). This study concluded that planted aloes may help heal overgrazed rangelands and local economy. To advance this knowledge, an experimental design study titled Facilitative Effects of *Aloe* Shrubs on Grass Establishment, Growth, and Reproduction in Degraded Kenyan Rangelands: Implications for Restoration, was undertaken by King and Stanton (2007). Findings of this study indicate that planting aloes can improve the effectiveness of grass reseeding for rangeland restoration, and that *Aloe secundiflora* offers great potential for drylands income generation because its medicinal sap and gel are economically valuable. Consequently, given that *Aloe secundiflora* can facilitate grass recovery, rangeland rehabilitation can be simultaneously combined with sustainable sap production for a win-win combination of

ecological and economic benefits thus improving livelihoods of the local communities as per the government strategies.

Kenya Forestry Research Institute (KEFRI) undertook a research on aloe resources with a specific focus on utilization and the scope for commercialization Mukonyi *et al*., (2001) and noted that *Aloe turkanensis* and *Aloe scabrifolia*, both of which are cut for extracts, are threatened by Aloe cutters. This was similarly noted by Oldfield (2003) who also observed that other Aloe species may be threatened because of indiscriminate aloe collection for international trade. Oldfield (2003) reported that the local value and international demand for aloe products and the potential for sustainable trade to contribute to rural livelihoods in Kenya appears to be significant and recommended that:

i. Information be solicited from importing countries, notably China, on the levels of import of Aloe extracts from East Africa;
ii. CITES parties and NGOs support the development of community propagation and cultivation schemes for aloe species used medicinally to take the pressure off wild populations and support rural livelihoods; and
iii. Propagation and cultivation guidelines for aloe species with medicinal values, and certification schemes for sustainable wild harvesting and/or cultivated plants be developed as proposed by the Kenya Wildlife Service and be supported and promoted as an economic incentive for CITES compliance.

The implementation of the 2nd and 3nd recommendation by Oldfield, (2003) led to several aloe propagation and cultivation community initiatives as listed earlier in the

introduction section of this report. This study 'Factors Affecting Aloe Propagation and Cultivation was aimed at identifying factors influencing the implementation of Oldfield's (2003) 2nd recommendation. The 3rd recommendation led to the development and gazettement of, the Wildlife (Conservation and Management) Aloe Species Regulations, 2007 in Kenya, and development of guidelines for growing aloes for farmers and extension officers by Kenya Forestry Research Institute.

The wildlife (Conservation and Management) Aloe Species Regulations, 2007 spell out the aloe utilization and commercialization in Kenya. Under these regulations, all persons intending to engage in propagation and cultivation of aloe species apply for registration to KWS (*a register of artificial propagation of Aloe species is kept by the KWS)* while the Aloe Management Unit is used to manage wild growing Aloe species . In considering applications for registration the two guiding principles under these regulations are:

a) "That artificial propagation of aloe species is provided an environment for sustainable utilization not detrimental to its conservation in the wild or of its supporting ecosystems;" and
b) "That the conservation of aloe species and their natural habitats and microhabitats is enhanced"

These principles mainly focus on aloes growing outside protected areas, i.e., on private land, trust land and communal land. The conservation of these aloes can only be enhanced through landowners and regulatory agencies. This can be achieved through, as proposed by Lubia et al., (2008), promotion of aloes as alternative sources of income,

promotion of aloe cultivation as a competitive land use option and multiple land use that incorporate aloes, e.g., grazing/ aloe farming as measures that can be enhanced for conservation of aloes growing outside protected areas.

Following the gazettement of the wildlife (Conservation and Management) Aloe Species Regulations, 2007, strategy for conservation and management of commercial aloe species in Kenya was formulated by KWS to provide a framework for implementation of the regulations and guide sustainable conservation and utilization of the aloe resources in the country. The strategy focuses on striking a balance between social-cultural, economic and ecological needs as the core pillars of sustainable development. However, the strategy envisions challenges to the sustainable utilization of aloes ranging from social, economic and environmental protection as follows:

i. Unsustainable utilization of wild aloe populations through over reliance on wild populations, limited aloe cultivation and lack of standardized protocols for harvesting aloes;
ii. Research and development for quality planting materials, pests and diseases control;
iii. Value addition to raw products through limited technology innovation, access to credit facilities and quality assurance procedures;
iv. Awareness on conservation, management and utilization of aloes including land tenure and changing use patterns, undervaluation of aloe as commercial plant, resource ownership and lack of information on agronomic practices;
v. Regulatory frame work for control of illegal trade, enforcement and compliance monitoring and cross border trade;

vi. Market and market access including fair trade (equity and benefits sharing), unclear and unfavorable market channels; and

vii. Operational institutional governance structure due to lack of viable community aloe bio-enterprises. (Lubia *et al*., 2008).

The information gaps necessary for high quality aloe product development in aloe production range from identification, selection, propagation, management, harvesting and post harvest handling of aloe species. Mukonyi and Oduor, (2008) provided guidelines for aloe farming and identifies various factors hampering efforts by farmers to grow indigenous commercial aloes in Kenya as:

i. Lack of technical know-how in seed collection and handling, and nursery establishment;

ii. Pests and diseases that affect the productivity of aloes and whose management is not well known;

iii. Lack of knowledge in harvesting cycles that are based on age and seasons; and

iv. Information on propagation, management and harvesting of the commercial indigenous aloes.

2.2.3 Aloe Marketing in Kenya

Market and market access is a challenge facing aloe conservation and management of commercial aloes. A Policy Analysis Study, "Improving Marketing Access for Drylands Commodities Project" carried out by UNDP (2005) observed that though aloe production has been a fall back for communities in the drylands during periods of drought especially in the north rift, the Aloe trade has not expanded to other places

other than the districts of origin due to poor marketing skills and lack of information both by consumers and producers of these products. The locals who produce natural based products also face the problem of intellectual property rights whereby their products are not patented and could be claimed by anybody who wants to deal in them.

NAREDA, (2003) report concluded that the aloe business in Kenya is shielded in a closed cartel-like operation system and recommended the opening up of the marketing component in order to spur its growth and improve pricing structure while Oldfield, (2003) noted that systems had not been in place for effective monitoring of trade of East African *Aloe* species.

Though, the enactment of Wildlife (Conservation and Management) Aloe Species Regulations, (2007) spell out the system of aloe conservation and management, lack of organized marketing systems and information gathering has led to improper pricing and unfair equitable benefits to resource owners impacting negatively to aloe conservation in the country. Aloe product value chain marketing should be streamlined through the government marketing and regulatory structures to ensure better pricing and benefits to rural communities. Well coordinated marketing institution would encourage small scale participation in aloe propagation and cultivation (Lubia *et al*., 2008).

2.3 Summary of the Literature Review

Research shows that naturally occurring aloes benefit grassland ecosystems ecologically. i.e., it is associated with higher surrounding vegetation cover, plant species diversity, soil seed banks, and soil retention. Consequently, given that aloes can facilitate grass recovery, rangeland rehabilitation can be simultaneously combined with

sustainable sap production for a win-win combination of ecological and economic benefits thus improving livelihoods of the local communities. This is crucial in Kenya since drylands occupy 80% of the land area and support 28% of the total human population. Consequently, government agencies responsible for conservation and management of natural resources have initiated programmes to encourage alternative pastoral projects in drylands and utilization of aloes is one such a project.

However, Kenyan aloe species are listed under Appendices II of CITES. The utilization of aloes in Kenya is therefore subject to CITES guidelines and procedures. To ensure sustainable utilization of aloes and adherence to CITES guidelines and procedures, several efforts to improve the aloe sector have been initiated. Among the initiatives was the development of a subsidiary legislation on aloe, the Wildlife (Conservation and Management) Aloe Species Regulations, 2007. The regulations spell out the aloe utilization and commercialization in Kenya.

Outside the protected areas i.e., on private land, trust land and communal land, aloe species conservation is threatened by habitat destruction, grazing on range grasses and direct exploitation. The conservation of aloes in these areas can only be enhanced through co-operation consent of landowners and regulatory agencies adopting and improving aloe propagation and cultivation schemes. This study intends to investigate factors affecting aloe propagation and cultivation in Kieni West division, Kenya.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter focuses on the research design and the methodology adopted. It begins by defining the research design and outlines the sample used and criteria for selection. It describes the research instruments used and procedures for their administration to the target population. Finally, it outlines the methods adopted in the analysis of data.

3.2 Research Design

The research design selected and used in this study was a case study. The rationale for the research design was informed by the need to have in-depth investigation of factors affecting aloe propagation and cultivation in Kieni West division. The study was carried out in two locations randomly selected from the five location of the division i.e. Mugunda and Gatarakwa locations. Data was collected from all the sub locations of each location namely: Kamiruri, Nairutia, Ruirii and Kariminu sub locations of Mugunda location and Watuka, Embaringo, Lamuria and Kamariki sub locations of Gatarakwa location.

3.2.1 Study Area

3.2.1.1 Location

The study was based in Kieni West division, a semi arid zone of Nyeri North district in Central province, Kenya. Figure 3.2 shows the location of the study area in Kenya.

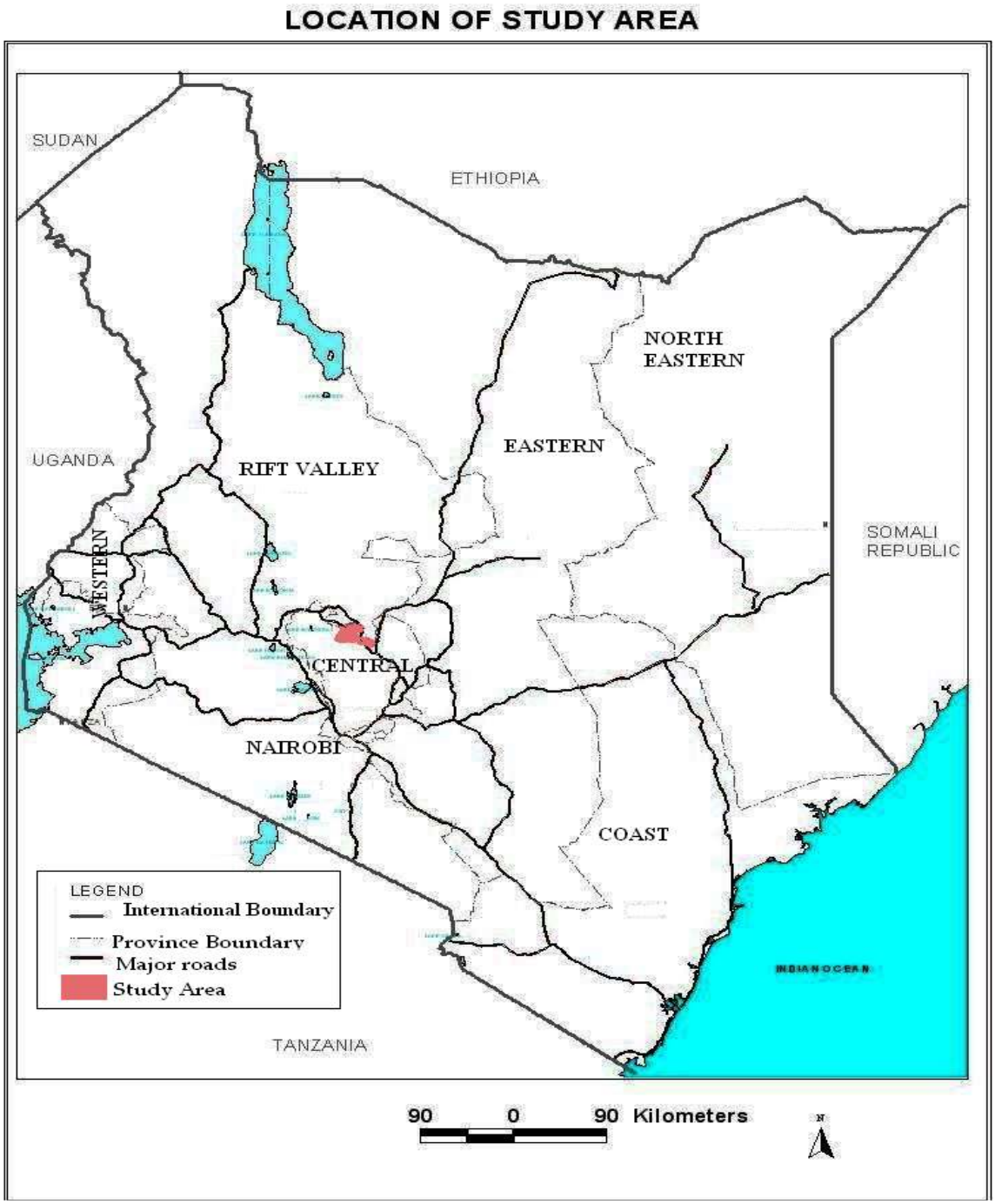

Figure 3.2 Map of Kenya showing location of the study area: Kieni West Division, Nyeri North District, Central Province.

Source: Survey of Kenya

Administratively the division has: Mweiga, Endarasha, Gatarakwa, Mwiyongo and Mugunda locations covering a total area of 1,230 $km^{2.}$ Figure 3.3 shows the locations of the Kieni West division and the boundaries of Nyeri North district.

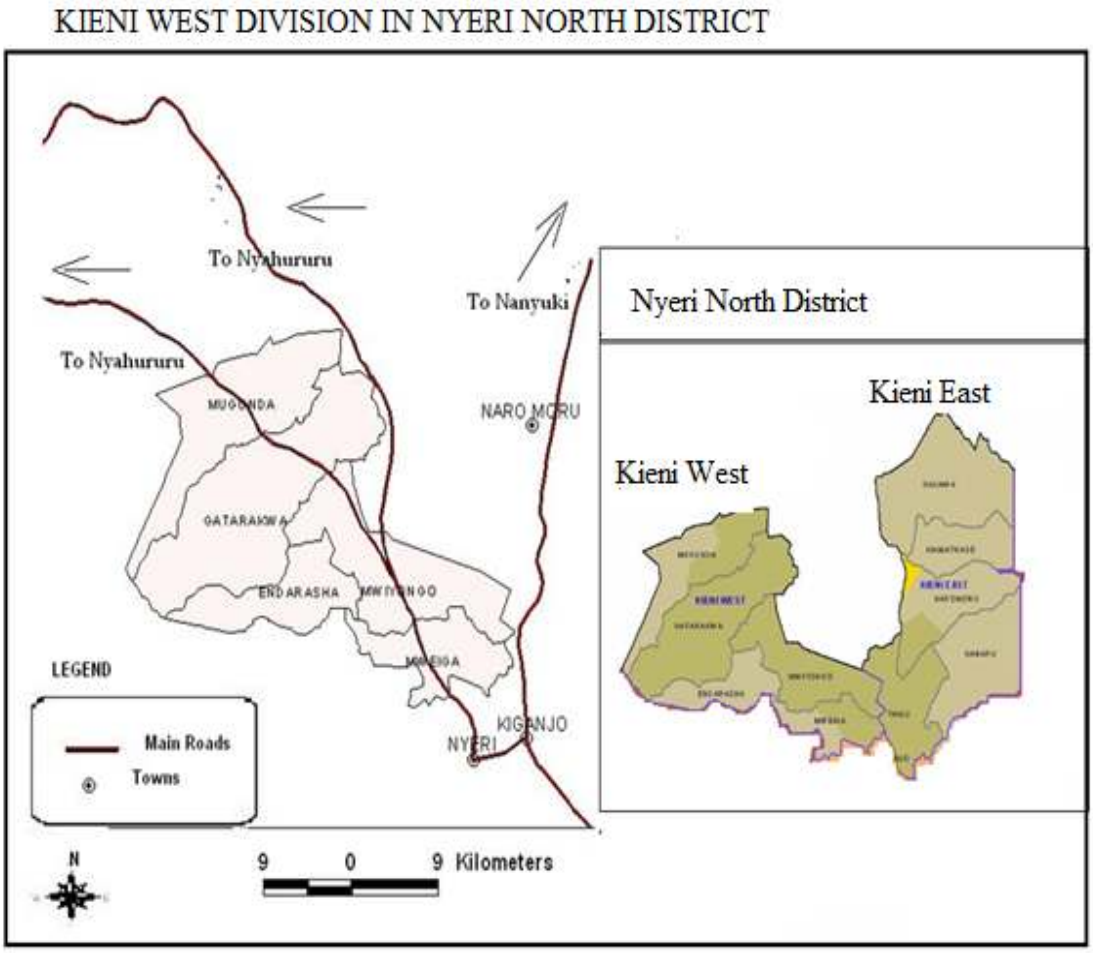

Figure 3. 3 Map of the study area showing administrative units (locations) studied.
Source: Survey of Kenya

Kieni West division was purposely selected for the study. The choice of the study area was influenced by the need to conserve indigenous aloes that naturally grow wildly in the area, need to diversify economic activities and improve livelihoods of the

community; and the fact that there were initiatives to introduce aloe propagation and cultivation in the area.

3.2.1.2 Topography and GPS Co-ordinates

Kieni West Division lies within the Longitude 36^{o} 40' 60 E and Latitude 0^{o} -51'0 S. This can be termed as an "intermontane" division since it lies between Mt. Kenya to the east and Nyandarua (aberdare) ridges to the west. The division borders to the east Kieni east division and to the North Laikipia district while to the south is Tetu (West division of Nyeri district.

3.2.1.3 Natural Vegetations and Soils

The division is characterized by low primary vegetation productivity and low seasonal variability in water availability (both surface and accessible ground water). This explains the scant vegetation in the division and soil erosion that has taken place first in the areas where vegetation has been cleared either through clearing or overgrazing (Price Waterhouse Coopers and ALRMP, 2005.)

3.2.1.3 Climatic and Drainage

Kieni West division lies in the leeward side of the Aberdare ranges and is characterized by unreliable rainfall of between 550mm to 950mm per annum. The driest locations are Gatarakwa and Mugunda which are in Agro climatic zones V and VI. (Price Waterhouse Coopers and ALRMP, 2005). The division has a flat terrain and experiences long periods of sunshine and windy conditions.

3.2.1.4 Social Economic Activities

Agro-pastoralism is the dominant livelihood system in the division i.e. households supplement their agricultural income with livestock-based activities. Crop agriculture is primarily rain-fed and the key crops grown are wheat, maize and legumes. Some horticulture is also practiced especially in some parts of Endarasha and Mweiga locations (Price Waterhouse Coopers and (Arid Lands Resource Management Project (ALRMP), 2005). Other sources of livelihoods are formal employment, casual waged labour and business.

Due to common droughts in the division there are frequent crop failure and consequent food insecurity. This leaves the local community with limited alternative livelihoods. Consequently, there are efforts by the local institutions e.g. Kieni Aloe Plantations and Kamuiga Artemisia Farmers in collaboration with the government and NGOs to assist local community diversify their economic activities. The diversified economic activities include adoption of draught resistant food crops and cash crops such as aloe propagation and cultivation.

3.2.1.5 Aloe Farming Activities

Aloe propagation and cultivation was a new innovation being introduced by local community institutions in collaboration with the government agencies. The technology was at the creation of awareness stage. However, the communities had not adopted the technology for reasons discussed in the results and discussion sections of this study. The Aloe species grows naturally in the area i.e. in the private land and thus conservation of these species can only be done in collaboration with the land owners.

3.3 Sample and Sampling Procedure

3.3.1 Population

Kieni West division comprises of five locations with an estimated population of 68,461 people. With an assumed average of five people per household in the division; the target population was 13,692 households/farms. Assuming that the five locations had an evenly distributed population, the average population per location was estimated to be 2,738 households/farms. Since two locations were randomly selected for this study, the accessible population totaled to 5,476 households/farms.

3.3.2 Sample Size

Using the accessible population, the formula below was used to determine the sample size to be used in this study. According to Mugenda and Mugenda, (1999) the formula is applicable in studies where the target population is greater than 10,000. Thus, the formula was applicable in this study since the target population was13, 692.

$$n = \frac{Z^2 pq}{d^2} = \frac{(1.96)^2 (0.4)(0.6)}{(0.05)^2}$$

Where:

n = the desired sample size (if the target population is greater than 10,000)

z = the standard normal deviate at the required confidence level (1.96)

p= the proportion in the target population estimated to have characteristic being measured

q= 1-P.

d= the level of statistical significance set (0.05)

A sample size of 370 households/farms was determined as being representative of the whole population. However, 400 respondents were interviewed and 380 responses analyzed as explained in the results and discussion section of this thesis.

3.3.3 Sampling Procedure

Two research guides from every sub location were recruited through the office of the chief Mugunda location and the chief Gatarakwa location. The research guides assisted in directing the researcher and the research assistant within the sub locations as requested. A sample size of at least 50 respondents per sub location was targeted.

In every sub location, the sub-chief office was used to identify farmers engaging in aloe propagation and cultivation. In some cases such farmers were identified by other farmers during the interview. The farmers engaging in aloe propagation and cultivation were purposively visited for an interview. The sub chief's office was used as the central point during the study. The direction of movement from the sub chief's office was randomly selected. Systematic random sampling was then used whereby after interviewing one household, the next household/farm was skipped.

Kamuiga Artemisia Farmers, a local institution promoting aloe propagation and cultivation in the division was purposely selected for interview. The rationale for selecting the institution was informed by the fact that Kamuiga Artemisia Farmers, a common interest self help group was an umbrella body of eleven self help groups in the division promoting aloe propagation and cultivation.

3.4 Research Instruments

The data was collected using semi-structured interviews. This involved use of two interview schedules for different respondents i.e. interview schedules for individual respondents and interview schedules for institutions promoting aloe propagation and cultivation in the division. The rationale for using interview method for data collection was informed by the need to obtain high response rate and in-depth data for the study.

3.4.1 Administration of the Research Instruments

Prior to data collection process, the study area was visited for the purpose of introduction to the area administration. This was followed by a pilot study. These activities were informed by the need to familiarize with the modes of instruments administration and to test the instruments. The interviews were conducted by both the researcher and the trained research assistant. All individual respondents were interviewed on their farms with every member of a household being encouraged to participate. The interview took about 15-20 minutes. An appointment was made with the Kamuiga Artemisia Farmers officials and an interview conducted.

3.5 Data Analysis

The study yielded qualitative data which was analyzed based on the objectives of the study as outlined in chapter one. Thus, the data was generated in various categories, themes and patterns as per the research objectives. Analysis of data was done using Statistical Package for Social Scientists (SPSS) Test Editor. Frequencies, percentages and chi-squired tests were used in data analysis. All the tabulations and the analyzed data are presented in the next chapter.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter present the results obtained from the investigation in the form of data analysis and presentation. The results of the study are discussed in the context of the research objectives. Analysis, presentation and discussion of the findings are organized under the research objectives subtitles as outlined in chapter one.

4.1.1 Response Rate

As shown in Table 4.2, 400 respondents were interviewed surpassing the expected sample size of 370. This was attributed to the sampling procedure used where a target sample size of fifty respondents per sub location was achieved from the eight sub locations selected for data collection. However, only 380 interview schedules were adequately answered and thus analyzed in this study.

Table 4.2 Response rate

Expected No. of Responses	% of Expected Responses	Actual Responses	% of actual Responses	Analyzed Responses	% of analyzed Responses
370	100%	400	108%	380	103%

4.2 State of Awareness, Knowledge and Skills of Aloe Propagation and Cultivation

The purpose of this research objective was to determine the state of awareness, knowledge and skills of aloe propagation and cultivation in Kieni West division community and establish the state of adoption. The responses investigated, analyzed and discussed in this report covered the following three areas;

i. State of community general awareness in propagation and cultivation of aloes

ii. State of community technical skills in propagation and cultivation of aloes

iii. Factors perceived by the community as affecting adoption of aloe propagation and cultivation in the area.

4.2.1 State of community general awareness in aloe propagation and cultivation

Table 4.3 shows and summarises state of respondents' general awareness in aloe cultivation. 56.6% (215) of the respondents' were aware of aloe cultivation while 20.5% (78) had aloes naturally growing in their farms without knowledge of its commercial importance. Aloes were observed (Plate 4.1) to grow naturally throughout the division, especially in Lamuria sub-location. Though 56.6% were aware of aloe cultivation, only 2.1% (8) of the total sample size, i.e. (3.7% of those aware) had propagated aloes for various reasons.

Table 4.3 State of general awareness in aloe propagation and cultivation

	Are you aware of aloe propagation as a commercial enterprise?		
	Response	**Frequency**	**% Frequency**
1	Yes and already farming	8	2.1%
2	Yes with interest but not started farming	74	19.5%
3	Yes and already growing naturally in the farm	70	18.4%
4	Yes but have not had interest	63	16.6%
	Subtotal	**215**	**56.6%**
5	No but already growing naturally in my farm	78	20.5%
6	Not at all	87	22.9%
	Subtotal	**165**	**43.4%**
	Total	**380**	**100%**

This indicates that general awareness has not resulted in the adoption of aloe cultivation. The skewed relationship of awareness (56.6%) and the limited activity in terms of aloe farming (2.1%) should raise concern especially to the KWS as the management authority, and calls for quick action to guard against would be unsustainable activities such as harvest of wild populations described by the respondents as 'naturally growing in the farm'. The over reliance on wild aloe populations is unsustainable and a threat to the conservation and management of aloes and was similarly identified as a challenge by the strategy for conservation and management of commercial aloe species in Kenya (Lubia *et al*., 2008).

Plate 4. 1 Aloes naturally growing on a private land in Lamuria sublocation

4.2.2 State of community technical skills in aloe propagation and cultivation.

The technical knowledge and skills for aloe propagation and cultivation in the community considered in this study were:

i. Legal requirements as per the Kenya Wildlife (Conservation and Management) Aloe Species Regulations, 2007;
ii. Seedlings acquisition; and

iii. Information on propagation, management and harvesting of the commercial indigenous aloes.

4.2.2.1 Legal Requirements

The respondents' awareness on national regulation for the aloe trade was evaluated based on the Wildlife (Conservation and Management) Aloe Species Regulations, 2007. The regulation requires that a person intending to engage in propagation of aloes for commercial purposes apply to be entered in the register kept by KWS as an artificial aloe propagator. Table 4.4 summarizes the respondents' awareness on legal guidelines and procedures.

Table 4.4 Aloes regulation awareness

Are you registered as an artificial aloe propagator?		
Responses	**Frequency**	**% Frequency**
No but planning to apply to KWS	3	1%
No I am not aware of any registration required	377	99%
Total	**380**	**100%**

The Wildlife (Conservation and Management) Aloe Species Regulations, 2007 was not known by 99% (377) of the respondents. It is apparent from the cross tabulation, Table 4.5 below that out of the 8 respondents who had planted aloes 7 of them were not aware of any registration required for aloe cultivation. In terms of percentage, this is equivalent to 87.5 % of those already farming and not aware of aloe regulation.

Table 4. 5. Comparison of awareness vs. registration of aloe propagators

Are you aware of aloe cultivation?	Are you registered as an artificial aloe propagator?		
	No but planning to apply to KWS	Not aware of any Registration Required	**Total**
Yes and already farming	1	7	8
Yes with interest but not started farming	1	72	74
Yes and already growing naturally in the farm	1	67	70
Yes but have not had interest	0	63	63
No but already growing naturally in my farm	0	78	78
Not at all		87	87
Total	**3**	**377**	**380**

The only farmer engaging in aloe cultivation and aware of registration of aloe propagators was "planning to apply". This shows a lapse in enforcement and compliance monitoring of the Aloe Species Regulations, 2007.

4.2.2.2 Seedlings Acquisition

Table 4.6 summarizes varying sources of the aloe seedlings. The local institutions have established nurseries and provide 11% of the seedlings to the community. Plate 4.2 below shows Kieni Aloe Plantations Conservation Farm in Mugunda location where aloe nurseries are established. However, 66% respondents did not know how to acquire aloe seedlings and 23 % would uproot from the fields of absent landlords, road reserves and other public places which is an unsustainable practice.

Table 4.6 Sources of aloe seedlings

If you have planted or wanted to plant aloes how would you get seedlings?		
Sources of seedlings	**Frequency**	**% Frequency**
Own nursery	9	2%
Kieni Aloe Plantations	18	5%
Kamuiga Artemisia Farmers	13	3%
Someone within Kieni	4	1%
Someone outside Kieni	0	0%
Uprooting in the fields	86	23%
No idea	250	66%
Total	380	100%

Apparently there is a gap of knowledge of aloe seedlings acquisition in Kieni West division community. Mukonyi and Oduor, (2008) identified lack of technical know-how in seed collection and handling, and nursery establishment as one of the information gaps in aloe production, and published a guideline for KEFRI intended to address these gaps and assist farmers in sustainable production and utilization of aloes in Kenya.

4.2.2.3 Information on Propagation, Management and Harvesting of Aloe.

The respondents were asked to describe aloe cultivation activities from land preparation to post harvest handling and their responses evaluated against KEFRI guidelines for growing aloes that details aloe propagation, spacing, transplanting, tending and management, pest and diseases, harvesting and processing (Mukonyi and Oduor, 2008). Responses were cross tabulated for comparison with aloe general awareness as in Table 4.7.

Table 4. 7 General awareness vs. actual knowledge and skills

Are you aware of aloe cultivation?	Describe activities involved in aloe cultivation from land preparation to harvesting				Total
	Excellent	Fair	Slight	No idea	
Yes and already farming	0.0%	0.0%	0.8%	1.3%	2.1%
Yes with interest but not started farming	0.0%	0.0%	1.1%	18.4%	19.5%
Yes and already growing naturally in the farm	0.3%	0.8%	1.5%	15.8%	18.4%
Yes but have not had interest	0.0%	0.3%	0.3%	16.1%	16.6%
No but already growing naturally in my farm	0.0%	0.0%	1.3%	19.2%	20.5%
Not at all	0.0%	0.5%	2.4%	20.0%	22.9%
Total	0.3%	1.6%	7.4%	90.8%	100.0%

Among the respondents' aware and cultivating aloes, only 37% (i.e. 0.8% of the total sample) had slight knowledge of aloe cultivation activities while the remaining 63% (i.e. 1.3% of the total sample) lacked the knowledge of aloe cultivation activities. 90.8% lacked knowledge of activities involved in aloe cultivation from planting to harvesting.

Practical knowledge and skills of aloe cultivation were compared with Knowledge of seedlings acquisition as shown by Figure 4.4.

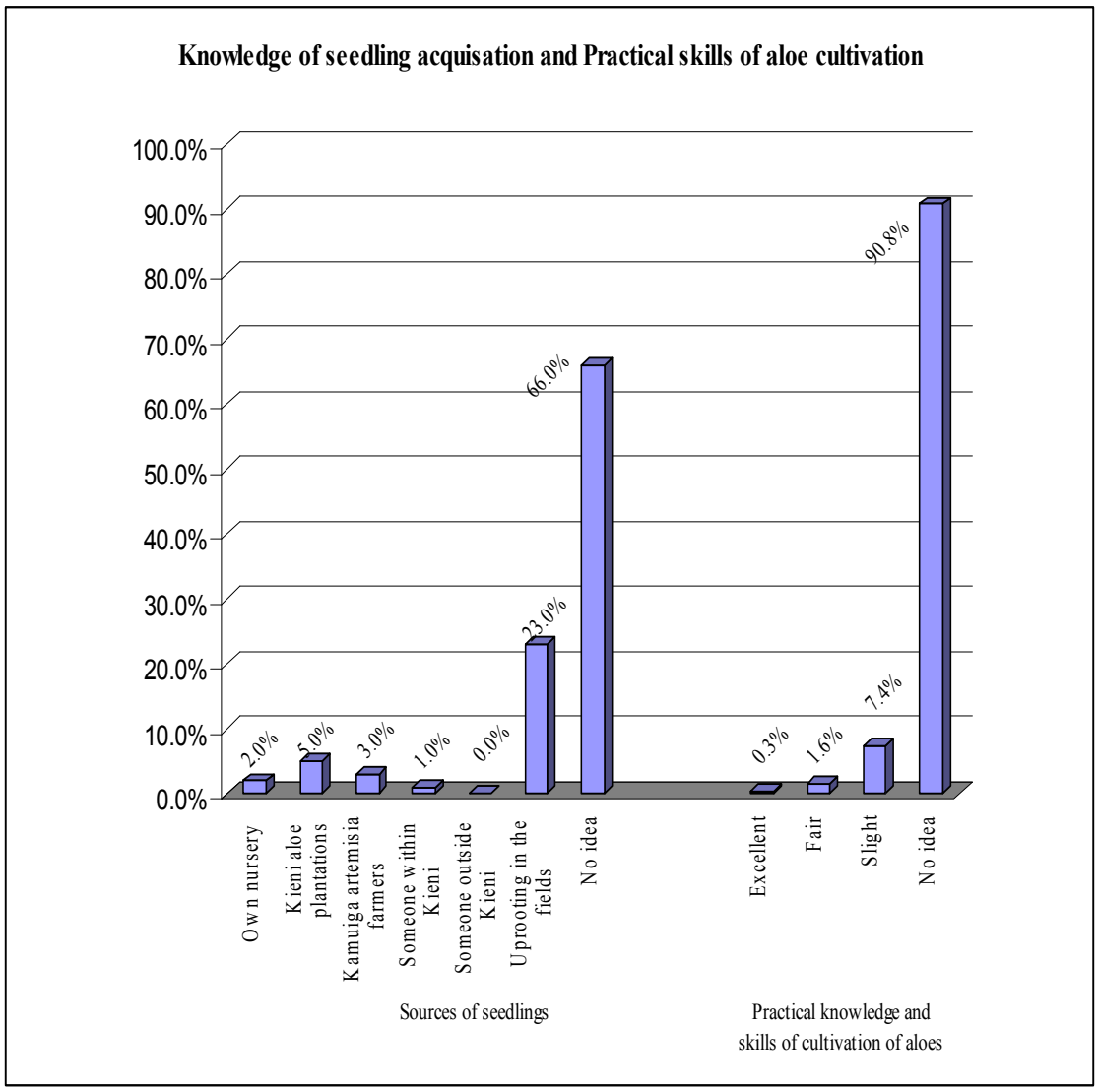

Figure 4. 4 Knowledge of seedlings acquisition vs. practical skills of aloe cultivation

The comparison shows that 44% of the respondents could acquire seedlings but only less than 10% had practical knowledge of aloe cultivation. Lack of information on agronomic practices is a challenge to conservation and management of aloes especially where the aloes are uprooted from wild populations in this case (23%) and not successfully nurtured to maturity (Lubia *et al*., 2008)

4.2.3 Factors Affecting Aloe Propagation and Cultivation in Kieni West Division

The respondents were asked to give reasons why they plant or would not plant aloes. The reasons were categorized as restraining factors and driving factors affecting aloe propagation and cultivation as perceived by the community in Kieni West division as shown by Table 4.8.

Table 4.8 Identified factors affecting aloe propagation and cultivation

Driving Factors			**Restraining Factors**		
Arid Environmental conditions.	129	33.95%	Lack of Market	202	53.16%
Financial benefits	122	32.11%	Lack of technical skills	78	20.53%
Alternative medicine for family and Livestock	61	16.05%	Other economic activities	48	12.63%
Conservation and aesthetics	36	9.47%	Resistant to change	31	8.16%
Awareness of aloe cultivation	29	7.63%	Small land sizes	17	4.47%
Natural fence	2	0.53	Aloe regulation	2	0.53%
Local brews	1	0.26%	Financial constraints	2	0.53%
Total Responses	**380**	**100%**		**380**	**100%**

The individual factors affecting aloe propagation and cultivation, whether driving factors or restraining factors do so with a varying magnitude of impact. Using percentage frequencies as shown by Table 4.8 above, proportional weight of impact for each factor was drawn and illustrated in Figure 4.5. The width of the arrow indicates the proportional magnitude while the direction of the aloe indicates the impacts of the factor on the desired state. Figure 4.5 was used in this study in the development of the conceptual framework as shown by Figure 1.1

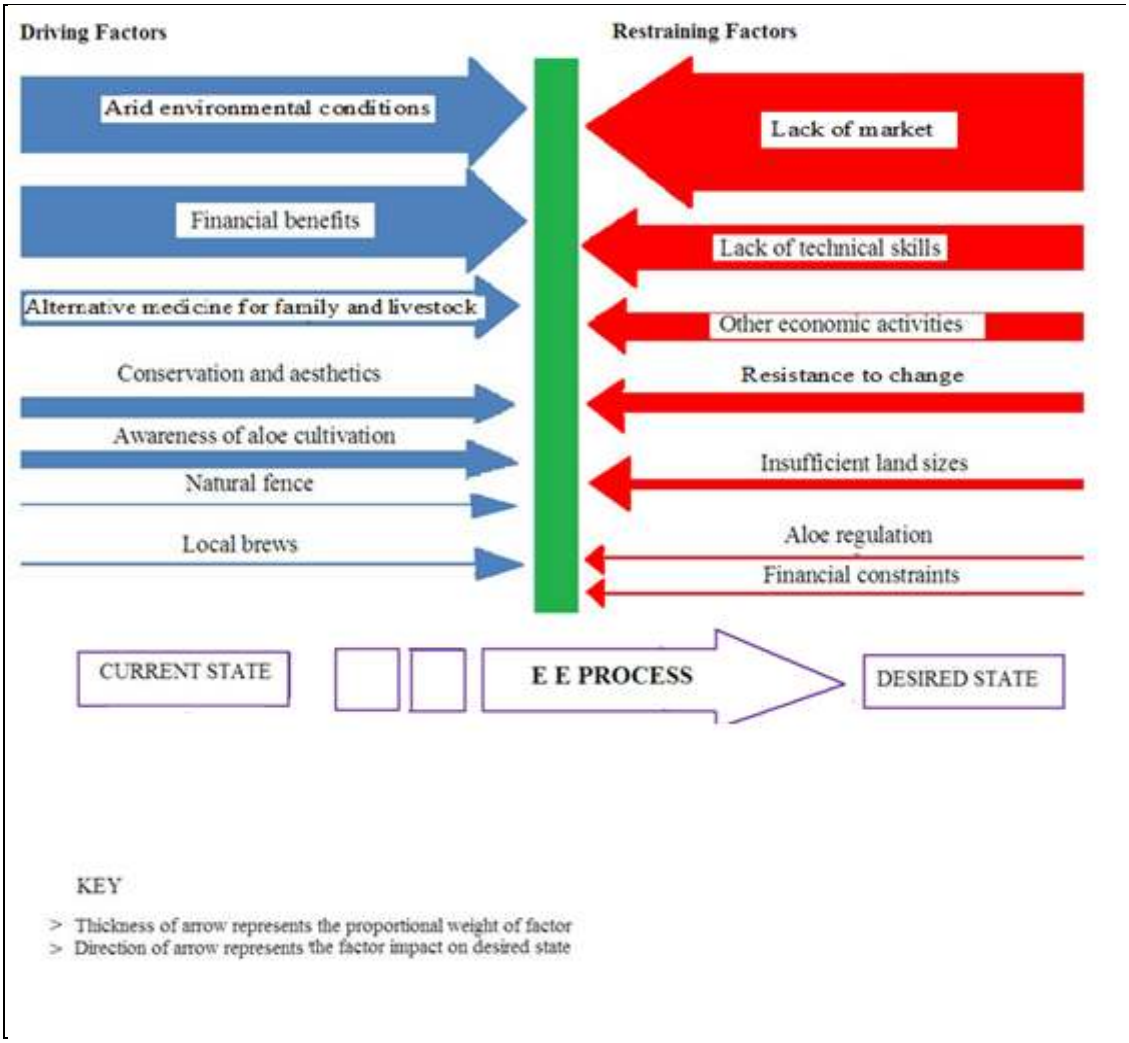

Figure 4. 5 The impacts of factor affecting aloe propagation and cultivation

Understanding of the impact of each factor affecting aloe propagation and cultivation, i.e. the proportional weight of the impact and the impact on the desired state is vital in promoting aloe propagation and cultivation in Kieni West division and other ASALs districts in Kenya. Lack of market and financial benefits are two factors though impacting on opposite direction to the desired state can be said to be related. Thus provision of market will assure the community of the financial benefits that they so desire. Lubia *et al*., (2008) identifies market and market access in terms of unclear and

unfavorable market channels as one of the challenges of aloe conservation and management in Kenya.

There is a possibility that the other restraining factors affecting aloe propagation and cultivation are only justifications that can be easily overcome if clear and favorable market channels are established. For instance, the community may:

i. Not be eager to know the technical aspect of tendering a plant that they have no market for
ii. Be easily lured to other promising economic activities that pay them even though not sufficiently.
iii. Resist planting aloes in their farms because of lack of market and may prefer what they have always done over the years.
iv. Consider highly the opportunity cost of planting aloes over other agricultural products whose market is well established
v. Not be willing to learn the legal requirements and procedures of a plant that has no economic value to them
vi. Not be willing to invest in an agricultural business whose market is unclear.

4.2.3.1 Research Hypothesis 1

The first hypothesis of this study stated that community awareness in Aloe propagation and cultivation increases adoption. The hypothesis was tested using chi-squared at 5% level of significance. The categories used were individual respondents' Aloe adoption time schedules and general awareness as shown by Table 4.9. In testing this research hypothesis the eight respondents who had adopted aloe cultivation were grouped

together with those planning to adopt within five years to avoid cells having expected count less than 5.

Table 4.9 Association between awareness and adoption of aloe propagation and cultivation.

General Awareness	Respondents' Aloe farming Adoption Time Schedules				Total
	To adopt in five years	Yes after market establishment	Not sure of the future plans	Never	
YES	17	141	53	19	230
	14.53	122.26	70.21	23	230
NO	7	61	63	19	150
	9.47	79.74	45.79	15	150
Total	24	202	116	38	380
	24	202	116	38	380
Other tests		Value	Approximate significance		
Phi Cramer's V		0.234 0.234	0.000		
0 cells (.0%) have expected count less than 5. The minimum expected count is 9.47					
Pearson Chi-Square =20.791, DF=3, p-Value 0.00012					

Approximate significance value of 0.000 indicates that there is absolutely no association between awareness and adoption of aloe propagation and cultivation. Therefore the hypothesis that Community awareness in aloe propagation and cultivation increases adoption is rejected. However, in practical terms it's clear that there are those who have planted and are not aware of the commerciality of the innovation while others know but have not planted. This test is supported by results illustrated by Figure 4.5 where awareness was shown with a relatively small proportional weight as a driving factor affecting aloe propagation and cultivation.

4.3 Strategies used in Promotion of Aloe Propagation and Cultivation

The purpose of this research objective was three fold: i.e. to identify the institutions in Kieni West division involved in promotion of aloe propagation and cultivation, to identify strategies used by the identified institutions and to evaluate their success. This was done by:

i. Investigating how the respondents aware of aloe propagation and cultivation leant about it.
ii. Determining the participation of institutions in marketing of aloes.
iii. Determining the strategies used by the identified institutions in promotion of aloe propagation and cultivation.

4.3.1 How the Respondents learnt about aloe cultivation

Asked how they leant about aloe cultivation, the respondents named the institutions as tabulated in Table 4.10 below. The number of respondents aware of aloe cultivation as shown in Table 4.10 was higher than the total sample size because 23 responses learnt from more than one source. Most respondents 28.3% (114) learnt about aloe cultivation though media, 19.7% (79) from local community institutions, i.e., Kieni Aloe Plantations and Kamuiga Artemisia Farmers.

Table 4.10: Source of information about aloe cultivation in Kieni West Division

If you are aware of the aloe cultivation how did you learnt about it?		
Source of information	**Frequency**	**% Frequency**
Kieni Aloe Plantations	53	13.2%
Kamuiga Artemisia Farmers (Self-help Groups)	26	6.5%
Somebody within Kieni	38	9.4%
Somebody outside Kieni	7	1.7%
Media	114	28.3%
Government Agricultural Extension Services	0	0
Sub total responses	**238**	59.1
Not aware	165	40.9%
Total responses	**403**	**100%**

4. 3. 1.1 Government Extension Services

From the results of Table 4.10 above no respondent had learnt about aloe cultivation from the government agricultural extension services. To investigate how dynamic the government can be or is in promoting Aloe propagation and cultivation, its performance in the extension services of the already established agricultural activities was evaluated and used to rate it effectiveness. The responses in Table 4.11 show that 71% (269), i.e. 45% (171) and 26% (98) had not benefited from any government extension services. This may be an indicator that the demand driven extension services adopted by the government may be: unknown and not well understood by the majority of the community members or ineffective.

However, government agencies collaborate with community self-help groups such as Kamuiga Artemisia Farmers in promoting aloe cultivation activities.

Table 4. 11 Government extension services

Has the government extension services assisted you in your farming activities?		
	Frequency	**% Frequency**
Yes	29	8%
Sometimes	10	3%
Rarely	72	19%
Never	171	45%
No idea the services exits	98	26%
Total	380	100%

The government institutions identified as collaborating with Kamuiga Artemisia Farmers in aloe cultivation activities are: KEFRI, Kenya Agricultural Research Institute (KARI), Ministry of Agriculture and Livestock Development, Kenya Forest Service (KFS), KWS, Kenyatta University (Department of Alternative Health and Nutrition), Kenya Industrial Research Development Institute (KIRDI), NMK and University of Nairobi (School of Biological Sciences).

4.3.2 Aloe Marketing in Kieni

Evaluation of effectiveness of the institutions dealing with promotion of aloe propagation and cultivation in Kieni was also based on their direct participation in aloe marketing. The respondents were asked where they sold or would sell their aloe products and responses tabulated as shown below in Table 4.12. 63.95% (243) of the respondents were not marketing aloes for various reasons, and 35% (133) were not aware that aloes are sold.

The results of the interview with Kamuiga Artemisia Farmers indicated that the organization had no market and was trying to establish market networks. The group was also involved in value adding of aloe sap through assistance of KIRDI and other

collaborating institutions. However, they had not established market for the aloe products. Lack of finance to process aloe products was prohibitive given that the group members were the sole financiers. In conclusion, there was no aloe market information and access in Kieni West division.

Table 4. 12 Aloe marketing

If you have been growing or are planning to grow aloes where do you market or would you market your products?		
	Frequency	**% Frequency**
Kieni Aloe Plantations	1	0.26%
Kamuiga Artemisia Farmers	1	0.26%
Somebody within Kieni	1	0.26%
Somebody outside Kieni	1	0.26%
Don't market at all	243	63.95%
No Idea its sold	133	35.00%
Total	380	100.00%

Similarly, lack of clear market information which was attributed to unclear and unfavorable market channels, was observed to be a deterrent to aloe cultivation, conservation and management by Lubia *et al*., (2008)

Given their ability in marketing other agricultural products (e.g., milk, wheat, beef, poultry, among others) where the market is established as shown by Figure 4.6, it can be argued that the community is quite enterprising and with clear market channels the aloe enterprise would boom.

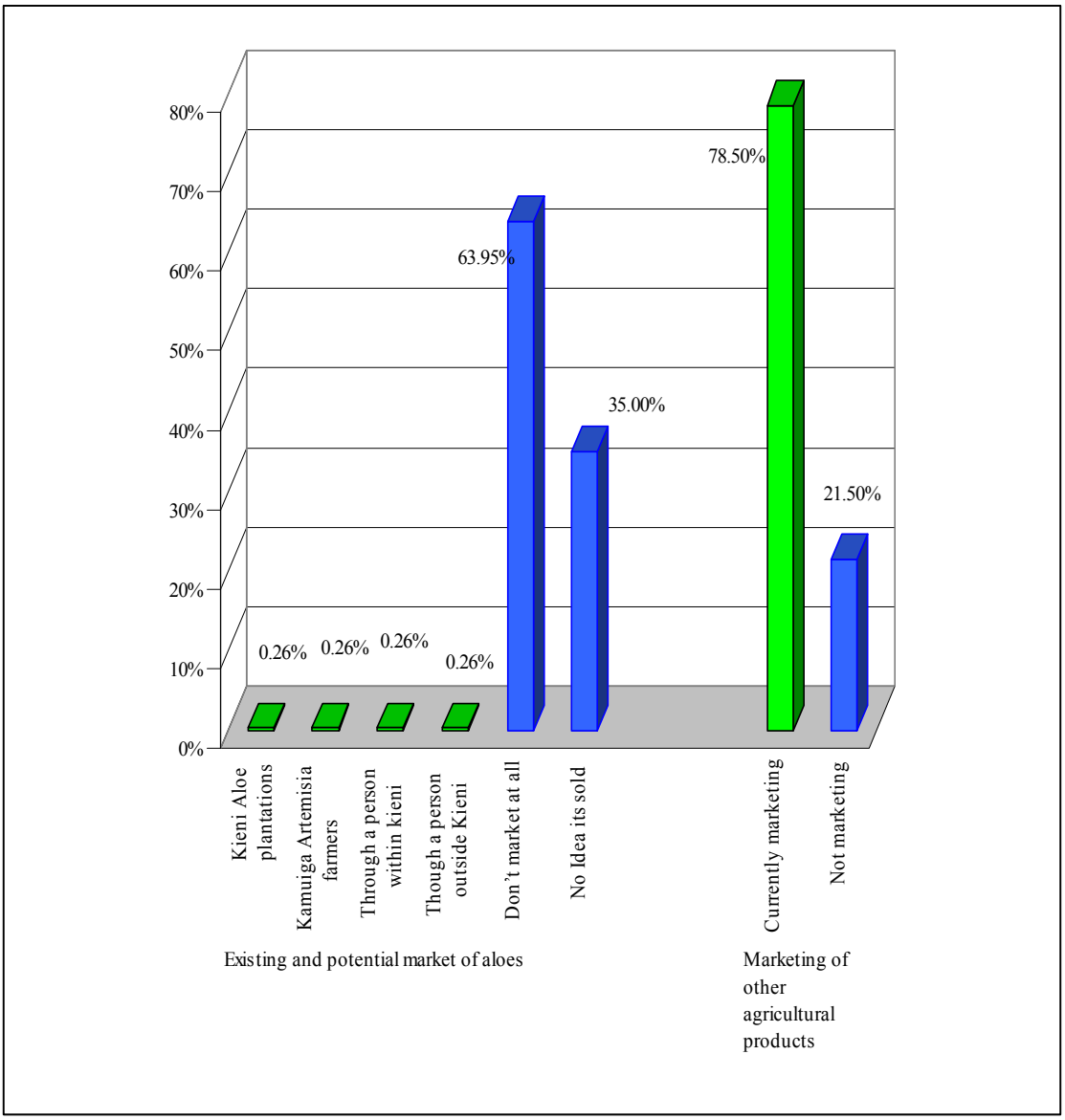

Figure 4. 6 Knowledge of aloe and other products market information in Kieni

4.3.3 Strategies used in promotion of aloe propagation and cultivation in Kieni West division.

The local institutions named in Table 4.10 have adopted the following strategies in promotion of aloe propagation and cultivation in Kieni West division: Formation of

self-help groups, use of demonstration farms, word of mouth, involvement of the local leaders and collaboration with the government agencies for training.

4.3.3.1 Formation of Self Help Groups

Kamuiga Artemisia Farmers an umbrella body of 11 self help groups in Kieni West division was formed to facilitate development agendas in the area. The objective of the group was to introduce and promote economic activities that were compatible with the environmental conditions of the area. The strategy was to encourage the various self help groups recruit members and train them to adopt various technologies including aloe propagation and cultivation. To evaluate the success of this strategy the membership of individual farmers to the self-help groups and Kieni Aloe Plantations was analyzed.

Table 4.13 summarizes the responses of the respondents and relates membership to the general awareness of aloe propagation and cultivation. The results shows that only 6.8% (26) respondents (i.e. group members and those planning to join) were aware of community groups dealing with aloe enterprises in the division, 83.4% (317) of the respondents did not know of any group while 9.7% (37) had no interest in joining any group. Only 0.5% of respondents participating in aloe cultivation were members of community aloe bio-enterprise.

Table 4.13: Comparison of community group membership and general awareness

Are you aware of aloe cultivation	Are you a member of any group that promotes aloe propagation				
	Yes, already a member	No but Planning to Join	No I don't know of any group	No & not interested in joining	**Total**
Yes and already farming	2 *(0.5%)*	0 *(0.0%)*	6 *(1.6%)*	0 *(0.0%)*	**8** (*2.1%)*
Yes with interest but not started farming	2 *(0.5%)*	5 *(1.3%)*	61 *(16.1%)*	6 *(1.6%)*	**74** *(19.5%)*
Yes and already growing naturally in the farm	6 *(1.6%)*	9 *(2.4%)*	45 *(11.8%)*	10 *(2.6%)*	**70** *(18.4%)*
Yes but have not had interest	1 *(0.3%)*	1 *(0.3%)*	55 *(14.5)*	6 *(1.6%)*	**63** *(16.6%)*
No but already growing naturally in my farm	0 *(0.0%)*	0 *(0.0%)*	73 *(19.2%)*	5 *(1.3%)*	**78** *(20.5%)*
Not at all	0 *(0.0%)*	0 *(0.0%)*	77 *(20.3%)*	10 *(2.6%)*	**87** *(22.9%)*
Total	**11** *(2.9%)*	**15** *(3.9%)*	**317** *(83.4%)*	**37** *(9.7%)*	**380** *(100.0%)*

However, some respondents were members but had not adopted aloe cultivation as illustrated by Figure 4.7 where18.2% of group members had adopted aloe cultivation while 9.1% of group members had no interest in aloe cultivation; a factor attributed to self-help groups being involved in several self-help economic activities.

Out of 83.4% respondents who did not know of any group promoting aloe farming in the area as shown by Figure 4.7, 1.9% were involved in aloe cultivation and 19.2% had interests of commercial aloe farming thus showing a potential for aloe cultivation in the division. The self help group strategy of promoting aloe propagation and cultivation in Kieni West division should therefore prioritize efforts to the respondents' with interest in aloe farming without knowledge any group existence (19.2%). Similarly Lubia *et al*.,

(2008) identified lack of viable community aloe bio-enterprises as one of the challenges of aloe conservation and management.

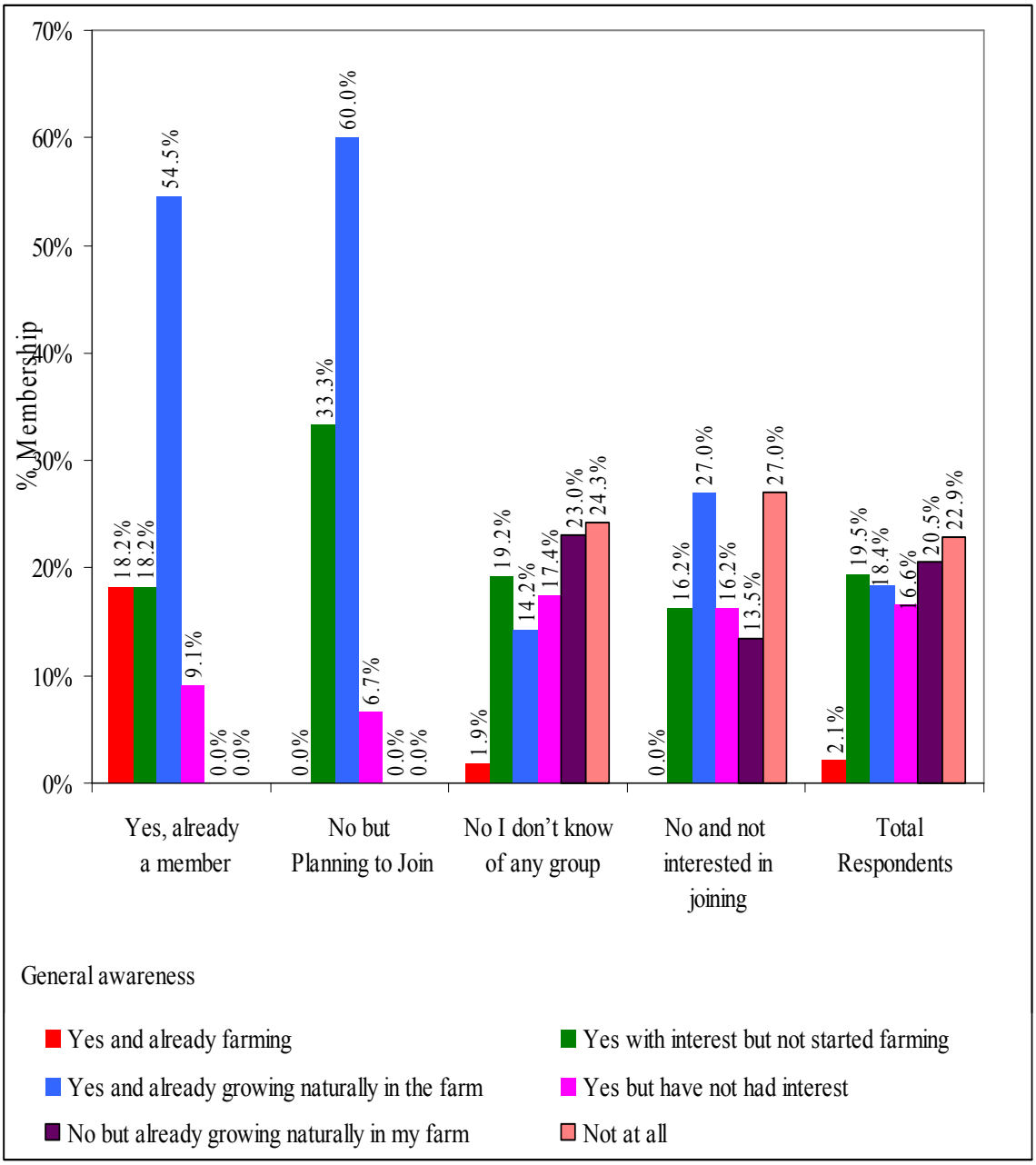

Figure 4. 7 Comparison of community group membership and general awareness

4.3.3.2 Research Hypothesis 2

The second hypothesis of this study stated that Adoption of aloe propagation and cultivation was associated with membership to local institutions promoting the innovation. The hypothesis was tested using chi-squared test of association at 5% level of significance. Table 4.13 above was collapsed to avoid expected frequencies less than 5 as shown in Table 4.14 below.

Table 4. 14 Research Hypothesis 2

Cross Tabulation and Chi-Square Analysis				
Awareness of Aloe Propagation and Cultivation		**Membership to Local Institutions**		**Total**
		YES	**NO**	
YES	Count	26	189	215
	Expected Count	14.7	200.3	215.O
NO	Count	0	165	165
	Expected Count	11.3	153.7	165.0
Total	Count	26	354	380
	Expected Count	26.0	354.0	380.0
Chi-Square		**Value**	**Df**	**Significance**
Pearson Chi-Square		21.419	1	0.00
Likelihood Ratio		31.074	1	0.00
TEST		**Value**		**Appropriate Significance**
Nominal by Nominal	Phi	0.237		0.00
	Cramer's V	0.237		0.00
0 cells (.0%) have expected count less than 5. The minimum expected count is 11.29				

Appropriate significance of 0.00 indicates that there is no any association between awareness and membership to local institutions. Formation of self help groups as a strategy of accelerating rate of creation of awareness and adoption had not worked as would be expected. This could be associated to the fact that the local institutions were relatively new and lacked capacity to train the community and to market the Aloe products.

4.3.3.3 Demonstration Farms, Public Field days and Government Agencies Collaboration

Demonstration Farms were established by various institutions for training. Kieni Aloe Plantations established Kieni Aloe Plantations Conservation Farm in Mugunda Location as shown by Plate 4.2. The Farm was used to establish aloe nurseries and also as a training ground for those interested in aloe propagation and cultivation.

Plate 4. 2 Kieni Aloe Plantations Conservation Farm in Mugunda Location

Kieni Aloe Plantations kept a list of farmers who had visited their farm to train on aloe propagation and cultivation. It was observed that the trained farmers had come from several parts of the country such as Laikipia, Nyandarua, and Embu. However, the institution had not established a mechanism of follow-ups and thus there was no way of telling whether the training had led to adoption of aloe propagation and cultivation or not.

Though Kamuiga Artemisia Farmers was planning to purchase a farm for demonstrations, lack of funds was limiting. However, one group member of Loresho Self Help Group and Kamuiga Artemisia Farmers had temporally availed her farm for group demonstrations and trainings. However, as shown by Plate 4.3 the survival rate of the Aloe seedlings transplanted in this farm was low and scanty. This was attributed to

lack of knowledge on propagation and management even among the training institutions. This conclusion was based on the fact that transplantation of the aloe seedlings was done during a very dry period. Trainings of transplantation of seedlings from the nurseries to the farm should be done for this group to avoid future loss of the plants.

Plate 4. 3 Aloes planted by Loresho Self Help Group

Kamuiga Artemisia Farmers and Kieni Aloe Plantations also participate in public field days where different interest groups are invited to showcase different uses of aloe products such as cosmetics, soaps and alternative medicines. Various activities involved in aloe propagation and cultivation are also demonstrated and the importance of adopting aloe propagation and cultivation in the area highlighted especially by the political local leaders, area administration, government agencies and other invited institutions. The groups also participate in agricultural shows especially Nyeri Agricultural show held annually to showcase aloe products made in collaboration with government agencies such as KIRDI among others.

4.3.3.4 Word of Mouth, Involvement of Local Leaders and Media

Table 4.10 shows that word of mouth was one of the strategies used in promoting aloe propagation and cultivation i.e. (somebody within Kieni and somebody outside Kieni). Word of mouth strategy as a source of information contributed to 11.1% (45) of the total awareness as illustrated by Table 4.10. However, this strategy while it may be good in creation of general awareness, there was no evidence to show that the strategy really contributes significantly to the adoption of the innovation. Word of mouth was established to have been used by the local leaders i.e. the local MP especially during the political campaigns to encourage the locals to embrace aloe farming as an economic activity. Media was also used by the institutions for mass public training on aloe propagation and cultivation in collaboration with government institutions especially KWS. Most respondents as per Table 4.10 leant about aloe propagation and cultivation though Media 28.3% (114). Though not all media training was an initiative of the local institutions, there was some collaboration with the government agencies especially KWS in some media programs of training aimed at promoting aloe propagation and cultivation.

4.4 Limitations /Concerns Affecting Adoption of Aloe Propagation and Cultivation.

The purpose of this research objective was to assess the limitations/concerns affecting adoption of aloe farming in Kieni West division as perceived by the community. Asked why they had not adopted aloe propagation and cultivation at all for those who had not or adopted in small scale for those who had, the individual respondents listed the following reasons: Lack of ability to meet basic human needs; small land sizes, climatic and environmental concerns. Kamuiga Artemisia Farmers identified poverty as a major

concern affecting adoption of aloe propagation and cultivation in Kieni West division. Poverty was observed to enslave the community and pre-occupies them with activities that put daily food on the table for their families. This scenario has left the community with little or no time for other innovations including adoption of aloe propagation and cultivation. The concerns listed by respondents above as affecting aloe propagation cultivation were further analyzed for detailed information as below.

4.4.1 Lack of Ability to Meet Basic Human Needs

The basic human needs as identified by the respondents were: domestic needs and children's education. Thus the community prioritizes acquisition of daily food and children's education and introduction of any innovation, aloe propagation and cultivation included must in practical terms assist the community to meet these obligations. For further analysis, the ability of respondents to meet basic human needs was considered against respondents' duration of stay in Kieni and involvement in other economic activities besides farming

4.4.1.1 Duration of Stay

Table 4.15 compares the ability to meet basic needs and duration of economic activities in the farm. As shown below only 42.1% were able to meet the basic needs. Table 4.15 shows that while 53.4% (203) have been residents in Kieni for over 10 years only 26.1% (99) were able to meet their basic human needs. However, to ascertain whether there was any statistical association between the duration of farming/stay and ability to meet basic needs, a Chi-squire statistic of association was obtained using SPSS data editor as shown by Table 4.16

Table 4. 15 Meeting basic needs vs. duration of economic activities in farms

Duration of the economic activity in the farm	What the farm economic activity has enabled the farmer to achieve				
	Enough for education of children and all domestic needs	Enough for education of children only	Enough for domestic use only	Not enough for domestic needs	Total
1 Year	3 *(0.8%)*	3 *(0.8%)*	6 *(1.6%)*	1 *(0.3%)*	13 *(3.4%)*
2-5 Years	27 *(7.1%)*	3 *(0.8%)*	37 *(9.7%)*	4 *(1.1%)*	71 *(18.7%)*
6-10 Years	31 *(8.2%)*	5 *(1.3%)*	46 *(12.1%)*	11 *(2.9%)*	93 *(24.5%)*
Over 10 Years	99 (*26.1%)*	9 *(2.4%)*	79 (*20.8%)*	16 *(4.2%)*	203 *53.4%)*
Total sample	160 *42.1%*	20 *5.3%*	168 *44.2%*	32 *8.4%*	380 *100%*

The Chi-Square statistical test, Phi and Gramers'V was used to determine the strength of association between ability to meet basics and duration of farming. Approximate significance value of 0.179 indicates a very weak association between ability to meet basics needs of the respondents and duration of farming or stay in Kieni. The results indicate that there is no significant association between the number of years the respondents have farmed in Kieni West division and the ability to their meet basic needs.

Table 4. 16 Association between Duration of stay vs. Ability to Meet Basics

Cross Tabulation and Chi-Square Analysis				
Duration of Stay in Kieni		**Ability to Meet Basic Needs**		**Total**
		Able to meet basics	**Unable to meet basics**	
Short Stay	Count	30	54	84
	Expected Count	35.4	48.6	84.0
Long Stay	Count	130	166	296
	Expected Count	124.6	171.4	296.0
Total	Count	160	220	380
	Expected Count	160	220	380
Chi-Square	**Tests**	**Value**	**Df**	**Significance**
Pearson Chi-Square		1.807	1	0.179
Likelihood Ratio		1.829	1	0.176
TEST		**Value**		**Appropriate Significance**
Nominal by Nominal	Phi	-0.069		0.179
	Cramer's V	0.069		0.179
0 cells (.0%) have expected count less than 5. The minimum expected count is 35.37.				

However, the weak association may be an indicator that some people who have stayed in the area for long may have learnt to adapt in their environment. Therefore, introduction of new technology such as aloe propagation and cultivation should be in partnership especially with this group as a source of information to avoid repetition of past failures and to take advantage of known success.

4.4.1.2 Involvement in Other Economic Activities besides Farming

Table 4.17 shows that while 26.6% (101) of the respondents were engaged in other economic activities besides farming only 11.3% (43) in this category met their basic needs. 73.4% (279) depended on farming only and 30.8% (117) in this category met their basic needs.

Table 4. 17 Comparisons of farming vs. farming and other economic activities

What the farm economic activity has enabled the farmer to achieve	Farming & other economic activities	Farming only	Totals
Enough for education of children and all domestic needs	43 *(11.3%)*	117 *(30.8%)*	160 *42.1%*
Enough for education of children only	5 *(1.3%)*	15 *(3.9%)*	20 *5.3%*
Enough for domestic use only	45 *(11.8%)*	123 *(32.4%)*	168 *44.2%*
Not enough for domestic needs	8 *(2.1%)*	24 *(6.3%)*	32 *8.4%*
Total	101 *(26.6%)*	279 *(73.4%)*	380 *100.0%*

4.4.1.3 Research Hypothesis 3

A Chi-square test was done as shown by table 4.18 to establish whether there was an overall significant difference in the way farmers achieved their needs against the random expectation that engagement in other economic activities was diversionary and lacked sufficient returns for meeting basic needs.

Phi and Cramer' V appropriate significance of 0.911 indicates that there is a very strong relationship between the ability to meet basics and the economic activities engaged in. However, there is no significance evidence to conclude that one economic activity is preferable over the other in terms of meeting basic needs.

Table 4. 18 Achievement of the Farmer vs. Economic Activity Engaged in

Cross Tabulation and Chi-Square Analysis				
		Economic Activity Engaged in		
Achievements of the Farmer		**Farming Only**	**Farming and other activities**	**Total**
Enough	Count	117	43	160
	Expected Count	117.47	42.53	160.0
Not Enough	Count	162	58	220
	Expected Count	161.53	58.47	220.0
Total	Count	**279**	101	380
	Expected Count	279.0	101.0	380.0
Chi-Square		**Value**	**Df**	**Significance**
Pearson Chi-Square		0.012	1	0.911
Likelihood Ratio		0.012	1	0.911
TEST		**Value**		**Appropriate Significance**
Phi Cramer's V		-0.06 0.06		0.911
				0.911
0 cells (.0%) have expected count less than 5. The minimum expected count is 42.53				

This concept is further explained by Figure 4.8 overleaf showing that 43.6% engaging in other economic activities relatively compares to 41.6% of those depending on farming only. However, those with extra activities and could not meet their basic needs were higher i.e. 11.9% as compared to 7.2% who depended on farming alone. It's evident that some residents engage in activities that lack sufficient returns. Adoption of alternative dry lands projects such as sustainable utilization of aloes would help to optimize land productivity and households' income.

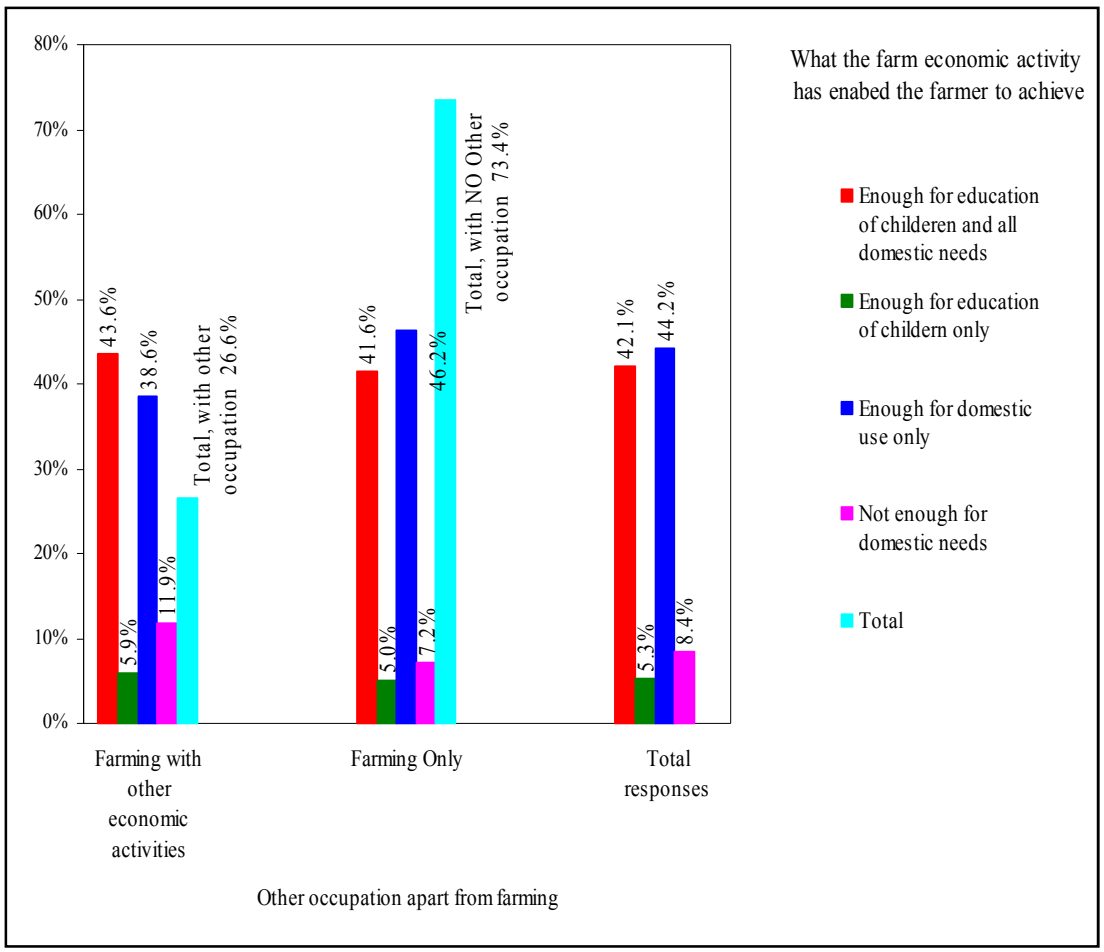

Figure 4.8 Achievement of economic activities in comparison with all occupations

4.4.2 Land sizes and ownership

Land sizes and ownership were major concern in the community. Table 4.19 shows that most of land i.e. 41.1% was owned by 8.7% of the population. The success of aloe propagation and cultivation adoption is dependent on both optimal land utilization and productivity for small scale land holders and large scale production for large land holders. Focusing on the large land holders alone may not alleviate poverty and focusing on small land owners alone may not be an economical venture for

industrialization. Multiple land use incorporating aloes and grazing or aloes and farming would ensure optimal land utilization as shown by Plates 4.4 and 4.5.

Table 4.19 Land Sizes

Land size in acres	Respondents frequency & Land size distribution			
	Frequency	% Frequency	Total land	% land size
0.25 -5	280	73.7	831.7	35.4
6 to 10	67	17.6	551	23.5
above 10	33	8.7	964.5	41.1
Total	380	100	2347.2	

Most of the land is owned by the old as shown by Table 4.20 where old people own 46.69% as compared to 13.62% owned by the youth. This is a big challenge to aloe propagation especially where the old lacks the enthusiasm to try on new innovations. Lubia *et al*., (2008) recognizes land tenure and changing land use patterns as a challenge to aloe conservation and management. Therefore strategies are needed to promote aloe conservation and management in Kenya through wise land management practices

Plate 4. 4 Wild and domestic animals graze in Lamuria sub location

Plate 4. 5 Aloes planted along the fence in Lamuria Sub-location

Table 4.20 Land ownership

	Size of land in acres				
Age in Years	0.25-5	6 to 10	above 10	Frequency	% Frequency
Youth (18-35)	172.07	60.17	87.5	319.71	13.62%
Middle age (36-55)	437.53	206.89	287.2	931.61	39.69%
Old (55 & above)	222.10	283.94	589.8	1095.86	46.69%
Total	831.70	551	964.5	2347.18	100%
Frequency	35.43%	23.47%	41.09%	100%	

4.4.3. Arid Environmental Conditions

The main environmental concerns affecting the community were identified as: prolonged dry periods, rainfall unreliability, floods, pests and diseases, and soil erosion. Since evidence of storm erosion was frequently observed, respondents were interviewed on their knowledge on soil erosion control. Figure 4.9 shows that there was fair knowledge of soil erosion i.e. 65% (243) which could be expected to translate to better control of soil erosion. However, this was not the case and other factors other than the

awareness contribute to soil erosion. These factors may include overgrazing and clearing of trees and shrubs, suggesting that causes of soil erosion are understood.

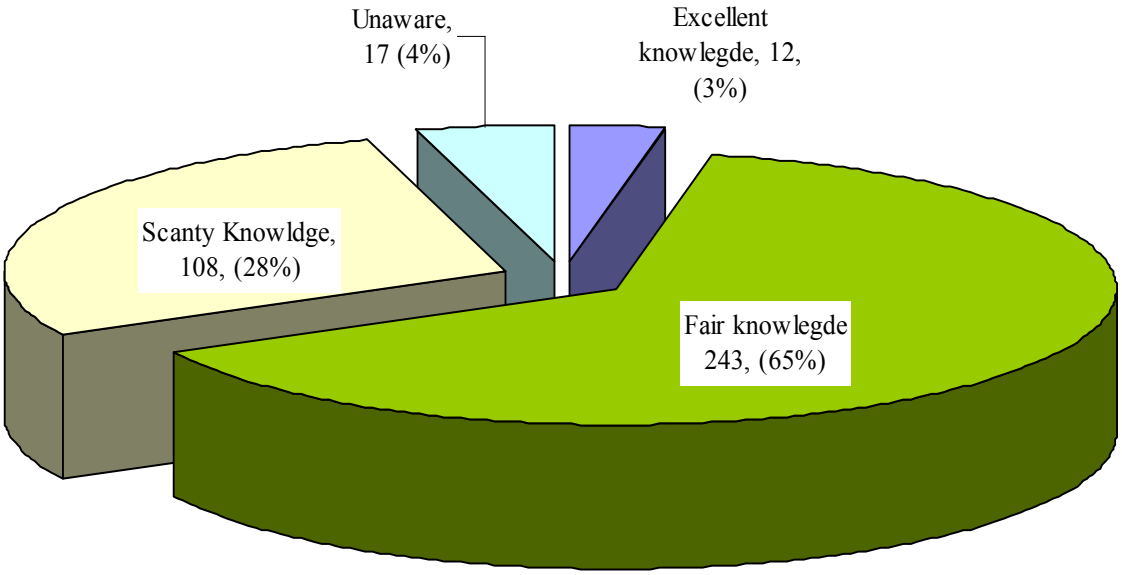

Figure 4. 9 Knowledge on soil erosion control

The promoters of aloe propagation and cultivation in Kieni West division need to understand the above stated environmental concerns affecting the community with an aim of embracing an integrated and participatory approach in addressing them. Otherwise the same challenges are likely to impact on aloe propagation and cultivation.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The study was aimed at determining factors affecting aloe propagation and cultivation Keni West division, Nyeri North District. In this regard three objectives were set. This chapter summarizes the findings of study and areas of further research are suggested in relevant aspects so as to improve the strategies for conservation and management of aloes in Kenya.

5.2 Conclusions

5.2.1 State of community Awareness, knowledge and skills

The results indicated that the respondents were generally aware of aloe propagation and cultivation (i.e. 56.6% (215) respondents) were aware. However, general awareness was not an adequate incentive for the respondents' to participate in aloe propagation and cultivation since only 3.7% (8) of those aware had adopted the innovation. Further, the community lacked technical skills necessary in aloe propagation and cultivation. These are: knowledge of legal requirements governing aloe propagation and cultivation in Kenya; the knowledge and skills of acquiring aloe seedlings; the knowledge and skills of managing aloes in their farms from planting to harvesting. Further the results indicated that there are two categories of factors affecting aloe propagation and cultivation: driving factors and restraining factors. The driving factors were mainly economic while the restraining factors were knowledge or information based. The factors identified to have the greatest impacts were: financial benefits associated with aloe propagation and cultivation; and lack of market.

5.2.2 Strategies used by local institutions in promoting aloe enterprises

The results indicated that media is leading in creation of aloe propagation and cultivation awareness at 28.3% (114). The combined effort of the local community institutions and farmer to farmer training contributed to 29.3% (117) of awareness. This indicates that, if well empowered with specific practical skills, the local people can learn to be promoters of positive innovations in the community, especially through self-help groups. Further demand driven extension services offered by government may not be well understood or known by majority of the respondents (i.e.71% (269) did not know of the existence of the services) to the extent that none of the respondents who were aware of aloe propagation and cultivation had learnt from the government. The third finding of the study on this objective indicated that the institutions expected to promote aloe propagation and cultivation were not directly involved with the marketing of the aloes. This was a major challenge to aloe cultivation in Kieni West division.

5.2.3 Competing Economic Activities

This study identified concerns, values and characteristics of the community that may hinder or promote adoption of aloe propagation and cultivation. These factors were: ability to meet basic needs, land sizes and ownership, and arid environmental conditions. Despite the economic potential of aloe enterprises, local residents turned to other activities that they were familiar with and whose products had ready markets.

This study was set to investigate factors affecting aloe propagation and cultivation in Kieni West division. The results indicated that community in Kieni West division was generally aware of aloe propagation and cultivation as an alternative economic activity

suitable for the area. However, financial gains, the real concern of the community was not guaranteed for lack of clear and favorable market channels. Therefore, this study concluded that adoption of aloe propagation and cultivation can not be realized unless those issues are comprehensively addressed by the government agencies and other stakeholders interested in promotion of aloe propagation and cultivation.

5.3 Recommendations for Development of Aloe Subsector

From the foregoing findings of the study basic recommendations are proposed to the government agencies, NGOs and community based organizations promoting aloe propagation and cultivation in Kenya and researchers.

1. Kenya Wildlife Service should devise effective communication mechanism to the community regarding all the legal requirements and procedures regulating aloe trade in the country. The communication should not prioritize on penalties and fines but on public training. The training should aim at achieving voluntary compliance because of realized benefits as opposed to enforced compliance by policing.

2. The institutions promoting aloe propagation and cultivation in the country should provide technical support as well as favorable market and marketing channels.

3. Government of Kenya should establish a development authority/Board modeled to bring together small scale aloe farmers in the ASALs districts under one umbrella for the purpose of formation of aloe cottage industries and marketing. This would make the aloe sector grow without being nipped off by the middle men and make the farmers develop confidence in the aloe sector. The Aloe Development Authority

(ADA) should be charged with the responsibility of developing technologies and innovations aimed at value addition of aloe sap. This is in line with Kenya vision 2030.

5.4 Recommendations for Further Research

1. Government agencies promoting aloe propagation and cultivation should study and analyze the factors affecting aloe propagation and cultivation in all the ASALs districts in Kenya for strategic planning.
2. Environmental education researchers should investigate the role of environmental Education in improving resource use and management of the self-help groups in Kenya.
3. Government of Kenya should investigate the effectiveness of the demand driven extension services especially where new technologies and innovations are being introduced for adoption.

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APPENDICES

APPENDIX1

INDIVIDUAL RESPONDENTS INTERVIEW SCHEDULE

The purpose of this interview schedule is to collect information on aloe propagation and cultivation in Kieni west division for the purpose of assessing the factors affecting its propagation and cultivation. The information collected will be treated with confidentiality and used for the purpose of this research.

1. Farm details and Personal data

Location ……..

Sex: Male Female

1.1 Age of the farmer…….

a) 20-30 Yrs b) 31-40 Yrs c) 41-50 Yrs

d) 51-60 Yrs e) 61-70 Yrs f) 71 and above Yrs

1.2 Size of the farm in acres……

a) Up to 5acres b) 6 to 10 acres

c) 11to 15 acres d) above 15 Years

1.3 Any other occupation apart from farming: Yes No (If yes, which one …….

1.4 Economic activities currently in the farm

a) Cash crops……..……..

b) Food crops ……..

c) Fodder crops……

d) Dairy cows…… **Yes** **No** (If yes how many……

e) Beef ……**Yes** **No** (If yes how many ……

f) Poultry……**Yes** **No** (If yes how many …….

a) Bee hives…… **Yes** **No** (If yes how many hives……

b) Others……

1.5 How long have you used the farm in the above identified economic activities

a) 1 years
b) 2-5 years
c) 6-10years
d) Over 10years

1.6 What has the above economic activities enabled you to achieve?

a) Enough for education of my children and all my domestic needs
b) Enough for education of my children only
c) Enough for my domestic needs only
d) Not enough for my domestic needs.

Do you have constrains associated with economic activities you have identified above? Yes No : If yes, which are these constraints?

……
……
……

1.7 How do you handle the constrains identified above

……
…….....

1.8 What do you think are the solutions to the above constrains

……
……
……

1.9 Do you market your farm products: Yes… No…..

If yes where do you market ……
…….

1.10 Do you face challenges in marketing these products: Yes….

No…..

If yes state the challenges

- …….
- …….

Is there other vegetation growing in the farm other than crops? Yes… No….. Name the vegetations (Can be observed)

a) Grasses……
b) Shrubs……
c) Trees……

1.11 Is there evidence of soil erosion due to any of the following (Can be observed

a) Storm water……
b) Wind……
c) Overgrazing ……
d) Others……

Give a brief description of the activities involved in soil erosion prevention and control……

1.12 Is the farm mechanized

Highly ____ Slightly_____ None_____

2. Aloe propagation and cultivation activities

2.1 Are you aware of aloe cultivation as a commercial enterprise?

a) Yes and already farming (Year of planting ……
b) Yes with interest but not started farming
c) Yes and already growing naturally in my farm
d) Yes but have not had interest
e) No but already growing naturally in my farm
f) Not at all

2.2 If you are aware of aloe cultivation how did you learnt about it?

a) From Kieni aloe plantation
b) From Kamuiga Artemisia Farmers
c) From a friend or relative within Kieni
d) From a friend or relative outside kieni
e) Media
f) Not aware

2.3 If you have planted or wanted to plant aloes, where would you get the seedlings?

a) Own nursery
b) From Kieni aloe plantation
c) From Kamuiga Artemisia farmers
d) From a friend or relative within Kieni
e) From a friend or relative outside kieni
f) Uprooting from the wild
g) No idea.

2.4 Aloe propagation may require several activities from planting to maturity. Describe the various steps and activities involved from land preparation to harvesting?.....

……..

2.5 The government engages extension services to train farmers on farming activities including how to market their products. Has the extension services assisted you in your farming activities?

a) Yes, (how and when…….
b) Sometimes (give last time…….
c) Rarely. Can't recall when last…….
d) Never……..
e) No idea the services exist……

2.6 If you have not been assisted, what areas do you feel the extension services would assist you?

- …….
- …….

2.7 If you have been growing aloe, where do you market your products?

a) To Kieni aloe plantation
b) Kamuiga Artemisia framers
c) Through a friend , relative or business person within Kieni

d) Through a friend , relative or business person outside kieni

e) Don't market at

f) No idea it's sold……

2.8 If you have not started growing aloe are there plans to start and when

a) Yes this season,

b) Yes next season

c) Yes within five years

d) Yes after market has been established

e) Not sure of future plans

f) Never (give reasons…….

2.9 Are you registered as an artificial aloe propagator?

a) Yes (Name registering authority)……

b) No but have applied to ……

c) No but planning to apply……

d) No I'm not aware of any registration required……..

2.10 Are you a member of a group that promotes the aloe propagation and marketing activities?

a) Yes already a member (Name of the group……

b) No but planning to join (Name of the group……

c) No (I don't know of any group)

d) No and not interested in joining any

2.11 If you have planted what reason has made you plant and if you have not planted what reason would make plant aloes.

1 ……..……

2 … …..……. …….….

2.12 What reason discourages you from planting aloes in your farm

3.5 Any remarks and observation useful for this study

……..

……..

Thank you

APPENDIX 2

INSTITUTIONS INTERVIEW SCHEDULE

The purpose of this interview schedule is to collect information on aloe propagation and cultivation in Kieni west division for the purpose of assessing the factors affecting its propagation and cultivation. The information collected will be treated with confidentiality and used for the purpose of this research.

1. How was Kamuiga Artemisia Farmers started and why was it formed?

……

……..

2. What is the membership of the group?

……

……..

3. Are there training programmes for the farmers

……

……..

4. What training methods do you use in training the farmers

……

……..

5. How would you rate Aloe propagation and cultivation in Kieni

……

……..

6. What activities is Kamuiga Artemisia Farmers involved in

……

……..

7. Are you the one who does the marketing for the farmer

……

……..

8. Where do you get marketing information from

……

……..

9. What is the cost of running the organization

……

……..

10. Do you process aloe products or do you sell them raw

……

……..

11. Additional comments or observations

……

……..

APPENDIX 3

LETTERS OF CORESPONDENCES

1. Research authorization by Kenyatta University Graduate School
2. Research authorization by the National Council for Science and Technology
3. Research clearance permit No. NCST 5/002/R/146 dated 24.2.2009
4. Research authorization by office of district officer Kieni West Division
5. Research authorization by ministry of education-district education office Nyeri North

KENYATTA UNIVERSITY
GRADUATE SCHOOL
P.O. Box 43844,
NAIROBI
Tel. No. 810901/9 Ext. 57830
E-mail: kallps@yahoo.com

Our Ref: N50/CE/11147/06
Your Ref:

Date: 21st January, 2009

The Permanent Secretary,
Ministry of Higher Education, Science & Technology,
P.O. Box 30040,
NAIROBI.

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION
MS. SARAH WACHUKA IRUNGU – REG. NO. N50/CE/11147/06

I write to introduce Ms. Sarah Wachuka Irungu who is a Postgraduate Student of this University. She is registered for M.Sc. (Environmental Education) degree programme in the Department of Environmental Sciences.

Ms. Irungu intends to conduct research for a project entitled, **"Factors affecting aloe propagation and cultivation in Kieni West Division, Kenya."**

Any assistance given to her will be highly appreciated.

Yours faithfully,

JOHN M. ODONGI
FOR: DEAN, GRADUATE SCHOOL

JOM/fwk

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telegrams: "SCIENCETECH", Nairobi
Telephone: 254-20-241331, 241349,
254-20- 311761, 241376,
Fax: 254-20- 213215

When replying please quote

P. O. Box 30623 –00100
NAIROBI- KENYA

REF: NCST/5/002/R/146/5

24th February 2009

Ms. Irungu Sarah Wachuka
Kenyatta University
P.O. Box 43844
NAIROBI

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on, *'Factors Affecting Aloe Propagation and Cultivation in Kieni West Division, Kenya'*

I am pleased to inform you that you have been authorized to carry out research in Kieni West Division in Nyeri District for a period ending 31st December 2009.

You are advised to report to the District Commissioner and the District Education Officer Kieni West District before embarking on your research.

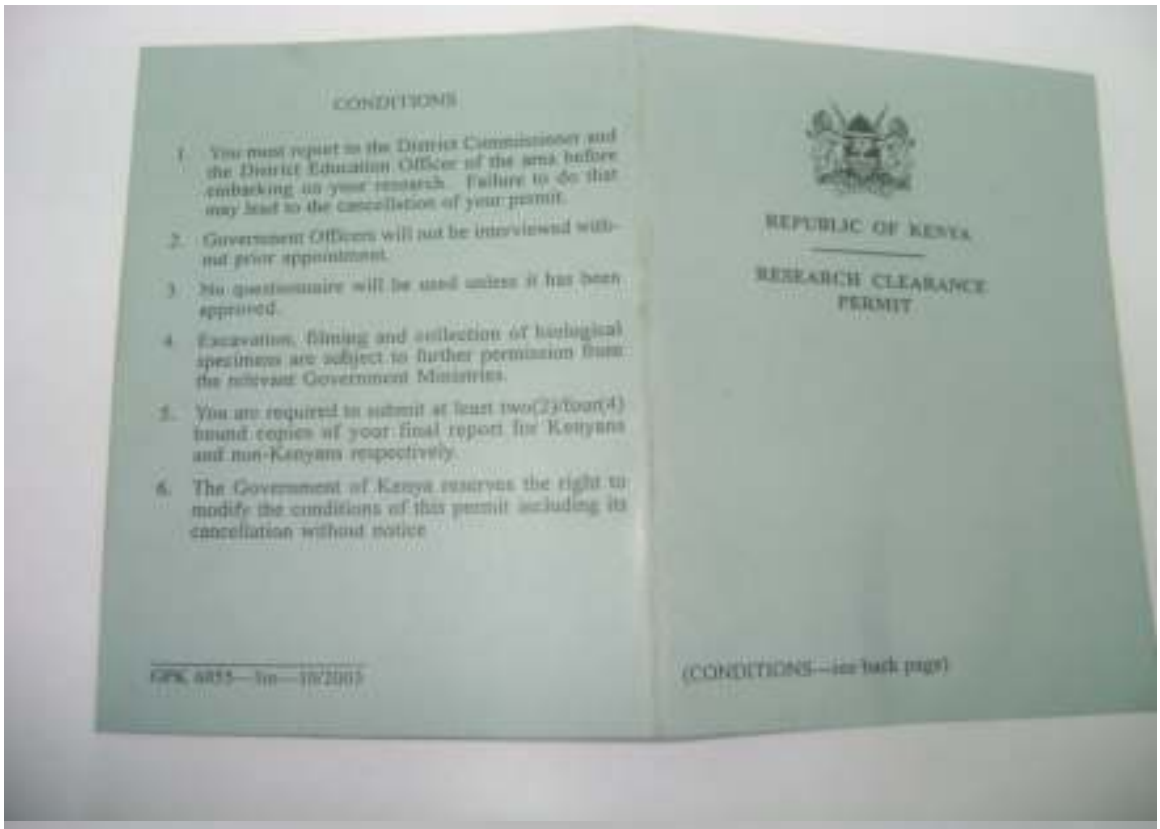
On completion of your research, you are expected to submit two copies of your research report to this office.

SAID S. HUSSEIN
FOR: EXECUTIVE SECRETARY

Copy to:

The District Commissioner
Nyeri District

The District Education Officer
Nyeri District



CONDITIONS

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

GPK 6855—5m—10/2003

REPUBLIC OF KENYA

RESEARCH CLEARANCE PERMIT

(CONDITIONS—see back page)

Form 2

This is to certify that:

Prof./Dr./Mr./Mrs./Miss TSUNGU BERLA WACHUKA

of (Address) KENYATTA UNIVERSITY P.O.BOX 43844 NAIROBI

has been permitted to conduct research in Location, KIENI WEST Division, NYERI District, CENTRAL Province, on the topic FACTORS AFFECTING ALOE PROPAGATION AND CULTIVATION IN KIENI WEST DIVISION, KENYA

for a period ending 31ST DECEMBER, 09

Form 3

Research Permit No. NCST/5/002/R/196

Date of issue 24.1.2008

Fee received KSHS.1000

SAID S. MUBARIK

Applicant's Signature

Secretary National Council for Science and Technology

OFFICE OF DISTRICT OFFICER,
KIENI WEST DIVISION,
P.OBOX 32,
MWEIGA.
30TH MARCH 2009.

Ref No.ADM 2/3/volII/51

TO ALLCHIEFS,
KIENI WEST DIVISION,
GATARAKWA DIVISION.

RE: RESEACH AUTHORIZATION: IRUNGU SARAH WACHUKA.

The above named person has been authorized to carry out research on factors affecting Aloe propagation in Kieni west and Gatarakwa Division.

Please accord her the necessary assistance.

M.OLE PELELA
DISTRICT OFFICER
KIENI WEST DIVISION

CC.
A.E.O
KIENI WEST DIVISION
GATARAKWA DIVISION

MINISTRY OF EDUCATION

Telephone: 020- 8008608 or 020- 24631
FAX: 020- 8008608
When replying please quote

District Education Office
NYERI NORTH
P O Box 205-10102
KIGANJO

25TH MARCH 2009

REF: NYI/N/GEN I/VOL I/50

To Whom It May Concern:

RE: IRUNGU SARAH WACHUKA

The above named has been authorized to carry out research on factors affecting Aloe propagation and cultivation in Kieni West Division

Accord her the necessary assistance.

S.M. KIMATHI
FOR: DISTRICT EDUCATION OFFICER
NYERI NORTH