HOUSEHOLD CONSUMPTION OF MEDICINAL PLANTS. A CASE
STUDY OF KAKAMEGA FOREST IN KENYA

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PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF
THE DEGREE OF DOCTOR OF PHILOSOPHY IN ECONOMICS OF
KENYATTA UNIVERSITY.

AUGUST, 2016
DECLARATION

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

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School of Economics
Kenyatta University
DEDICATION

This work is dedicated to six great people:

My late mother, Rosemary

My wife, Fridah

My late father, Joseph

My children, Rawlings, Leon and Powell
ACKNOWLEDGEMENT

I honor and exalt my Lord Jesus Christ for enabling me to successfully complete the PhD (Economics) programme. My sincere appreciations go to my supervisors; Prof. Almadi Obere and Dr. Peter Ng’ang’a for their invaluable comments, guidance and encouragement in writing this thesis. In the same vein, I am grateful to Dr. Wilfred Nyangena for his insights in the development of the thesis.

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Finally, my gratitude to my wife Fridah Kanja and children Rawlings Ramogi, Leon Kiogora and Powel Lang’ni for their understanding during the times I was away.

I thank you all and God Bless you abundantly.
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ABBREVIATIONS AND ACRONYMS

AEM  Averting Expenditure Method
ARVs  Anti-Retrovirals
AU   African Union
BVN  Bivariate Normal Distribution
CAM  Complementary Alternative Medicine
CITES Convention on International Trade in Endangered Species
CPRs  Common Property Resources
CPNRs Common Property Natural Resources
CVM  Contingent Valuation Method
HIV/Aids  Human Immune Virus/Acquired Immune Deficiency Syndrome
HPM  Hedonistic Price Method
ICIPE International Center of Insects Physiology and Ecology
ICRAF  International Center of Research in Agro-forestry
IID  Independent and Identical Distribution
KDHS  Kenya Data Household Survey
KFS  Kenya Forestry Services
KShs  Kenya Shillings
KEMRI  Kenya Medical Research Institute
KEMSA  Kenya Medical Supply Agency
KNBS  Kenya National Bureau of Statistics
KWS  Kenya Wildlife Services
MLE  Maximum Likelihood Estimate
MM  Modern Medicine
MoH  Ministry of Health
MPs  Medicinal Plants
MRS  Marginal Rate of Substitution
NGOs  Non Governmental Organizations
NTFPs  Non Timber Forest Products
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
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<tbody>
<tr>
<td>OLS</td>
<td>Ordinary Least Squares</td>
</tr>
<tr>
<td>PMUI</td>
<td>Plant Medicine Utility Index</td>
</tr>
<tr>
<td>RUM</td>
<td>Random Utility Model</td>
</tr>
<tr>
<td>TCM</td>
<td>Travel Cost Method</td>
</tr>
<tr>
<td>TEV</td>
<td>Total Economic Value</td>
</tr>
<tr>
<td>TM</td>
<td>Traditional Medicine</td>
</tr>
<tr>
<td>THPs</td>
<td>Traditional Health Practitioners</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
</tr>
<tr>
<td>US$</td>
<td>United States Dollar</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>WTP</td>
<td>Willingness -To-Pay</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Variant plant species in an ecological zone</td>
</tr>
<tr>
<td>Biopiracy</td>
<td>Theft of genetic resources from a locality without the knowledge of the natives.</td>
</tr>
<tr>
<td>Conservation in-situ</td>
<td>The conservation of a plant species within its natural habitat.</td>
</tr>
<tr>
<td>Conservation ex-situ</td>
<td>The conservation of a plant species out of its habitat.</td>
</tr>
<tr>
<td>Ecological zone</td>
<td>Natural set up of plants in a specific geographical area.</td>
</tr>
<tr>
<td>Endangered species</td>
<td>Situation in which the numbers of species are declining with their use being more than stock replacement.</td>
</tr>
<tr>
<td>Herbal medicines</td>
<td>Pharmaceutical plants used in treatment of human and livestock diseases.</td>
</tr>
<tr>
<td>Hospitals/Clinics</td>
<td>Facilities where conventional medicine is practiced.</td>
</tr>
<tr>
<td>Traditional Practitioners/</td>
<td>Providers of therapeutic relief by use of plant medicine; animal medicine and spiritual means.</td>
</tr>
<tr>
<td>Complementary Alternative</td>
<td></td>
</tr>
<tr>
<td>Medicine</td>
<td></td>
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</table>
ABSTRACT

Herbal medicine, commonly referred to as alternative medicine, has been treated with a lot of skepticism among the conventional medicine practitioners. It has been described as inferior to conventional medicine with no proven safety and efficacy, perhaps only associated with rural areas where conventional medicine is not easily accessible. Thus, with economic progress and advancements in conventional medicine, one would expect decline in herbal medicine consumption. In Kenya, 70% of the population is dependent on herbal remedies for their ailments. This is against a backdrop of improved access to conventional medical facilities, attributable to increasing sector development expenditure. Therefore, this thesis sought to analyse the factors that influence herbal medicine consumption by univariate logit approach; establish joint consumption for both conventional and herbal medicine by bivariate probit approach; estimate economic value of herbal medicine by Willingness-To-Pay approach and; establish herbal consumption relationship to herbal medicine availability in Kakamega forest by qualitative analysis. Overall, the thesis makes contribution in terms of both literature and methodology. Results showed that consumption of conventional medicine and herbal medicines were indeed inter-dependent. This decision was influenced by gender, education, price of conventional medical treatment, distance to medical facilities, and health insurance cover. Kakamega forest herbal medicines were found to have an economic value. Herbal medicine cultivation influenced 72 percent of the total economic value. Herbal medicine biodiversity was found to be declining due to over-harvesting for consumption. This was influenced by wild exploitation from the forest. The policy implication of these findings is that, herbal medicine remains important but its efficacy should be verified and regulated to protect consumers. In the short and medium term, the government should provide well targeted subsidies on medical services to eliminate the dangers of consumers falling into the traps of unscrupulous providers of unproven herbal remedies. To harness their economic value and reduce wild exploitation, the government and non-governmental organizations should implement incentives that will encourage production of herbal medicines with proven safety and efficacy. This could be tenable by monitoring wild exploitation and developing herbal inventory.
CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Medicinal plants (MPs) consumption is wide spread in developing countries. This is because it is in some cases the only source of healthcare delivery for sick human and livestock in most rural areas (Mafimisebi, 2012 and Ogunlela, 2007). By 2003, more than 3.5 billion people in developing countries used medicinal plants for primary healthcare (WHO, 2003). The developing countries MPs consumption ranges from 60 to 90 per cent of country population (WHO/AFRO, 2003). It is in recognition of this critical role of MPs that the African Union (AU) declared 2001-2010 a decade for African traditional medicine with specific emphasis on MPs use on treatment and prevention of ailments.

The MPs sub-sector is intricately interwoven in the rural economies of developing countries. Notably, the 2010 annual global demand for MPs and their products was estimated at US$14 billion and is projected to grow to US$5 trillion by 2050 (Otieno et al., 2012). In China for example, by 2006 the sub-sector employed over 100 million people and equally drew an annual export trade volume of US$30 billion from herbal exports (Lakshmani, 2007). For Africa, South Africa has a relatively developed MPs sub-sector in the region. By 2002, it absorbed a workforce of 133,000 people with a large proportion being rural women. This translated to US$600 million contribution to annual revenue which was about 5.6 per cent of South Africa annual budget (Dold et al., 2002).
In Kenya the economic potential of this sub-sector has not been ascertained. However many communities in Kenya have taken up farming of medicinal plants. This is probably informed by the fact that MPs demand exceeds supply in some areas (Barnett and Lybbert, 2000; Kisangau and Kokwaro, 2004). Furthermore, traditional practitioners (TPs) are willing to make journeys in excess of 200 kilometers to collect the required plants an indication of scarcity (Barnett and Lybbert, 2000). About 30,000 Kenyans benefit from bio-prospecting and conservation projects undertaken by ICIPE in Western Kenya and Coastal provinces, an indication of the potential MP economic value. Not only is the cultivation attempting to bridge the MPs scarcity but equally providing sustainable livelihoods in regions where they are commercialized. For instance, the large scale cultivation of Mgombero (Mondia Whyte) in Kakamega generates KShs 30,000 to KShs 45,000 annually for three harvests from an eighth of an acre (Otieno et al., 2012). In the Rift Valley, Chinchona is cultivated and the bark exported for extraction of quinine used in malaria treatment. Therefore, the economic value of MPs cannot be ignored specifically for the rural economy. Harnessing the economic potential of the MPs sub-sector in Kenya through growing herbs, picking from wild, packaging and selling them would create jobs in the economy. This course is in consonance with Vision 2030 objective of enhancing equity and wealth creation for the poor in Kenya (Republic of Kenya, 2008).
The MPs utilization levels often trade under conditions of imprecise prior information passed on from generation to generation. This surrounds the stochastic nature of the hazards associated with their consumption activities. For instance the MPs providers in Kenya are unknown and there is allegation that MPs providers have no training and specialization. These points out to the high risks associated with safety and efficacy of MPs (Kisangau and Kokwaro, 2004). For instance Orwa (2002) and Luigi (2007) indicate some MPs to have adverse effects on liver and lungs for cancer and HIV/Aids patients. Further, herbal medicine is scandalized as ‘witchcraft’ i.e. as black magic (Owuor et al., 2006). Notwithstanding, consumption is still on the rise and widespread (WHO, 2005).

In Kenya, there is no estimate of increasing rate of MPs consumption except for mention in literature. The literature such as Orwa, 2002; Mander, 2004; Kisangau, and Kokwaro 2004; Rath, 2005 indicate that MPs consumption is exacerbated by low prices of MPs. However, Mwabu, Ainsworth, Nyamete (1993) reveal that substantial consumption of MPs existed even in cases where MPs prices were high and conventional medicine prices were low. No doubt, they form a critical component of national health care system in developing countries.

Recognizing this role, several institutions such as Kenyatta University, Moi University, Maseno University, Egerton University and University of Nairobi have established botanical gardens. The Kenya Forestry Research Institute, Kenya Medical Research Institute and International Center for Research and Agro-
forestry amongst others, have been actively involved in conducting research on
the medicinal compounds in plants. This has resulted into an increasing number of
profiteering herbalists with indiscriminate harvesting of various MPs species
without proven knowledge and practice on the medicinal values of these plants.
One such plant is the African Cherry found only in Kakamega forest and Mt.
Elgon that is exploited for both domestic and export markets. The excess demand
is for various medical uses including treating allergies, inflammation, fever, chest
pain, heart burn, kidney diseases, malaria, stomach ache and animal medicines. It
is an endangered species listed in Appendix II of CITES in 1994 for international
trade monitoring.

It is possible that widespread consumption of MPs may increase healthcare access
for poor rural households essentially improving their welfare. This is informed by
the fact that one in four prescriptions of modern medicine contains one or more
plant products (WHO, 2005). Consequently, integrating the MPs in the
mainstream healthcare system may significantly reduce the healthcare budget for
developing countries (WHO/China, 2008 and Luigi, 2007). Also pooling of
ethno-medicine knowledge on MPs may result in increased rural household
incomes. Moreover, the cultivation of MPs to ease exploitation from the wild and
MPs degradation may generate substantial incomes for the rural households (Dold
et al., 2002; Bhat, 2003; Owuor et al., 2006).
1.2 Herbal Medicine Consumption in Kenya

The World Health Organization indicates that 70 % of Kenya’s population depends on traditional medicine of which, about 90 per cent of traditional medicine is medicinal plants (WHO, 2005). Harvesting of MPs for consumption is from the wild and is indiscriminately done leading to Kenya being with the second highest number of the endangered medicinal plant species in the East Africa region. The adoption of commercial cultivation of MPs in various parts of the country is a strong indication of increased MPs demand and the need to conserve the endangered MPs species. The low ratio of medical doctors to the population of 1:20,000 in Kenya may depict low access to conventional medicine and thus low consumption of conventional medicine. High ratio of traditional doctors to the population of 1:987 may on the other hand indicate high access and rising demand for MPs consumption in Kenya. (Lambert, 2004; Kokwaro, 1991; Gachathi, 1989).

Gene technology has given unlimited powers to developed countries to exploit the genetic resources of developing nations resulting to biopiracy. This has threatened the existence of some ethno medicinal plants and endangering the very existence of valuable medicinal plant resources. This is exacerbated by the unscrupulous collection of medicinal plants from wild habitat by traders. Cases of biopiracy such as enzyme puradex collected from Lake Bogoria for commercial manufacture of detergents and; SE50 bacteria strain collected from Ruiru dams in 2004 for manufacture of anti-diabetic drug for management of type II diabetes are
also strong indication of medicinal plant consumption value (KWS, 2011). The situation is attributed to the common property natural resource (CPNRs) regime of MPs. The generated revenues are lost for lack of ascertained economic value and fully kept inventory of MPs in Kenya. Countries such as India, China and Brazil have supportive policies with potential to transform the MPs sub-sector into self-propelling industry both for local market and for exports. In Africa, only South Africa and Egypt have developed this subsector and are now major exporters. In Kenya, the MPs sub-sector is not developed.

1.3 Conventional Health Services Access in Kenya

Kenya had approximately 7,608 health institutions by the year 2012 owned by Ministry of Health (MoH); faith based organizations/other NGOs; and other private institutions. The MoH provides half of health facilities with the highest number being hospitals, health centers and dispensaries at 273, 579 and 2716 respectively (Republic of Kenya, 2012). Significant to healthcare access is the seven year growth in the number of registered medical personnel specifically doctors and pharmacists as depicted in table 1.1.
### Table 1.1: Number of Registered Medical Personnel

<table>
<thead>
<tr>
<th>YEAR</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctors</td>
<td>6628</td>
<td>6897</td>
<td>7129</td>
<td>7549</td>
<td>8092</td>
<td>8682</td>
<td>9149</td>
</tr>
<tr>
<td>Dentists</td>
<td>974</td>
<td>1004</td>
<td>898</td>
<td>930</td>
<td>985</td>
<td>1045</td>
<td>1090</td>
</tr>
<tr>
<td>Pharmacists</td>
<td>2860</td>
<td>2921</td>
<td>3097</td>
<td>3205</td>
<td>2076</td>
<td>2202</td>
<td>2355</td>
</tr>
<tr>
<td>Registered Nurses</td>
<td>14073</td>
<td>15948</td>
<td>29678</td>
<td>32941</td>
<td>35148</td>
<td>37907</td>
<td>41371</td>
</tr>
</tbody>
</table>


Figure 1.1 is even more illustrative of the selected medical personnel growth critical to medicare access. For instance the number of dentists and pharmacists is almost static in the seven year period 2008-2014. This growth rate of medical personnel is too low to achieve World Health Organization standard ratio of 1:1000 population in Kenya. These probably provide an avenue of access to traditional medicine and in particular the increase in herbal consumption since it is probably the only source that can meet the rising medical demands for increasing population.

![Figure 1.1: Selected Type of Registered Healthcare Personnel per 100,000 Populations](image)

The Government of Kenya effort to facilitate health service access is reflective in the health sector expenditure growth. The development expenditure has significantly increased from KShs 4.87 billion to KShs 32.74 billion while recurrent expenditure increased from KShs 26.93 billion to KShs 60.41 billion in the 2008/09 to 2013/14 fiscal period (Republic of Kenya, 2012). Despite the expansion of health facilities, the sector is still confronted with challenges in geographical distribution of the health workforce and insufficient supplies due to inadequate funds. In addition, of an estimated 1.5 million people living with HIV/AIDS and 720,000 eligible for ARV treatment, nearly 220,000 eligible people were without treatment in 2012/13 (Republic of Kenya, 2012). In recognition, preferences for traditional medicine are on the rise with emphasis on medicinal plants.

1.4 Traditional Medicine Policy in Kenya

In 1970, efforts were initiated to incorporate traditional medicine in the national health system in Kenya. This never took off given the efficacy of these traditional medicines as well as suspicion by the THPs and conventional doctors on piracy of knowledge. Kenya’s five year development plan of 1983-1988 recognized the importance of TM by entrenching the traditional midwives role in health improvement. The traditional medicine practice and promotion was further recognized in the Kenya’s development plan of 1989-1993 through MPs. The Kenya Medical Research Institute was established in 1984 to enhance medical research on the efficacy and effectiveness of alternative medicine. Patent laws
were revised in 1999 with the purpose of including legal protection of traditional medicine (Vasishti et al., 2004). There exists no policy and laws that regulate this subsector except say for registration of THPs by the Ministry of Culture and Social Services.

1.5 Statement of the Problem

Herbal medicine, commonly referred to as alternative medicine, has been treated with a lot of skepticism among the conventional medicine practitioners. It has been described as inferior with no proven safety and efficacy, perhaps only associated with rural areas where conventional medicine is not easily accessible. Thus, with economic progress and advancements in conventional medicine, one would expect decline in herbal medicine consumption. Existing evidence, however, does not seem to support this notion. For example, in 2010, annual global demand for medicinal plants and related products was estimated at US$ 14 billion and projected to grow to US$ 5 trillion by 2050. In Kenya, 70% of the population is dependent on herbal remedies for their ailments. This is against a backdrop of improved access to conventional medical facilities, attributable to increasing sector development expenditure and recurrent expenditure.

In fact, MPs demand exceeds supply in some areas. Furthermore, matters of MPs value have not been sufficiently established for declaration though there is evidence that TPs are willing to make journeys in excess of 200 kilometers to collect the required medicinal plants. For instance, there are no ascertained costs
and or benefits of *Chinchona* bark exports for quinine extraction for malaria treatment from the Rift Valley. To meet the MPs excess demand and conservation requirements for sustained livelihoods, MPs cultivation is supported by national and international institutions such as Kenya Forestry Research Institute, Kenya Forestry Services, botanical gardens of Kenyatta University, Moi University, Maseno University, Egerton University and University of Nairobi, ICIPE and ICRAF. For example, ICIPE promotes cultivation of *Miondo Whyte* in Kakamega County, Western Kenya.

Most literature ignore empirics and only provide description of the herbal medicine sub sectors economic importance, healthcare access, need for regulation and intellectual property rights. These literatures are mainly in sociology and more ethno botany and scarcely in economics. While some studies attribute high demand for herbal remedies to low prices, some studies showed that herbal remedies were sought even where prices of conventional medicine were much lower. A few studies have modeled socio-economic factors that drive use of herbal medicine. However, they have ignored the inter-dependence of the decisions to consume conventional medicine and or herbal medicine. Instead they used multivariate logistic and Ordinary Least Squares (OLS) framework which could not address possible endogeneity bias arising from the inter-dependence of the two consumption decisions.
1.6 Research Questions

The study answered the following research questions:

(i) What determines consumption of medicinal plants of Kakamega Forest?

(ii) What is the effect of medicinal plant consumption on conventional medicine consumption amongst households living around Kakamega Forest?

(iii) What is the economic value of medicinal plants of Kakamega Forest?

(iv) What is the relationship of medicinal plants consumption on their availability in Kakamega Forest?

1.7 Objective of the Study

The overall objective is to establish the determinants of medicinal plants consumption in Kenya. The specific objectives of the study are to:

(i) Analyze the determinants of medicinal plants consumption of Kakamega Forest.

(ii) Establish the effect of medicinal plant consumption on conventional medicine consumption amongst households living around Kakamega Forest.

(iii) Estimate the economic value of medicinal plants of Kakamega Forest.

(iv) Establish the relationship of medicinal plants consumption on their availability in Kakamega Forest.
1.8 Significance of the Study

This study is of importance to the Government of Kenya in documenting rational plant medicine use by drawing policies on wild exploitation or cultivation of medicinal plants and safe consumption. Equally, the existing and potential investors in the pharmaceutical plants industry are able to plan for future production based on present MPs demand. It will contribute to data based literature on herbal medicine consumption and economic valuation of medicinal plants.

1.9 Scope and Limitation of the Study

The study was limited to raw medicinal plants. Primary data was collected in Kakamega Central and limited to the extent in which the MPs are consumed. Production of and trade on MPs though important was not included in the study.

1.10 Organization of the Study

Chapter one provides information about world MPs consumption and describes the MPs consumption situation in Kenya. Chapter two presents the literature review and focus on theoretical and empirical literature. Chapter three presents the theoretical framework for the study, the model specification and estimation method. Chapter four provides the results and discussions. Chapter five is a summary of the study with the policy implications and suggested areas for further research.
CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction
The chapter examines the related theoretical and empirical literature to the study problem. The theoretical literature attempts to explain household behavior while the empirical literature covers MPs consumption and conventional medicine consumption.

2.2 Theoretical Literature
The study is guided by utility maximization, profit maximization and common property natural resource and contingent valuation theories.

2.2.1 Utility Maximization Theory
From the perspective of neoclassical economics, the market system is considered to be the preferred institution for allocating scarce resources. The market system guided by the free expression of individual consumer and producer choices would lead to constrained maximization of the society well-being since consumers have unlimited wants to satisfy with limited resources. Assuming rationality, herbal medicine or pharmaceuticals would receive first preference in as far as the allocation of the scarce resources is concerned since they are paramount to human existence. The problem of preference between pharmaceuticals and herbal medicine are essentially problems of allocation. Most literature demonstrates that conventional medicine is out of reach for many in developing countries, an
indication that they are scarce (Mwabu, Ainsworth and Nyamete, 1993; WHO, 2003; Morgan, 2005 and Robinson, 2006). However, with an increase in per capita income, improvements in public health systems and medical technology, many should access conventional medicine. The household, therefore, maximizes utility by consuming herbal medicine and pharmaceuticals.

Herbal medicine markets are either missing or imperfect and as such the household decision becomes non-recursive because the household deliberately decides how much of herbal medicine to consume that affects the consumption of pharmaceuticals (Singh et al., 1986). In such cases, herbal consumption affects income and income affects herbal consumption. In developing countries, highly imperfect markets are characterized by high transaction costs and constraints on marketed quantities (Thorbecke, 1993; Ellis, 1993). This theory however fails to recognize that households decision on consumption of herbal medicine can also be influenced by the households own production of herbal medicine.

2.2.2 Household Production Theory
Households are both consumers and producers of herbal medicine. Assuming a competitive market for herbal medicine then they will take prices as given. The problem will be on minimizing costs in order to maximize profits. The household production function model provides a framework for examining interactions between demand for market goods and the availability of a public good such as herbal medicine (Varian, 2013). This framework is based on the assumption that
there is a set of technical relationships amongst goods used by households in the implicit production of utility yielding final services. The household, therefore, maximizes utility by consuming home-produced and market-purchased goods, and leisure time, subject to full income constraint (Becker, 1965). Production and consumption decisions would be recursive if markets existed and functioned properly because prices would be exogenous, leisure and labor-time would be independent, household labor allocation would be determined by market wage and the household’s full income would be the only thread between household consumption and production (Singh et al., 1986).

This theory has been criticized that households are not typical profit maximizers and make a lot of tradeoffs between profits and other equally important, but not necessarily economic objectives.

2.2.3 Market Valuation

Medicinal valuation may be approached in several ways by looking at the actual market value of the plants when traded; the market value of the drugs of which they are source material; the value of the drugs in terms of their life saving properties and using a value of “statistical life” (Brown and Moran, 2009; Shackleton et al., 2004). Founded on the economic approaches, many simple and complex models have been developed to determine the market value of natural resources. The simple approach uses cross sectional data and market valuation based on the medicinal plant value of a unit of land as biodiversity support. Pierce
and Puroshothaman (1992) posit that for any given area, say a hectare, there will be some probability, \( p \), that the biodiversity ‘supported’ by that land will yield a successful drug, \( D \). Letting the value of the drug be \( V_i(D) \), where subscript \( i \) indicates one of two ways of estimating the value: the market price of the drug on the world market (\( i=1 \)), or the ‘shadow’ value of the drug which is determined by the number of lives that the drug saves and the value of a statistical life (\( i=2 \)). Since there are many other factors of production producing value in the drug, letting \( r \) be the royalty that could be commanded if the host country could capture all the royalty value and letting \( a \) be the coefficient of rent capture. Then, the medicinal plant value (\( V_{mp} \)) of a hectare of ‘biodiversity land’ is determined as:

\[
V_{mp}(L) = p.r.a.V_i(D)
\]

2.1

The complex approach takes dynamic optimization that requires market data collected over a period of time. For a renewable resource, to determine the existence and stability of the steady-states, the net growth function and period of harvest is mandatory. For many renewable resources, the growth function is dependent on an intrinsic growth rate, carrying capacity and, periods of increasing and decreasing marginal additions to stock. Harvest of the resource can be specified as the choice variable, or modeled as a production function subject to technology, effort and market conditions. For instance, in the fisheries literature such as in Conrad and Clark (1994), it is standard practice to estimate a catchability coefficient \( q \) to represent technology, and model production as dependent on stock \( X \), and effort \( E \), in a constant returns to scale Cobb-Douglas function:
\[ Y_t = H(X_t, E_t) = qX_tE_t \]

Effort, in turn, is modeled as a function of profitability:

\[ E_{t+1} = E_t + \eta[pH(X_t, E_t) - cE_t] \]

Where, \( \eta > 0 \) represents the speed at which effort adjusts to profit, \( p \) captures the price per unit of harvest, and \( c \) equals the cost per unit effort. The allocation decision in this framework is a balance (or marginal trade-off) between the net benefits of more \( Y_t \) in the current period or more \( X_{t+1} \) in the next period, the source of future growth and benefits. Larger future stocks can also have the added benefit of reducing future harvest costs.

The MPs sector in Kenya is informal and therefore lacks well developed data on the market variables such as statistical life, royalty, price of drugs, harvest rate, growth rate, and effort. This renders market valuation ineffective and the need to use non-market valuation techniques to capture the value of this sector.

### 2.2.4 Non-market Valuation Techniques for Natural Resource Goods

According to Kahn (2005), value is determined by people and not by either natural law or government. Government own values that are incorporated into policy do not necessarily reflect society’s value. Value is determined by people’s willingness to make trade-off, as best observed with market goods, where the willingness to make trade-off is reflected in peoples willingness to pay a monetary price for the good. Implying that, an expenditure on one good (MPs) reduces expenditure on the other good (modern medicine). For market goods, the inverse
demand curve represents a marginal willingness to pay function. There are two major classes of techniques for measuring the value of non-market goods: direct or stated preferences valuation and indirect or behavioral valuation.

For indirect or behavioral valuation, the researcher observes individual behavior in response to changes in public goods and from this behavior attempts to infer the value of changes in the public good. These approaches focus on measuring direct use value and are not particularly useful in measuring indirect use value (Freeman, 1992; Kahn, 2005). The common methods used include: Averting Expenditure Method (AEM), Travel Cost Method (TCM) and Hedonic Price Method (HPM).

Averting expenditure is designed to reduce the damage caused by pollution. For example Kshs3 billion spent on bottled water use and; a policy that made tap water as clean as bottled water would be worth at least KShs 3 billion (Jhingan and Sharma, 2007).

Travel Cost Method looks at how far visitors travel to come to a recreation site. Inference on the value of the site is made by placing a value on the cost of travel. TCM has both direct costs (e.g. airfare) and indirect costs (e.g. the opportunity cost of travel time). Inference in the value of a change in quality is made by looking at demand during different time periods. Time and travel cost expenses incurred to visit a site represent the “price” of access to the site
Thus, peoples’ willingness to pay (WTP) to visit the site can be estimated based on the number of trips that they make at different travel costs. This is analogous to estimating peoples’ WTP for a marketed good based on the quantity demanded at different prices. The drawbacks of TCM are that it estimates only use value and not existence value by focusing on recreational use. More so the estimates can bias downward if access to a site is deterred by congestion. However, it is useful in valuing improvements to water bodies.

Hedonic Price Method is based on a theory of consumer behavior that suggests that people value a good because they value the characteristics of the good rather than the good itself (Freeman, 1992; Kahn, 2005; Jhingan and Sharma, 2007). According to this theory, an individual would not value MPs because the MPs directly give utility, but because they value the characteristics of safety, green consciousness and cost of access to provide utility. This method is of no relevance when dealing with many types of public goods such as nationwide air pollution and endangered species as no prices are available for them. However, it is useful in determining housing prices.

The direct or stated preference valuation is merited for measure of both direct use and indirect use value. Researchers pose contingent or hypothetical questions to respondents, inducing responses that trade off improvements in public goods (e.g. Environmental Quality) and services for money. From the responses, one can infer preferences for or the value of changes in public goods (Freeman, 1992;
Kahn, 2005). The Contingent Valuation Method (CVM) is the most prevalent in the direct or stated preference valuation.

Compared to other methods, CVM is more appropriate in valuing MPs given its merits of establishing both direct use and indirect use values. And the fact that it is not restricted to valuation of specific environmental and natural resource goods like in the indirect or behavioral valuation approaches makes it appropriate.

2.2.5 Common Property Natural Resource Theory

The theory of common pool resources indicate that most of the natural resources are non-excludable and individuals aim at maximizing their use in the short term against the social benefit. In the long term resources are degraded such that the private costs are less than social costs hence loss of societal welfare. The phenomenon is referred to as the tragedy of the commons (Hardin, 1968). With scarcity of the resources, market and prices emerge for collective economic behavior and provide exclusion which is good for the environment and; also a good incentive to conserve (Perrings, 2000). As the demand for medicinal plant surge, they attract price and the incentive to conserve in-situ and ex-situ for economic rent. This theory does not indicate how the market and prices for public goods such as medicinal plants can be created before depletion.
2.3 Empirical Literature

2.3.1 Literature on Medicinal Plant Consumption

A few studies have been done to explain medicinal plant consumption. Many studies approach the medicinal plant preference through complementary and alternative medicine. This is argued on the basis that 90 per cent of CAM is medicinal plants (WHO, 2005). This section reviews literature on the medicinal plant consumption.

Eisenberg et al., (1999) examined the profile of patient’s spending money and time on complementary and alternative medicine (CAM) in the United States. Using a randomized national phone survey of 1,539 US adults, the study revealed that one out of three CAM services users were of relative higher education and higher income. Though WHO (2005); Morgan (2005) and Robinson (2006) demonstrate that western medicine is out of reach for many in developing countries, in a developed country like USA it would be a matter of choice rather than cost as revealed from Eisenberg study. This is in tandem with Cocks and Dold (2000) findings that irrespective of education and income levels, consumption of MPs is not restricted to rural areas or low income groups. Though this study provided baseline information on CAM use, it does not apply rigorous statistical analysis based on theory and problem modeling.

Kennedy (2005) examined the national use, reasons for use and perceived efficacy of herbal products and dietary supplements. He used secondary analysis of CAM
to the 2002 National Health Interview Survey, conducted by the US National Center for Health Statistics where interviewees were asked if they had used natural herbs for their own health and treatment. Supplement users were asked whether they had used any of 36 specific herbs, how important the use of CAM treatment was to them, whether they had seen a CAM provider, and whether they had informed a conventional medical provider about their use. The results showed that 57.3% use herbs to treat specific conditions. More than half indicated the importance of herbs to their health and well being. Testing at 5% level of significance, use rate were higher for women (21%) compared to male (16.7%). and also high for college graduates (25%) against non-graduates (16.7%). These findings are consistent with that of Goldstein et al. (2007). Finally, only 33.4% told a conventional healthcare provider about their herb or supplement use. However, the study fails to explain the basis of choosing 36 specific herbs. Importantly lacks the theoretical underpinning to support the model.

Mander and Le Bretton (2005) study examined the high population growth rates and rapid urbanization effect on MPs demand in South Africa. The study showed that there is a positive relationship in the growing demand for MPs and the high population growth rates and rapid urbanization. Just like most studies in this area, it was qualitative with no theory or model to back it up. Cocks et al., (2004) study was in agreement that urbanization has led to increased demand for MPs. They indicated that trade on herbal medicine is no longer confined to traditional healers but to both formal and informal entrepreneurs. The result was rise in demand for
herbal medicine in the urban areas. However the study has similar shortcomings as in the Mander and Le Bretton (2005).

Birhan et al., (2011) study is in line with the study of Mafimisebi et al. (2012) in establishing the reasons for traditional medicine use, including medicinal plants. Though Mafimisebi focused on MPs for veterinary use, Birhan focused on traditional medicine for human use with no particular distinction of plant medicine, animal medicine and other medicine within the TM category. The study used cross-sectional data to establish reasons patients visit traditional healers’ clinics in Addis Ababa, Ethiopia. The study sought information on demographic characteristics, use and types of traditional medicine, source of healing knowledge, number of visitors per day, reasons for visiting traditional healers’ clinics, and common types of diseases treated by healers. Ten traditional healers and 306 patients attending traditional clinics were interviewed. The study showed the absence and presence of association among different socio-demographic variables with traditional medicine. The findings indicated that 52 % of patients reported to traditional healers as first choice when faced with health problems. And 35.6 % were dissatisfied with conventional medicine. Efficacy, cost, female gender and government employees were revealed to be the reasons behind conventional medicine dissatisfaction at 57.2 %, 2 %, 55.2 % and 29.4 % respectively. The study did not attempt to categorize the various TM to facilitate an in-depth analysis of proportional TM component use. Notwithstanding the study qualitatively stated that the increased emphasis on MPs use for a wide
variety of ailments is related to population rise, inadequate supply of drugs, prohibitive cost of treatment, side effects of several allopathic drugs and development of resistance to currently used drugs.

Mafimisebi et al., (2012) examined the extent of plant medicine (MPs) utilization by small holder livestock farmers in the states of Ogun, Ondo and Oyo in Nigeria using Plant Medicine Use Index (PMUI) and Ordinary Least Square (OLS) regression to capture utilization of MPs. The PMUI established the extent of MPs use while OLS method determined the socio-economic factors influencing MPs use. The variables used were, yearly household incomes, farmers age, farmers experience, formal education, household size, number of heads of animals, average number of travels by farmers outside own community annually, membership of trade/cooperative associations, mass media exposure of the farmer as individual by number of information media being accessed and; distance of farmers farm to the nearest veterinary clinic/hospital. The study revealed that farmers age, household size, distance to the nearest clinic/hospital, extent of travels had a positive effect on MP use while farmers income and number of heads of livestock had negative effect on MPs use at 5 % statistical level. The study was not grounded on theory and therefore no model support. It also did not provide for treatment of endogeneity problem having used OLS.

Ondicho et al., (2015) determined factors associated with utilization of herbal medicine by the Abagusii community among patients in herbal clinics in Gucha
district, Kenya. The study was cross sectional. It revealed that 68.9% prefer use of herbal medicine and 67.7% visit conventional hospital for the same or different health condition. This was qualified on the basis of better efficacy (83%). This study was not anchored on economic theory and pursued a qualitative analysis approach.

2.3.2 Effect of Medicinal Plants Consumption on Conventional Medicine Consumption

Goldstein et al., (2007) evaluated the rate of consumption and characterize the patients hospitalized in internal medicine department who consume herbal remedies and dietary. The study was done in two hospitals in Israel; where medical records were searched for evidence of medical team knowledge on herbal remedy or dietary supplement use. The study adopted a cross-section approach and used a multivariate logistic regression model to assess the relation between medical and socio-economic factors and the consumption of herbal remedies and dietary supplements. The revelations were that variables associated with hospitalization, incomes and benign prostate had a positive relationship to their consumption. Strikingly was that more females (34.8 %) were likely to consume herbs than males (21.9 %) with a p-value at 0.021; those with high incomes likely to consume herbal supplements (p-value 0.009); and the higher the level of education, the greater the tendency to consume herbal supplements. These findings are also in agreement with Eisenberg et al., (1999). However, Goldstein acknowledges that 94 % of the patients had not been asked specifically about
herbal consumption by the medical team. These drew down the credibility of the study, specifically relying on the findings that only 6% of the patients were assessed. Though very good on modeling the problem, it failed to provide the theoretical foundation of the study. Further that multivariate logistic regression is good for independent decision making and not for inter-dependent decision as shown between medical and herbal consumption. Bivariate probit approach results would have given a better inter-dependence relationship between medical and socio-economic factors and the consumption of herbal remedies.

Matheka et al., (2013) studied CAM use among diabetic patients in Africa with a Kenyan perspective. It was revealed that CAM is widely used among diabetic patients as an adjunct to conventional medicine in developing countries. The reason for CAM use was dissatisfaction and inaccessibility of conventional medicine; and recommendation by family and friends. This study was descriptive and lacked grounding in economic theory.

Githinji (2014) studied joint utilization of herbal products and conventional medicine in Githunguri District, Kiambu County, Kenya. He used cross sectional approach. Sample size of 324 patients attending herbal clinics was selected. Chi-square was used to determine the joint use of conventional medicine and herbal medicine. The result showed that 42.5% of the respondents jointly used herbal and conventional medicine. Respondents with chronic diseases (63.9%) and urban
resident (64.7%) influenced the joint consumption of herbal and conventional medicine. However, the study was not founded on economic theory.

Mwangi et al., (2014) examined the perceptions people with diabetes mellitus have towards herbal remedies; the extent to which they use herbal remedies and the association between the perceptions people have on herbal remedies and conventional medicine use in Muranga North district, Kenya. The study revealed that 12.4% interviewed admitted using herbal remedies in addition to conventional medicine as part of managing diabetes. However, the study was qualitative.

2.3.3 Literature on Economic Value of Medicinal Plants
Ruitenbeek (1989) study of Korup rain forest (426,000 hectares) in Cameroon determined the minimum economic value of genetic resources through the expected production value analysis. The analysis involved three parameters: the value of research discoveries (from historical information on patent values); the number of discoveries; an institutional factor describing the host nation’s ability to capture research revenues. The revenue capture was dependent on the licensing structure governing research in Cameroon. The study revealed a total expected annual value of US$85,000 for genetic resources, while the average value per hectare was between US$0.2-0.7. This value could have been under estimated given the efficiency of licensing structure to capture all the research revenue. Also that most of these genetic resources are not traded under perfect market conditions thus under-valued.
Balick and Mandelsohn’s (1992) study in South Africa used same parameters as in Ruitenbeek (1989) and added the number of drugs based on plants as a new variable. The study revealed that net annual genetic resource value ranges between US$19-61 per hectar. This finding contradicts the Ruitenbeek (1989). However, the range is wide and a narrow range or specific values per hectare need to be ascertained.

Pearce and Puroshothaman (1992) considered the value estimate as a function of number of species at risk, number of drugs based on plant species and the number of hacters likely to support medicinal plants. The commercial value estimate was revealed at USD20 per hacter. This value is in agreement with Balick Mandelsohn’s (1992) findings within the range of US$19-61 per hacter.

Sher et al., (2006) aimed at describing the domestication and cultivation of six high value medicinal plants in farm lands and analyzed their economic potential under farm land conditions. The study revealed highest mean score of 85.5 % and 77.6 % across all locations for two species while four species showed poor survival rates. The two species showed high economic potential under farmland conditions. This value was however descriptive and not specific as per earlier studies. The study was also not informed by economic theory and modeling.
2.3.4 Literature on Medicinal Plant Consumption and Availability

Wiersum et al., (2006) brought a new variable of culture in understanding of MPs demand. The study indicated that surge in MPs demand is due to great cultural significance attached to medicinal plants. Communities that lived in their original habitat completely rely on plant medicine. This is based on long term ethnomedicine knowledge transfer from generation to generation. The indications were that, growing demand is related to great cultural significance attached to medicinal plants and; growing demand increased wild overexploitation as well as increased interest in cultivation. The study was conducted in three villages of 250 persons in Amatola region of Eastern Cape, South Africa. This study was mainly qualitative and more so lacked theory and an estimation model. It also lacked justification for choice of the three villages in Amatola region and the statistical estimation of the cultural variability in the three villages.

Ragupathy et al., (2008) study on the vanishing cultures that posses knowledge on medicinal plants utility, revealed a decline in traditional aboriginal knowledge with the younger generation of Malasars in India. This is due to the young generation tendency to migrate towards lucrative jobs in more developed urban areas. This leaves the natural resource commodity to be harvested by non aborigines who might not attach conservancy value on its exploitation. This study was descriptive and did not consider economic theory.
2.4 Overview of Literature

Theoretical literature shows that households faced with highly imperfect markets have to make tradeoffs between purely economic and non-economic decisions. Meaning households are neither profit maximizers nor utility maximizers. Therefore production and consumption decisions have to be taken simultaneously. Further, households are constrained with imperfect market information such as herbal knowledge, herbal market demand with regard to herbal medicine production. Therefore it is important to analyze the household as utility maximizers constrained by market conditions and income.

There are many simple and complex models developed to estimate the market value of natural resources. Simple approaches use cross-sectional data and market valuation based on a unit of land as biodiversity support. Complex dynamic approaches take dynamic optimization that requires market data collected over a period of time. Market data on important variables such as statistical life supported by herbal, royalty on developed drug, price of drugs, harvest rate, growth rate are not yet developed for Kenya. Meaning non-market valuation techniques is appropriate. Non-market valuation approach involves estimation of direct and indirect use value. Economic value is determined by willingness to make tradeoffs. This is observed in willingness-to-pay a monetary price for a good. Averting expenditure, travel cost, hedonic price and willingness-to-pay approaches are all the non-market valuation techniques. However, AEM, TCM and HPM are able to capture direct use value only while willingness-to-pay
captures both direct and indirect use values. Therefore it is important to estimate the economic value of medicinal plants by use of willingness-to-pay approach.

Most natural resources are considered as public goods. There is non-rivalry and non-excludability in their consumption. Implying individuals lack the property rights to control and transfer the use rights. The CPNRs theory indicates that biological resources consumption by an individual diminishes the consumption of the other. CPNRS approach is appropriate in modeling the effect of biological resource use on biodiversity. However market data on growth function, effort function and harvesting function are necessary. But the market data is not available. Therefore the appropriate approach is to elicit respondent’s perception on biological use on biodiversity. This is important in setting stage for rigorous analytical work.

Empirical literature showed that gender, age, cost of conventional medicine, income, education, distance to clinic, nature of disease and social capital influenced herbal medicine consumption. Gender, income and education findings were similar to the reviewed studies. On the other hand, age; cost of conventional medicine; distance to clinic; nature of disease; household size and social capital findings were divergent. Cost of conventional medicine and nature of disease were showed to influence consumption of both conventional medicine and herbal medicine. These analyses were conducted within the complementary and alternative medicine framework. Given that 90% of CAM services comprise of
medicinal plants and 10% for animal medicine and spiritual healings, these findings may not be accurate. Moreover, most of these studies were descriptive and those that attempted modeling were not founded on economic theory. They used multivariate logistic approach and OLS model to examine socio-economic factors affecting CAM consumption decisions. The multivariate logistic model could not determine joint conventional and herbal consumption decisions while OLS did not cater for endogeneity problems. Therefore, based on economic theory, it is important that all the variables be re-estimated by Univariate logit for herbal medicine consumption only. Bivariate probit approach used to determine the demand drivers for herbal medicine, conventional medicine, and joint conventional and herbal medicine consumption. The estimation was by MLE.

Studies on MPs economic value found divergent results. This is because they relate to domestic medicinal plant use. Their use is either economic or non-economic therefore challenging economic valuation. More so the market data is not well developed for most countries except for China and India. Therefore it is important that direct use and indirect use values for medicinal plants be captured by WTP approach. Urbanization and Culture variables were found to drive wild exploitation of medicinal plants. Culture based on ethno-medicine was instrumental in sustainable medicinal plant consumption. Therefore it is important to establish the relationship of herbal medicine consumption and their availability.
CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter covers the research design, theoretical framework and the various empirical models used to answer the research questions. Also, presented is the working hypothesis, variable description, sampling technique, data collection and analysis.

3.2 Research Design

The purpose of this study was to analyze the determinants of medicinal plants consumption; to establish the effect of medicinal plant consumption on conventional medicine consumption and; to estimate the economic value of medicinal plants. It also established the effect of medicinal plants consumption on their availability.

This study adopted quasi experimental research design. Cross-sectional data was collected between June and August’ 2014 from a household survey of adjacent-households to Kakamega forest in Kakamega County. Questionnaires were used to collect data from a household sample of 384. Survey questions on MPs value was of the discrete contingent valuation type-that is, the questions were hypothetical to respondents to induce trade off in MPs for money. To provide equal opportunity of response to all households, a random sampling method was used. The variables used in analyzing the determinants of consumption for MPs of
Kakamega forest and the joint consumption of MPs and conventional medicine were household characteristics (age, gender, education, household size, incomes); herbal price; pharmaceutical price; distance to the nearest medical clinic/hospital; access to herbal information; distance travelled out of Kakamega county to access herbal and dummy variables for health insurance; hospital/doctors recommendations; disease severity; and geographical location. The data collected was analyzed using Random Utility Model (RUM) after undergoing cross-sectional property tests. WTP approach was used to estimate the herbal economic value and qualitative analysis for effect of MPs of Kakamega forest use on MPs availability.

3.3 Determinants of Medicinal Plant Consumption

3.3.1 Theoretical Framework for Determinants of Medicinal Plants Consumption

Utility maximizing theory was the adopted framework for analyzing the determinants of medicinal plants consumption. The choice between pharmaceuticals and MPs are essentially problems of allocation. Most literature such as Mwabu, Ainsworth and Nyamete (1993); WHO (2003); Morgan (2005); and Robinson (2006) demonstrate that pharmaceuticals is out of reach for many in developing countries, including Kenya. Supposing a consumer has a bundle of medicines \( X = (X_1, X_2) \) where \( X_1 \) is conventional medicine and \( X_2 \) is herbal medicine, from which to make his/her choice, the consumer will choose a utility maximizing combination of medicines that satisfy the budget constraint.
The consumers’ problem is defined as follows:

\[ \text{Max} U(X) \]

Subject to \( PX \leq M \); \( x \geq 0 \) \hspace{1cm} 3.1

Where, \( M \) is the fixed amount of money income available to a consumer. \( P = (P_1, ..., P_k) \) is a vector of prices of medicines 1, ..., k. The constraint implies that the consumer cannot spend more than he has in terms of income. For utility maximization, the indifference curve must be convex, implying that both pharmaceuticals \((X_1)\) and medicinal plants \((X_2)\) must be substitutes. The budget line now becomes \( P_1X_1 + P_2X_2 = M \).

The consumers’ problem can be restated as:

\[ \text{Max} U(X_1, X_2) \]

Subject to \( P_1X_1 + P_2X_2 = M \) \hspace{1cm} 3.2

An indirect utility function is derived

\[ V(P, M) = \text{Max} U(X_1, X_2) + \lambda(M - P_1X_1 - P_2X_2) \] \hspace{1cm} 3.3

It is the maximum utility achievable at given prices and income. The choice function \( X(P,M) \) also known as Marshallian demand or consumer demand function shows how much of each medicine the consumer demands at given level of prices and income. The utility maximization theory will only behave well in a case of convex indifference curves. The result of optimization will always be a local maximum.
3.3.2 Empirical Model for Determinants of Medicinal Plants Consumption

Assuming a unitary household model suggested by Strauss, Mwabu and Beegle (2000), Equation 3.4 is the random utility function, where \( x_i \) is the vector of independent variables, \( \beta \) parameter vector to be estimated and \( \varepsilon_i \) is the random term associated with the \( i^{th} \) observation.

\[
U_i = x_i \beta + \varepsilon_i \tag{3.4}
\]

Let ‘i’ stand for household ‘i’ choice of herbal medicine use ‘h’ or choice of modern medicine ‘m’. Where \( h = 1, \ m = 2 \). Category ‘h’ is chosen if \( U_i^* \) is higher than conventional medicine, that is:

\[
U_i = h; \text{ If } U_i^* = \begin{cases} h & \text{if } U_i^* = \text{Max}(U_i, U_2^*) \\ 0 & \text{otherwise} \end{cases} \tag{3.5}
\]

The probability that household ‘i’ chooses herbal consumption ‘h’ equals to the probability that the utility derived from using ‘h’ is greater than modern medicine consumption. Therefore the utility function for household ‘i’ choosing ‘h’ is as follows:

\[
\Pr(U_i = h|m) = \Pr(U_h^* > U_1^*, U_h > U_2^*)
= \Pr((\varepsilon_h - \varepsilon_1) > m(\beta_h - \beta_h), (\varepsilon_h - \varepsilon_2) > m(\beta_2 - \beta_h)) \tag{3.6}
\]

From this probability, only the differences between the \( U_i^* = h \) are identified and hence a reference category has to be assigned. Since the distribution of \( U_i = h \) depends on the distribution of \( \varepsilon_i^* = h \), different assumptions lead to
different preference models. Gumbel distribution is assumed for $\varepsilon_i^* = h$ such that the probability of choosing a decision has a logit function. The logit regression model is used to explain independent choice decision. The following dependent variables are observable in the logit estimation process: $U_i = 1$: MP>0, MM≤0 (household consume medicinal plants) and; $U_i = 2$: MP≤0, MM>0 (household consume modern medicine). Where ‘MP’ is medicinal plants and ‘MM’ is modern medicine. The equation that was estimated is given by

$$\ln \left( \frac{P}{1-P} \right) = x_i \beta_{MP} + \varepsilon_{iMP}$$

3.7

Where $P$ is 1 if medicinal plants are chosen; zero otherwise. $x_i$ are the exogenous variables. $\beta$ are the coefficients of the exogenous variables.

The coefficients of the logit model cannot be interpreted directly. They are transformed into marginal effects, interpreted as the change in predicted probability associated with the changes in the exogenous variables. Following Maddala (1992), the marginal effects were computed as:

$$\frac{\partial P_i}{\partial X_{ij}} = \beta_j P_i (1 - P_i)$$

3.8
3.4 Effect of Medicinal Plants Consumption on Modern Medicine Consumption

3.4.1 Theoretical Framework for Effect of Medicinal Plants Consumption on Modern Medicine Consumption

Household production framework provide a basis upon which this objective is rooted and also the basis for the development of the model and various variables to be contained in the model. Households are confronted with the choice of complementary medicine and MPs in maximizing their health outcome. The household production technology approach provides for a relationship between demand for complementary medicine and the value of medicinal plants. In the household production framework, utility is a function of the level of final service flows from complementary medicine and medicinal plants as shown

\[ U = U(Z) = U(z_1, ..., z_j, ..., z_m) \]  

Where, \( Z \) is health outcome produced according to a technology common to all households. \( Z_j \) is denoted as household \( j \)th health outcome. Formally

\[ Z_j = Z_j(X_1, X_2) \text{ For } j = 1, ..., M \]  

Where \( X_1 \) represents a vector of complementary medicine available at given prices \( P_{x1} \) and \( X_2 \) represents a vector of medicinal plants. Therefore, the individual choice problem is stated in 3.1 and 3.2. However, since there exist other constraints such as time and knowledge that affect the consumption of medicinal plants. This problem can be solved by a two step procedure. Cost minimization of producing \( Z_j \) is derived by combining complementary medicines
and medicinal plants. This determines the implicit prices of final services $P_z$. Unlike market prices, they are not parametric to individual unless marginal costs are a constraint. Second step is to maximize (3.1) subject to budget constraint

$$C(Z) = C(X_1, P, X_2) \leq M.$$ 

The consumers’ problem is shown as

$$\text{Max} U(X_1, X_2)$$

Such that $C(Z) = C(X_1, P, X_2) \leq M$ \hspace{1cm} 3.11

The solution to equation 3.11 is a set of derived market goods demand:

$$X_1 = X_1(P, X_2, M).$$

These demand functions will reflect on both the role of $Q$ in household production technology (3.2) and the preferences over the final service flows. Thus a technical production relationship between medicinal plants and complementary medicine can be expressed in terms of the marginal rate of substitution of $X_1$ for $X_2$ ($MRS_{X_1,X_2}$). However for utility functions that are strongly separable (i.e. the possible effect of partitioning the goods entering into the utility function into subsets), there exist no interaction between conventional medicine and medicinal plants given that $X_2$ is the single argument in one of the subsets. It is therefore impossible to estimate the value of $X_2$ from market data.

For example; letting $X$ and $Y$ be subsets of complementary medicine. Strong separability utility function is formally:

$$U = U(U_1(X) + U_2(Y) + U_3(X_2))$$ \hspace{1cm} 3.12
Therefore strong separability means MRS between X and Y is independent of $X_2$. In principle it’s not possible to estimate the demand for $X_2$ from observable market data on transactions in X or Y.

### 3.4.2 Model Specification for Effect of Medicinal Plants Consumption on Modern Medicine Consumption

Empirical literature is mixed up on herbal medicine consumption decision with regard to herbal medicine prices and household incomes. Most studies indicate that relative high conventional medicine prices to low herbal prices led to probable rise in herbal medicine consumption. However, Mwabu, Ainsworth and Nyamete (1993) revealed that herbal medicine consumption even occurred in instances of high herbal medicine prices and low conventional medicine prices. On the other hand, low household income is attributed to increasing probability of herbal medicine consumption, but the studies by Goldstein et al. (2007); Cocks and Dold (2000) and Eisenberg et al. (1999) indicate that high income groups consume MPs. Moreover, the MPs consumption is amongst the hospitalized against the general concern of their safety and efficacy and the ‘witchcraft’ perception (Goldstein et al., 2007). Consumption of herbal medicine is probably dependent on conventional medicine consumption. Although they depict an imperfect market, their consumption can be dependent or independent of household production. Implying the analysis can be undertaken through non-separability or strong separability utility models (Freeman, 1993). Therefore the non-separability utility model will be adopted. Theoretical establishment will be
utility maximization derived from household output subject to the constraints of money income, prices amongst other earlier mentioned variables. The household output will depend on the prices of MPs and conventional medicine. Also that utility derived from MPs is greater than utility derived from conventional medicine.

Goldstein et al. (2007) and Mafimisebi et al. (2012) studies enriched the study. The study hypothesize the demand drivers for herbal medicine \((U_h)\) to be dependent on herbal medicine supply \((H_s)\), household characteristics \((H_c)\), price of herbal medicine \((P_{hm})\), price of conventional medicine \((P_{cm})\), distance to medical clinic/hospital \((D_{mc})\), perceived severity of the disease \((T_{ds})\), health insurance cover \((H_{hs})\), Social capital \((S_{in})\), Recommendation to consume herbal medicine by hospital/doctors \((H_{rm})\), geographical location \((L_g)\) and random factor \((\mu)\). The description and measures of the variables are contained in section 3.7.1.

The theoretical model is therefore given as:

\[
MP_h = f (MM_h, H_s, H_c, P_{hm}, P_{cm}, D_{mc}, T_{ds}, H_{is}, S_{in}, H_{rm}, L_g, \mu_{MP})
\]

\[
MM_h = f (MP_h, H_s, H_c, P_{hm}, P_{cm}, D_{mc}, T_{ds}, H_{is}, S_{in}, H_{rm}, L_g, \mu_{MM})
\]

Equation 3.13 are seemingly unrelated equations (SUR) showing the binary variables estimated in a single household model.
3.4.3 Empirical Model for Effect of Medicinal Plants Consumption on Modern Medicine Consumption

Following Goldstein et al. (2007) and Mafimisebi et al. (2012), the study adopts bivariate probit model to estimate the effect of herbal medicine consumption on modern medicine consumption. The bivariate probit model is

\[
MP_i^* = \gamma_i MM_i + \alpha_i X_i + \epsilon_{MP} MP_i = 1 \begin{cases} if & MP_i^* > 0 \\ 0 & otherwise \end{cases}
\]

\[
MM_i^* = \gamma_2 MP_i + \alpha_2 X_i + \epsilon_{MM} MM_i = 1 \begin{cases} if & MM_i^* > 0 \\ 0 & otherwise \end{cases}
\]

\[
\{\epsilon_{MP}, \epsilon_{MM}\} \sim BVN\left(\{0,0\}, \sigma_{MP}^2, \sigma_{MM}^2, \rho\right)
\]

The reduced form of the equation 3.14 to be estimated is given as

\[
I = \gamma \chi + \epsilon
\]

\[
\{\epsilon_{MP}, \epsilon_{MM}\} \sim BVN\left(\{0,0\}, \sigma_{MP}^2, \sigma_{MM}^2, \rho\right)
\]

Where \(I\) is unobservable innate measurable index of medicinal plant consumption and modern medicine consumption respectively; proxied by cumulative probability distribution of a normal distribution. \(\rho\) was the correlation measure of the extent to which the two errors covary. The correlation coefficient between the errors measures the extent of correlation between the two decisions. Where \(\sigma_i^2\) is the variance; MP, MM, are observed bivariate variables indicating household consumption status of MPs and MM; X are vectors of explanatory variables. The two equations were estimated by bivariate normal
probit if endogeneity bias does not exist i.e. if $\rho$ turn out to be significant (Green, 2002).

The reduced form parameters of equation 3.13 are estimated using maximum likelihood based on logistic distribution of ‘ε’. Since the probability of being in the two states of consuming medicinal plants and consuming modern medicine or both must add to unity, the logit involves estimating equation 3.15.

The bivariate normal (BVN) cumulative distribution function (Green, 2002) is given as follows:

$$
pr(MP = 1, MM = 1) = BVN\left(\alpha'_1X_1 + \gamma_1, \alpha'_2X_2 + \gamma_2, \rho\right)
$$

$$
pr(MP = 0, MM = 1) = BVN\left(-\alpha'_1X_1 - \gamma_1, \alpha'_2X_2, \rho\right)
$$

$$
pr(MP = 1, MM = 0) = BVN\left(\alpha'_1X_1, \alpha'_2, -\rho\right)
$$

$$
pr(MP = 0, MM = 0) = BVN\left(-\alpha'_1X_1, -\alpha'_2X_2, \rho\right)
$$

The log likelihood function for the bivariate model is calculated as follows

$$
\ln L = \sum_i \ln pr[MP, MM] \text{Where, } i=0, 1.
$$

The focus for this estimation was the rho which was used to establish the interdependence between herbal medicine and conventional medicine consumption.

The hypothesis test was as follows:

$H_0: \rho = 0$ (Accept that both consumption decisions are independent)

$H_1: \rho \neq 0$ (Reject that both consumption decisions are independent)
Section 3.7.1 contains the summary and variable measure to be fitted in the bivariate probit model for estimation.

### 3.5 Economic Value of Medicinal Plants in Kakamega Forest

#### 3.5.1 Theoretical Framework for Economic Value of Medicinal Plants in Kakamega Forest

Total economic valuation (TEV) approach was adopted to estimate the economic value of medicinal plants. Valuation based on observable market behavior may not give the true economic value of an environmental/natural resource commodity (Flores, 2003). And an appropriate estimate for economic value must therefore include the non-market, latent or political behavior towards an environmental/natural resource commodity. Therefore the Total Economic Value is the sum of direct use values (include consumption and production), indirect use values (include functional values such as erosion prevention) and non use values (such as existence values and option values).

This is stated in a functional form as follows:

\[
\sum_{i=1}^{N} TEV = \sum_{i=1}^{N} DUV + \sum_{i=1}^{N} IUV + \sum_{i=1}^{N} NUV
\]

Where DUV is direct use value, IUV is indirect use value, NUV is non-use values and \(i=1...N\) households.

Medicinal plants have two basic uses, commercial use by prescription or over-the-counter sales and traditional medicine use which may or may not attract a market
price. Both uses have an economic value. Non-market values for medicinal plants may be estimated by the Willingness-To-Pay (WTP) under defined conditions (Hussein, 2004).

3.5.2 Empirical Model for Economic Valuation of Medicinal Plants

In this study, consumption values, aesthetic values and cultivation values are reflections of direct use values, indirect use value for functional use and non-use value for existence use respectively. The respondents specify the herbal medicines consumed and at the same time give estimated three month WTP expenditure on each use options. Because of the imperfect market for medicinal plants, the WTP approach was adopted. Such that the TEV function is;

\[
\sum_{i=1}^{N} WTP_{for\,Kakamega\,Forest\,Herbs} = \sum_{i=1}^{N} WTP_{for\,Consumption} + \sum_{i=1}^{N} WTP_{for\,Aesthetics} + \sum_{i=1}^{N} WTP_{for\,Cultivation}
\]

3.19

Therefore, the model estimated was as follows:

\[
\frac{\sum_{i=1}^{N} WTP_{for\,Kakamega\,Forest\,Herbs}}{N} = \frac{\sum_{i=1}^{N} WTP_{for\,Consumption}}{N} + \frac{\sum_{i=1}^{N} WTP_{for\,Aesthetics}}{N} + \frac{\sum_{i=1}^{N} WTP_{for\,Cultivation}}{N}
\]

3.20

But this was average three month expenditure per household. The annual expenditure on Kakamega Forest herbal medicine would therefore be:
\[ TEV_{for\text{KakamegaForestHerbs}} = \left[ \frac{\sum_{i=1}^{N} WTP_{for\text{KakamegaForestHerbs}}}{N} \right] \times 4\text{quarters} \times N \]

Section 3.7.2 shows the definition and measurement of the variables fitted in equation 3.20. The results are interpreted as annual mean TEV expenditure for Kakamega forest herbs.

3.6 Relationship of Medicinal Plant Consumption to Medicinal Plants

Availability in Kakamega Forest

3.6.1 Theoretical Framework for Relationship of Medicinal Plant Consumption to Medicinal Plants Availability in Kakamega Forest

This objective is founded on common property natural resources (CPNRs) theory. That is medicinal plants are public goods. Lack of well defined rights to these biological resources may lead to depletion/degradation. The use of a biological resource for consumption and production is simply the economic value of biodiversity. The economic significance of biodiversity refers to its contribution to human welfare. To model the relationship of medicinal plant consumption to medicinal plant availability requires growth function, effort function and harvesting function of medicinal plants for Kakamega forest. Meaning market data is necessary to determine the relationship of herbal medicine consumption to
medicinal plants availability. However, the market data is not available and the only informative approach to the analysis is qualitative.

3.6.2 Analysis for Relationship of Medicinal Plant Consumption to Medicinal Plants Availability in Kakamega Forest

Qualitative analysis was based on perceptions of respondents. Responses were sought on Information on herbal knowledge, forest access under new forest management, herbs sourced out of Kakamega forest, herbs not effective as before, difficulty in finding herbs, reasons to difficulty in finding herbs, herbal sources, trends in forest cover and impact of forest cover decline was qualitatively analyzed through descriptive statistics to answer the question of medicinal plant use and availability. The meaning and measurement of these themes are in section 3.7.3. This analysis provided an insight on medicinal plant use on biodegradation and depletion. Therefore it was important in setting the ground for future rigorous analysis.

3.7 Definition and Measurement of Variables

3.7.1 Definition, Measurement and Expectation of Variables for Univariate Logit and Bivariate Probit Models

The following variables were used to estimate the Univarite Logit and Bivariate Probit models for objective one and two. The variables were defined and measured as follows:
Herbal medicine consumption: the choice to consume medicinal plants. 1 if consumes herbal medicine; 0 otherwise.

Pharmaceutical Consumption: the choice to consume conventional medicine. 1 if consumes pharmaceutical; 0 otherwise.

Gender: this is sex. Dummy variable: 1 if male; 0 otherwise. It was expected that relative to males, females have a high probability of herbal consumption. This was supported by Dold et al., (2002), Kennedy (2005), Goldstein et al., (2007) and Birhan et al., (2011). Gender was expected to have a positive effect on the probability of joint herbal and conventional medicine consumption.

Age of household head: chronological age of the household head, expressed in years. Increase in age was expected to increase the probability of herbal consumption. This was supported by Mafimisebi et al., (2012). Age was expected to have positive effect on the probability of joint herbal and conventional medicine consumption.

Household head formal education: this is the level of formal education for the household head, expressed as no-schooling, primary schooling, secondary schooling, college and university. Dummy variable: 1 if no schooling; 0 otherwise; 1 if primary; 0 otherwise; 1 if secondary; 0 otherwise; 1 if college; 0 otherwise; 1 if university; 0 otherwise. It was expected that the higher the education level
attained, the lower the probability of herbal consumption. This was supported by Mafimisebi et al., (2012). Education level was expected to have negative effect on the probability of joint herbal and conventional medicine consumption.

*Size of Household:* this is adults and children in a household by August 2014, expressed as number of persons. It was expected that as the household size increase, the probability of herbal consumption increase. This was confirmed by Mafimisebi et al., (2012), Mander and Le Bretton (2005) and Birhan et al., (2011). Household size was expected to have negative effect on the probability of joint herbal and conventional medicine consumption.

*Household income:* payment from agricultural and non agricultural employment in KShs per month. It was expected that an increase in income reduces the probability of herbal consumption. This was confirmed by Mafimisebi et al., (2012). Household income was expected to have negative effect on the probability of joint herbal and conventional medicine consumption.

*Price of herbal medicines:* proxy expenditure on herbals, expressed as three month average expenditure in KShs. It was expected that a rise in herbal prices reduces the probability of herbal consumption. This is supported by Orwa (2002), Mander (2004) and Kisangau and Kokwaro (2004). Herbal price was expected to have negative effect on the probability of joint herbal and conventional medicine consumption.
Price of conventional medicine: proxy by expenditure on conventional medicine, expressed as three month average expenditure in KShs. It was expected that a rise in conventional medicine prices increases the probability of herbal consumption. This is supported by Orwa (2002), Mander (2004), Kisangau and Kokwaro (2004) and Birhan et al., (2011). Conventional medicine price was expected to have negative effect on the probability of joint herbal and conventional medicine consumption.

Medical Insurance cover: possession of health insurance facility. Dummy variable: 0 if household is not a holder; 1 otherwise. Relative to those without health insurance, it was expected that health insurance holdership reduces the probability of herbal consumption. Medical insurance cover was expected to have negative effect on the probability of joint herbal and conventional medicine consumption.

Distance to the nearest medical clinic/hospital: how far a household lies from a health facility expressed in kilometers. It was expected that an increase in distance to the nearest medical clinic/hospital health insurance increases the probability of herbal consumption. This is supported by Mafimisebi et al., (2012). Distance to the nearest medical clinic/hospital was expected to have positive effect on the probability of joint herbal and conventional medicine consumption. This was supported by Matheka et al., (2013).
Social capital: social networks of a household, measured by number of social
groups a household participates in. It was expected that an increase in social
capital increases the probability of herbal consumption. This was supported by
Mafimisebi et al., (2012). Social capital was expected to have positive effect on
the probability of joint herbal and conventional medicine consumption.

Recommendation to consume herbal medicine by Hospital/Doctor: proposal to
consume herbal by trained college/university doctor. Dummy variable: 0 if not
recommended; 1 otherwise. It was expected that chance of recommending herbal
medicine by hospital/doctor increases the probability of herbal consumption. This
was supported by Goldstein et al., (2012). Recommendation to consume herbal
medicine by hospital/doctor was expected to have positive effect on the
probability of joint herbal and conventional medicine consumption.

Perceived Severity of the disease: nature of illness. Dummy variable: 0 if not
severe 1 otherwise. It was expected that probability of an increase in perceived
severity of the disease increases the probability of herbal consumption. This was
supported by Birhan et al., (2011). Perceived Severity of the disease was expected
to have positive effect on the probability of joint herbal and conventional
medicine consumption. This is confirmed by Githinji (2014) and Ondicho et al.,
Distance to herbal source: collection of herbs outside Kakamega forest expressed in kilometers. It was expected that probability of an increase in Distance to herbal source decreases the probability of herbal consumption. Distance to herbal source was expected to have positive effect on the probability of joint herbal and conventional medicine consumption.

Location: geographical location. Dummy variable: 1 if rural; 0 otherwise. Relative to urban residents, it was expected that the probability of being rural resident increase the probability of herbal consumption. This was supported by Mafimisebi et al., (2012). Location was expected to have positive effect on the probability of joint herbal and conventional medicine consumption. This is confirmed by Githinji (2014)

3.7.2 Definition and Measurement of Variables for Economic Value Model
The variables for total economic value for Kakamega forest medicinal plants were as follows:

Total Economic Value for Kakamega Forest Herbs: comprised of direct use value and indirect use value for the herbs, captured as WTP annual average expenditure in KShs.

WTP for Kakamega Forest Herbs: comprised of direct use value and indirect use value for the herbs, measured as total willingness to pay on a three month average expenditure in KShs.
WTP for Consumption of Kakamega Forest Herbs: this was the direct use value captured the willingness to pay on a three month average expenditure in KShs.

WTP for Aesthetics of Kakamega Forest Herbs: this was the indirect use value that captured the functional use value through purchase of MPs seedlings for beautification, captured in the willingness to pay on a three month average expenditure in KShs.

WTP for Cultivation of Kakamega Forest Herbs: this was the indirect use value that captured the existence value through planting of MPs for their availability, captured in the willingness to pay on a three month average expenditure, expressed as an average monthly expenditure in KShs.

3.7.3 Definition and Measurement of Variables for Relationship of Herbal Consumption and Herbal Availability in Kakamega Forest

The common themes used to evaluate medicinal plants use and MPs availability was as follows:

Medicinal Plants of Kakamega Forest: this was an inventory of MPs, captured by the MPs local names used by household heads.

Herbal Knowledge: this was the awareness and use of herbal medicine. Binary response coded: 1 Yes; 0 No.
Forest Access under new management: ability to enter the forest following policy change on forest entry, Coded: 1 Improved; 2 remained same; 3 Worsened.

Herbs sourced out of Kakamega forest: herbs not in the Kakamega forest accessed elsewhere. Binary response coded: 1 Yes; 0 No.

Herbs not Effective as before: current ability of specific herbs to treat specific ailments as before. Binary response coded: 1 Yes; 0 No.

Herbs difficult to find: availability of herbs which were early is to access, binary response coded: 1 Yes; 0 No.

Reasons for difficulty in finding herbs: why early available herbs are not easily found. Coded: 1 Climate change; 2 Over harvesting; 3 Forest land to agriculture; 4 Climate change and over harvesting; 5 Climate change and land for agriculture; 6: Over harvesting and land for agriculture.

Herbal sources: where herbs are accessed. Coded: 1 Forest; 2 Pharmacist; 3 Herbalist; 4 Forest and Pharmacist; 5 Forest and Herbalist; 6 Other unspecified source.

Trends in Forest Cover: assessing the vegetation cover. Coded: 1 Declined; 2 Increased; 3 Not changed.
Impact of Forest decline: assessing the effect of vegetation cover reduction on forest utilities. Coded: 1 Lack of fuel wood; 2 Lack of herbal medicine; 3 Lack of timber; Lack of other forest utilities.

3.8 Study Area

Kakamega forest is situated in Kakamega County of Kenya. The Forest is generally considered the Eastern-most remnant of the lowland Guineo-Congolean rainforest of Central Africa (KIFCON 1994; MFP 2002). Moreover, it is the only remaining rainforest in Kenya. Kakamega forest choice was informed by the high population resident communities (Mitchell, 2004). Blackett (1994) recognizes the forest to have the highest population density in rural areas of the world averaging 600 people per Km$^2$. The forest encloses indigenous forest and cover about 230 square kilometers. It is a host to about 160 tree and shrub species including a number of endemic plant species, mostly ferns and orchids. Many medicinal plants such as ‘mama mutere’ in local dialect have become an endangered species over the years. It is believed to have a multitude of medicinal qualities to help cure ailments such as prostate cancer and stomach aches. About 70 per cent of herbs in Western Kenya occur inside the forest and 30 per cent around the edge and immediate surrounding (Otieno et al., 2012). The Luhya community is the local inhabitants and relies on the forest for most of their needs. About 98 per cent of forest adjacent households use the forest to supply at least one essential household need. Most prevalent activity is grazing and fuel wood collection. The forest is protected by Forest department and Kenya Wildlife Service. Despite
being a protected forest, the forest has continued to be damaged and degraded. In attempt to conserve it, various local and international agencies such as ICIPE and ICRAF have in collaboration with the adjacent households initiated income generating activities such as supporting medicinal plant cultivation.

Traditionally, Kakamega County has had some of the worst health indicators such as higher fertility rates and higher incidence of HIV/AIDS. Fertility rate is 6.35 and is above the national average of 5.4 (KDHS, 2006). According to Blackett 1994 the region is one of the most densely-populated rural areas in the world, and pressure on forest resources is considerable. The average population density in the forest adjacent sub-locations is 600 people per Km² with higher figures to the South and West of the forest and in areas adjoining Kakamega municipality (Mitchell, 2004). The average household size is in excess of 10 (KDHS, 2006). The mean farm size of households living around Kakamega forest is 1.9 hectares, of which 1.5 hectares is potentially cultivable land.

3.9 Sampling Technique and Sample Size Determination

Simple random sampling technique was adopted for the study. The household was the sampling unit and the sampling frame by Biodiversity Monitoring and Transect Analysis East Africa (BIOTA-EA) project was adopted. The household head names in the BIOTA-EA project were simple randomly sampled by aid of research randomizer software. Village elders helped identify the sampled household heads for interview purpose.
According to the Kenya population census report of 2009, Kakamega county population is 1,660,651 persons with a total of 398,709 households. Using Krejcie and Morgan (1970) sample size table determination, a population size ranging between 250,000 - 500,000 at 95 per cent confidence level and a sample error of 5 per cent, the desirable sample size is 384. Therefore the sample size used in the study was 384.

### 3.10 Data Type, Collection and Analysis

The study used primary data collected at a household level focusing on MPs consumption and incomes; and equally identifying policy agenda for MPs consumption. The household survey was carried out among Kakamega forest communities between June-August, 2014 by the researcher.

To collect data, questionnaire to household heads was designed in alignment to systematic literature review. It was composed of the following eight parts: introduction; general awareness of medicinal plants consumption; individual status of medicinal plants consumption; individual assessment of medicinal plants consumption; benefits and costs from forest resources; information on household access to healthcare services; valuation of alternative medicine; and household roster-members of household education and employment. The robustness of the questionnaire was achieved through pilot survey of 20 households not statistically determined. Corrections were then made for the instruments internal consistency.
The research assistants used had university level of education and understood the local language. They were able to translate the questions from English to Luhya language for purpose of illiterate respondents. All the respondents were introduced to the purpose of the study and assured of their confidentiality. The questionnaires were then administered through a face to face interview to help clarify some questions.

The data was cleaned by removing outliers and then coded for analysis. Univariate logit approach was used to analyze the demand drivers for herbal medicine while bivariate approach and willingness-to-pay approach was used to analyze the joint consumption of conventional and herbal medicine; and to estimate economic value of medicinal plants respectively. STATA statistical packages aided the study analysis.

3.11 Ethical Consideration

National commission for Science, Technology and Innovation (NACOSTI) and Kenyatta University Graduate School granted the authority to carry out the study. All participants were assured of their confidentiality.
CHAPTER FOUR
EMPIRICAL FINDINGS

4.1 Introduction

This chapter presents diagnostic tests, descriptive statistics, the raw results and discussion of the raw results. The chapter is divided into six sections; section 4.2 presents the diagnostic tests, section 4.3 descriptive statistics, section 4.4 analyze the determinants of medicinal plants consumption, section 4.5 analyze joint effect of medicinal plant consumption on conventional medicine consumption, section 4.6 estimate the economic value of medicinal plants, and section 4.7 establish the effect of medicinal plants consumption on their availability.

4.2 Diagnostic Tests

Two variables are said to be correlated if their correlation coefficient is greater than 0.5. Primary schooling and Secondary schooling were correlated with a coefficient of 0.5010. However, no variables exceeded 0.5010 (see Appendix 2 Table A1). Hence correlation coefficient matrix did not suffer serious multicollinearity. A robust sample estimate was made for the models therefore solving the problem of heteroscedasticity. From Table 4.4, the p-value of 0.0002 for the test of ρ = 0 indicated no endogeneity problem. Figure A1 in Appendix 2, shows that the data fitted in the model was normally distributed. Since the sample mean of independent draws of a random variable gives an unbiased estimate of the variable’s true population mean of 0.0337, this distribution is normal. To confirm the model consistency, the Hosmer-Lemeshow approach was used. The
post estimation results (Appendix 2 Table A2) indicate that the sum observation that is Obs_1 and Obs_0 is equal to the sum of experiments that is Exp_1 and Exp_0 reflected in the total column. The results, therefore, confirm that the model is consistent and of a good fit.

4.3 Descriptive Statistics

Table 4.1 shows the descriptive statistics for categorical and continuous variables examined in the study. Categorical variables examined included: herbal use by households, gender of household heads, level of education of the household head, possession of health insurance, doctor’s advice on whether to use herbal medicine or not, severity of the ailment and residence of the household whether urban or rural. On these variables, the following were confirmed: 72% of the households had used herbal medicine in the last three months preceding the survey; 84% of the household heads were male; 5% of the heads had no education, 29% had primary school education, 41% had secondary school education, 16% had college level education while 9% had university education; 10% of household heads had health insurance; 4% of households sought herbal treatment on the advice of the doctor; 41% of the households had suffered severe ailments; and 80% of the households were living in rural settings. The continuous variables examined included; Age of household head, size of the household, household monthly income, price of herbal medicine, price of conventional medicine, number of social groups a household head is a member, distance to clinic/hospital, distance to herbal source. On these variables, the following were confirmed: the average
The age of household heads was 48 years, the average household size was 6 members, the average monthly income was KShs 15889.69, average herbal expenditure in the last three months preceding the survey was KShs 160.22, average conventional medicine expenditure in the last three months preceding the survey was KShs 1045.31, average number of social groups was 3, average distance to clinic/hospital was 1.6Km, average distance travelled to herbal medicine source in the last three months preceding the survey was 49Km.
Table 4.1: Descriptive Statistics of the Variables for Household Consumption of Medicinal Plants of Kakamega Forest

<table>
<thead>
<tr>
<th>Discrete Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbal Use</td>
<td>0.72</td>
<td>0.45</td>
</tr>
<tr>
<td>Gender</td>
<td>0.84</td>
<td>0.37</td>
</tr>
<tr>
<td>Education</td>
<td>0.29</td>
<td>0.45</td>
</tr>
<tr>
<td>1 if secondary</td>
<td>0.41</td>
<td>0.49</td>
</tr>
<tr>
<td>1 if college</td>
<td>0.16</td>
<td>0.37</td>
</tr>
<tr>
<td>1 if university</td>
<td>0.09</td>
<td>0.29</td>
</tr>
<tr>
<td>Medical Insurance</td>
<td>0.10</td>
<td>0.30</td>
</tr>
<tr>
<td>1 if doctors recommended herbal use</td>
<td>0.04</td>
<td>0.19</td>
</tr>
<tr>
<td>Perceived disease severity</td>
<td>0.41</td>
<td>0.49</td>
</tr>
<tr>
<td>Location</td>
<td>0.80</td>
<td>0.40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Continuous Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of household head</td>
<td>48</td>
<td>12</td>
<td>22</td>
<td>82</td>
</tr>
<tr>
<td>Size of Household</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Household Income</td>
<td>15889.69</td>
<td>12220.28</td>
<td>1000</td>
<td>6000</td>
</tr>
<tr>
<td>Price of herbal medicine</td>
<td>160.22</td>
<td>280.27</td>
<td>0</td>
<td>1500</td>
</tr>
<tr>
<td>Price of conventional medicine</td>
<td>1045.31</td>
<td>1576.92</td>
<td>0</td>
<td>1500</td>
</tr>
<tr>
<td>Social Capital</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Distance to clinic/Hospital</td>
<td>1.6</td>
<td>1.5</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Distance to herbal medicine source</td>
<td>49</td>
<td>83</td>
<td>30</td>
<td>116</td>
</tr>
</tbody>
</table>

| Number of Observations                | 384      |

Source: Author’s Computation
4.4 Analysis of the determinants of medicinal plants consumption

Table 4.2 shows results of the determinants of medicinal plants in Logit Model.

Table 4.2: Determinants of Medicinal Plants Consumption in Univariate Logit Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male household heads</td>
<td>0.7577**</td>
<td>0.037</td>
</tr>
<tr>
<td></td>
<td>(2.08)</td>
<td></td>
</tr>
<tr>
<td>Age of household head</td>
<td>-0.0827</td>
<td>0.287</td>
</tr>
<tr>
<td></td>
<td>(-1.06)</td>
<td></td>
</tr>
<tr>
<td>Age of household head squared</td>
<td>0.0054</td>
<td>0.472</td>
</tr>
<tr>
<td></td>
<td>(0.72)</td>
<td></td>
</tr>
<tr>
<td>Primary school level of education</td>
<td>-0.5574</td>
<td>0.437</td>
</tr>
<tr>
<td></td>
<td>(-0.78)</td>
<td></td>
</tr>
<tr>
<td>Secondary school level of education</td>
<td>-0.6485</td>
<td>0.346</td>
</tr>
<tr>
<td></td>
<td>(-0.94)</td>
<td></td>
</tr>
<tr>
<td>College level of education</td>
<td>-1.1793*</td>
<td>0.114</td>
</tr>
<tr>
<td></td>
<td>(-1.58)</td>
<td></td>
</tr>
<tr>
<td>University level of education</td>
<td>-1.9915**</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>(2.43)</td>
<td></td>
</tr>
<tr>
<td>Size of Household</td>
<td>0.0496</td>
<td>0.462</td>
</tr>
<tr>
<td></td>
<td>(0.74)</td>
<td></td>
</tr>
<tr>
<td>Household monthly income</td>
<td>-0.0000</td>
<td>0.052</td>
</tr>
<tr>
<td></td>
<td>(-1.94)</td>
<td></td>
</tr>
<tr>
<td>Price of Herbal Medicine</td>
<td>0.0018***</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>(2.79)</td>
<td></td>
</tr>
<tr>
<td>Price of conventional medicine</td>
<td>0.0001</td>
<td>0.426</td>
</tr>
<tr>
<td></td>
<td>(0.80)</td>
<td></td>
</tr>
<tr>
<td>Distance to nearest clinic/hospital</td>
<td>0.0808</td>
<td>0.416</td>
</tr>
<tr>
<td></td>
<td>(0.81)</td>
<td></td>
</tr>
<tr>
<td>Household with Medical Insurance</td>
<td>1.1918**</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>(2.18)</td>
<td></td>
</tr>
<tr>
<td>Insurance cover</td>
<td>0.0536</td>
<td>0.568</td>
</tr>
<tr>
<td></td>
<td>(0.57)</td>
<td></td>
</tr>
<tr>
<td>Herbal consumption recommendation by doctors</td>
<td>1.2473</td>
<td>0.249</td>
</tr>
<tr>
<td></td>
<td>(1.15)</td>
<td></td>
</tr>
<tr>
<td>Perceived severity of the disease</td>
<td>-0.1207</td>
<td>0.697</td>
</tr>
<tr>
<td></td>
<td>(-0.39)</td>
<td></td>
</tr>
<tr>
<td>Distance to herbal source</td>
<td>0.0015</td>
<td>0.446</td>
</tr>
<tr>
<td></td>
<td>(0.76)</td>
<td></td>
</tr>
<tr>
<td>Urban residence</td>
<td>-0.1242</td>
<td>0.746</td>
</tr>
<tr>
<td></td>
<td>(-0.32)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>3.3313</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.53)</td>
<td></td>
</tr>
</tbody>
</table>

Note: *, ** and *** mean significant at 10%, 5% and 1%, respectively; Z-scores are in parentheses.

Source: Author’s Computation
The average marginal effects, on which interpretation of results is based, are shown in Table 4.3 below.

Table 4.3: Marginal Effects for Determinants of Medicinal Plants Consumption

<table>
<thead>
<tr>
<th>Variable</th>
<th>Marginal effects</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male household heads</td>
<td>0.1430**</td>
<td>0.050</td>
</tr>
<tr>
<td>Age of household head</td>
<td>-0.0142</td>
<td>0.286</td>
</tr>
<tr>
<td>Primary school level of education</td>
<td>-0.0769</td>
<td>0.391</td>
</tr>
<tr>
<td>Secondary school level of education</td>
<td>-0.0917</td>
<td>0.277</td>
</tr>
<tr>
<td>College level of education</td>
<td>-0.1896*</td>
<td>0.066</td>
</tr>
<tr>
<td>University level of education</td>
<td>-0.3642****</td>
<td>0.006</td>
</tr>
<tr>
<td>Size of Household</td>
<td>0.0085</td>
<td>0.461</td>
</tr>
<tr>
<td>Household monthly Income</td>
<td>-0.0000**</td>
<td>0.049</td>
</tr>
<tr>
<td>Price of Herbal Medicine</td>
<td>0.0003***</td>
<td>0.004</td>
</tr>
<tr>
<td>Price of conventional medicine</td>
<td>0.0000</td>
<td>0.425</td>
</tr>
<tr>
<td>Distance to nearest clinic/hospital</td>
<td>0.0139</td>
<td>0.414</td>
</tr>
<tr>
<td>Household with Medical Insurance cover</td>
<td>0.1637***</td>
<td>0.004</td>
</tr>
<tr>
<td>Household heads with Social capital</td>
<td>0.0092</td>
<td>0.568</td>
</tr>
<tr>
<td>Herbal consumption recommendation by doctors</td>
<td>0.1631*</td>
<td>0.096</td>
</tr>
<tr>
<td>Perceived severity of the disease</td>
<td>-0.0208</td>
<td>0.698</td>
</tr>
<tr>
<td>Distance to herbal source</td>
<td>0.0003</td>
<td>0.445</td>
</tr>
<tr>
<td>Urban residence</td>
<td>-0.0210</td>
<td>0.743</td>
</tr>
</tbody>
</table>

**Predictive power**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct prediction</td>
<td>73.4%</td>
</tr>
<tr>
<td>False prediction</td>
<td>26.6%</td>
</tr>
</tbody>
</table>

*Note: *, ** and *** mean significant at 10%, 5% and 1%, respectively; Z-scores are in parentheses.*

Source: Author’s Computation
The findings of equation 3.7 after logistic regression were that gender, education, household income, price of herbal medicine, medical insurance cover, and herbal consumption recommendation by doctors/hospital influenced herbal medicine consumption.

Being male, relative to female, raises the likelihood of consuming herbal medicine by 14.3%. This finding contradicts Kennedy, 2005 and Goldstein et al., 2007 that female’s herbal medicine consumption rate was higher than males. However, the finding is plausible because herbs are mainly extracted from forests. It would be easier for the males to venture into the thick forests in search of the medicinal plants. Moreover, the key informants indicated that expertise in herbal remedies in the study area is dominated by men.

Relative to not having education at all, university level of education and college level of education reduces the likelihood of herbal medicine consumption by 36% and 19% respectively. University education had a strong influence on herbal consumption. Implying university graduates are less likely to consume herbal medicine compared to those with no schooling. This could probably be explained that the educated may be keen on information about herbal safety and efficacy. Eisenberg et al., 1999; Kennedy, 2005 and Goldstein et al., 2007 findings contradict the study finding. That is the higher the education level the higher the tendency to consume herbal medicine. However these studies were mainly on
herbal supplements which are the processed raw herbal medicines that appeal to the highly educated.

Household income was found to influence the choice of herbal consumption. Household income was found to have a negative relationship with the choice for herbal medicine consumption. An increase in household income would have a very small effect in reducing herbal consumption. This is in agreement with the Mafimisebi et al., 2012 study that covered raw herbal consumption. However the finding contradicts Eisenberg et al., 1999 and Goldstein et al., 2007 study that covered consumption of processed herbals. That is the high the household income the high the tendency to consume herbal medicine. This is likely because the household with an income raise are able to buy processed herbals with proven safety.

Notable, was the conflict between the findings of household income and price of herbal medicine that explained the nature of herbal medicine to be an inferior good.

The herbal price influenced herbal consumption. Price of herbal medicine was found to have a positive relationship with the choice of herbal medicine consumption. An increase in herbal price by one Kenya Shilling increases the choice of herbal consumption by 0.03 per cent. This result supports Mwabu, Ainsworth, Nyamete (1993) that substantial consumption of MPs existed even in
cases where MPs prices were high and conventional medicine prices were low. The increase in herbal price resulting to increase in herbal consumption would mean that high prices are indicative of their safety and efficacy.

Relative to not having medical insurance cover, health insurance has a probability of increasing choice of herbal medicine consumption by 16.3%. Given that insurance is a proxy to income, this will contradict our findings in income variable and therefore not consistent with medicinal plants consumption behavior.

Despite, Eisenberg et al., (1999) and Goldstein et al., (2007) agreeing that the higher the income the higher the tendency to consume herbal medicine. This situation could be explained by lack of variability in health insurance holdership since only 0.09% had health insurance.

Relative to doctors/hospital not recommending for herbal medicine consumption, herbal consumption recommendation by doctors/hospital was found to increase the probability of herbal medicine consumption by 16.3%. This was in agreement with Goldstein et al., (2007) that variables associated with hospitalization had a positive relationship to herbal medicine consumption. This could probably be explained by the doctors knowledge and understanding of the active substance in some herbal medicines that could be more effective than in modern medicine.
Age of household head, size of household, price of conventional medicine, distance to nearest medical clinic/hospital, social capital, perceived severity of disease, distance to herbal medicine source and location were found to be insignificant in influencing herbal medicine consumption. Notable was the unexpected negative relationship between age of household head and herbal medicine consumption. However, Mafimisebi et al., 2012 revealed that age was statistically significant and had a positive effect on herbal consumption. Although the negative relationship between age and herbal medicine consumption contradicts Mafimisebi et al. (2012), it could be because old age related diseases may require coping strategies rather than cure. Furthermore, as one grows old, if he/she relies on his or her own effort to obtain the herbal medicine, he may be slowed down by the advancing age.

Most of the variables in the study are categorical data based on a questionnaire survey. The determinants of herbal medicine consumption model had a predictive power of 73.4%. This implied correctly identified factors that influenced herbal medicine consumption. The model was therefore 73.4% accurate.

4.5 Analysis of Joint Herbal and Conventional Medicine Consumption

Univariate logit model results could be potentially biased should there be an omitted variable that determine herbal consumption (Greene, 2006). This potential for unobserved heterogeneity could result in the error term in the model being correlated with the explanatory variables that capture herbal consumption.
This potential problem can be addressed by bivariate probit model. This would imply that herbal consumption variable will capture not only the true effects of herbal consumption but also the effect on pharmaceutical consumption of having this unobservable characteristic. Therefore bivariate probit approach provides for examining the inter-dependent consumption decision between herbal and pharmaceuticals. Bivariate probit results for equation 3.15 are presented in Table 4.4. The significance of LR test ($\rho = 0$) implies that decisions about use of herbal medicine and/or conventional medicine are not independent. Both decisions are affected by the same unobservable heterogeneities. Thus, the decisions are jointly determined. This is plausible because herbal medicine and conventional medicine are substitutes and this is reflected in the negative sign of the Rho. This was confirmed by Goldstein et al., (2007) and Birhan et al., (2011). Therefore, estimation of separate equations yields unreliable results as observed in the univariate logit approach to estimating demand drivers for herbal medicine consumption.
Table 4.4: Results of Bivariate Probit Estimations for Determinants of Herbal Medicine Consumption, Conventional Medicine Consumption, Joint Herbal and Conventional Medicine Consumption

<table>
<thead>
<tr>
<th>Variable</th>
<th>HERBAL MEDICINE</th>
<th>CONVENTIONAL MEDICINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male household heads</td>
<td>0.4558**</td>
<td>-0.4858**</td>
</tr>
<tr>
<td></td>
<td>(2.14)</td>
<td>(2.18)</td>
</tr>
<tr>
<td>Age of household head</td>
<td>-0.0372</td>
<td>0.0066</td>
</tr>
<tr>
<td></td>
<td>(-0.87)</td>
<td>(0.17)</td>
</tr>
<tr>
<td>Age of household head squared</td>
<td>0.0002</td>
<td>-0.0000</td>
</tr>
<tr>
<td></td>
<td>(0.51)</td>
<td>(-0.12)</td>
</tr>
<tr>
<td>Primary school level of education</td>
<td>-0.3378</td>
<td>0.5505</td>
</tr>
<tr>
<td></td>
<td>(-0.87)</td>
<td>(1.62)</td>
</tr>
<tr>
<td>Secondary school level of education</td>
<td>-0.4106</td>
<td>0.7004**</td>
</tr>
<tr>
<td></td>
<td>(-1.09)</td>
<td>(2.15)</td>
</tr>
<tr>
<td>College level of education</td>
<td>-0.6679</td>
<td>1.1343***</td>
</tr>
<tr>
<td></td>
<td>(-1.60)</td>
<td>(2.92)</td>
</tr>
<tr>
<td>University level of education</td>
<td>-0.9703**</td>
<td>0.7330*</td>
</tr>
<tr>
<td></td>
<td>(-2.12)</td>
<td>(1.78)</td>
</tr>
<tr>
<td>Size of Household</td>
<td>0.0299</td>
<td>0.0180</td>
</tr>
<tr>
<td></td>
<td>(0.79)</td>
<td>(0.48)</td>
</tr>
<tr>
<td>Household monthly Income</td>
<td>-0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td></td>
<td>(-1.33)</td>
<td>(0.75)</td>
</tr>
<tr>
<td>Price of conventional medicine</td>
<td>0.0001</td>
<td>0.0000</td>
</tr>
<tr>
<td></td>
<td>(1.54)</td>
<td>(1.16)</td>
</tr>
<tr>
<td>Distance to nearest clinic/hospital</td>
<td>0.0765</td>
<td>0.0536</td>
</tr>
<tr>
<td></td>
<td>(1.45)</td>
<td>(0.99)</td>
</tr>
<tr>
<td>Household with Medical Insurance</td>
<td>0.5138*</td>
<td>-0.5060</td>
</tr>
<tr>
<td></td>
<td>(1.75)</td>
<td>(-1.85)</td>
</tr>
<tr>
<td>Household heads with Social capital</td>
<td>0.0344</td>
<td>0.0139</td>
</tr>
<tr>
<td></td>
<td>(0.67)</td>
<td>(0.28)</td>
</tr>
<tr>
<td>Herbal consumption recommendation by doctors</td>
<td>0.6048</td>
<td>-0.1136</td>
</tr>
<tr>
<td></td>
<td>(1.11)</td>
<td>(-0.30)</td>
</tr>
<tr>
<td>Perceived severity of the disease</td>
<td>-0.0674</td>
<td>0.1890</td>
</tr>
<tr>
<td></td>
<td>(-0.38)</td>
<td>(1.14)</td>
</tr>
<tr>
<td>Distance to herbal source</td>
<td>0.0006</td>
<td>-0.0010</td>
</tr>
<tr>
<td></td>
<td>(0.59)</td>
<td>(-1.04)</td>
</tr>
<tr>
<td>Urban residence</td>
<td>-0.0945</td>
<td>0.2122</td>
</tr>
<tr>
<td></td>
<td>(-0.43)</td>
<td>(1.06)</td>
</tr>
<tr>
<td>Constant</td>
<td>1.6257(1.42)</td>
<td>-0.7295(-0.68)</td>
</tr>
<tr>
<td></td>
<td>0.157</td>
<td>0.497</td>
</tr>
<tr>
<td>Rho</td>
<td>-0.9584</td>
<td></td>
</tr>
</tbody>
</table>

Wald test of rho=0: Chi2 (1)=14.3413***, Prob>Chi2=0.0002

Note: *, ** and *** mean significant at 10%, 5% and 1%, respectively; Z-scores are in parentheses.

Source: Author’s Computation
The coefficients of the bivariate probit cannot be interpreted directly. Thus, marginal effects were computed (see Table 4.5) and which interpretation was based.

Table 4.5: Marginal Effects for Determinants of Herbal Medicine Consumption, Conventional Medicine Consumption, Joint Herbal and Conventional Medicine Consumption

<table>
<thead>
<tr>
<th>Variables</th>
<th>Herbal Medicine Consumption</th>
<th></th>
<th>Conventional Medicine Consumption</th>
<th></th>
<th>Joint Consumption of Herbal and Conventional Medicine</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Marginal Effects</td>
<td>p-value</td>
<td>Marginal Effects</td>
<td>p-value</td>
<td>Marginal Effects</td>
<td>p-value</td>
</tr>
<tr>
<td>Male household heads</td>
<td>0.4558**</td>
<td>0.032</td>
<td>-0.4858**</td>
<td>0.029</td>
<td>-0.0162</td>
<td>0.822</td>
</tr>
<tr>
<td>Age of household head</td>
<td>-0.0372</td>
<td>0.382</td>
<td>0.0066</td>
<td>0.863</td>
<td>-0.086</td>
<td>0.511</td>
</tr>
<tr>
<td>Primary school level of education</td>
<td>-0.3378</td>
<td>0.384</td>
<td>0.5505</td>
<td>0.105</td>
<td>0.1199</td>
<td>0.230</td>
</tr>
<tr>
<td>Secondary school level of education</td>
<td>-0.4106</td>
<td>0.278</td>
<td>0.7004**</td>
<td>0.032</td>
<td>0.1541</td>
<td>0.112</td>
</tr>
<tr>
<td>College level of education</td>
<td>-0.6679</td>
<td>0.110</td>
<td>1.1345***</td>
<td>0.003</td>
<td>0.2167*</td>
<td>0.070</td>
</tr>
<tr>
<td>University level of education</td>
<td>-0.9703**</td>
<td>0.034</td>
<td>0.7330**</td>
<td>0.076</td>
<td>-0.0138</td>
<td>0.910</td>
</tr>
<tr>
<td>Size of Household</td>
<td>0.0299</td>
<td>0.432</td>
<td>0.0180</td>
<td>0.628</td>
<td>0.0151</td>
<td>0.194</td>
</tr>
<tr>
<td>Household monthly Income</td>
<td>-0.0000</td>
<td>0.183</td>
<td>0.0000</td>
<td>0.454</td>
<td>0.0000</td>
<td>0.672</td>
</tr>
<tr>
<td>Price of conventional medicine</td>
<td>0.0001</td>
<td>0.123</td>
<td>0.0001</td>
<td>0.246</td>
<td>0.0001***</td>
<td>0.024</td>
</tr>
<tr>
<td>Distance to nearest clinic/hospital</td>
<td>0.0765</td>
<td>0.148</td>
<td>0.0536</td>
<td>0.321</td>
<td>0.0412***</td>
<td>0.039</td>
</tr>
<tr>
<td>Household with Medical Insurance cover</td>
<td>0.5138*</td>
<td>0.080</td>
<td>-0.5060*</td>
<td>0.064</td>
<td>-0.0526</td>
<td>0.522</td>
</tr>
<tr>
<td>Household heads with Social capital</td>
<td>0.0344</td>
<td>0.503</td>
<td>0.0139</td>
<td>0.778</td>
<td>0.0149</td>
<td>0.331</td>
</tr>
<tr>
<td>Herbal recommendation by doctors</td>
<td>0.6048</td>
<td>0.268</td>
<td>-0.1136</td>
<td>0.764</td>
<td>0.1069</td>
<td>0.475</td>
</tr>
<tr>
<td>Perceived severity of the disease</td>
<td>-0.0674</td>
<td>0.701</td>
<td>-0.1889</td>
<td>0.254</td>
<td>0.0463</td>
<td>0.419</td>
</tr>
<tr>
<td>Distance to herbal source</td>
<td>0.0006</td>
<td>0.556</td>
<td>-0.0009</td>
<td>0.298</td>
<td>-0.0002</td>
<td>0.624</td>
</tr>
<tr>
<td>Urban residence</td>
<td>-0.0945</td>
<td>0.660</td>
<td>0.2122</td>
<td>0.287</td>
<td>0.4794</td>
<td>0.488</td>
</tr>
</tbody>
</table>

Note: *, ** and *** mean significant at 10%, 5% and 1%, respectively; Z-scores are in parentheses.

Source: Author’s Computation
Relative to households headed by female, households headed by males had 49% lower chance of using conventional medicine and 46% higher chance of using herbal medicine. While this contradicts the findings by Kennedy (2005) and Goldstein et al. (2007), it is plausible because herbs are mainly extracted from forests. It would be easier for the males to venture into the thick forests in search of the medicinal plants. Moreover, the key informants indicated that expertise in herbal remedies in the study area is dominated by men. It is also possible that it would be more convenient and easier for men to travel longer distances in rural settings in search of herbal remedies because in such settings women are more occupied with domestic chores. Gender did not have joint effect on herbal and conventional medicine consumption.

Education group has cumulatively shown an important result for the choice of pharmaceutical consumption. Relative to one without education at all, there was no significant difference with primary school level of education in conventional medicine consumption. The two were not any different in their decisions to use either herbal medicine or herbal medicine and conventional medicine jointly. A person with secondary school level of education had 7% higher probability to use conventional medicine, a person with college level of education had 113% higher probability to use conventional medicine while a person with university education had 73% higher probability to use conventional medicine. On herbal medicine consumption, those with university education had 97% lower chance than their counterparts without education; while for joint herbal and conventional medicine
consumption, those with high college level of education had 22% higher chance than their counterparts without education. This indicates that better educated people have inclination towards medicine whose efficacy is proven and well document. Such people may be hesitant to use unprocessed herbal medicine like those covered by our study. As noted by Eisenberg et al., (1999), Kennedy (2005) and Goldstein et al., (2007), better educated individuals have a preference for processed herbal remedies such as supplements. It is, thus, not surprising that better education tends to promote joint herbal and conventional medicine use.

Price of conventional medicine was positively correlated with joint consumption of herbal and conventional medicine. An increase of price of conventional medicine by one Kenya Shilling increases joint use of conventional and herbal medicine by 0.01%. The price of conventional medicine did not influence consumption of herbal and conventional medicine. This finding was consistent with Mwabu et al., (1993) and Eisenberg et al., (1999) that consumption of conventional medicine is a matter of choice rather than cost. However, Birhan et al., (2011) contradicts the findings that the dissatisfaction with modern medicine is prohibitive cost of treatment resulting to herbal medicine consumption.

Distance to the nearest clinic/hospital was positively correlated with joint consumption of herbal and conventional medicine. However, it had no effect on pharmaceutical consumption and herbal consumption. A household located one kilometer away from a health facility has a 4% higher probability of jointly using

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herbal medicine and conventional medicine. This is understandable because distance to medical facilities and price make conventional medicine less accessible and consumers may be motivated to supplement them with herbal remedies, especially when the latter is either more affordable or more easily accessible.

Medical insurance cover influenced herbal consumption and pharmaceutical consumption. Medical insurance highly influenced pharmaceutical consumption but not in the same aspect as herbal consumption. Relative to not having medical insurance cover, persons with medical insurance cover have high probability of decreasing pharmaceutical consumption by 51%. On the other hand, persons with medical insurance have high probability of increasing herbal medicine consumption by 54%. There was no joint consumption of conventional and herbal medicines. Given that medical insurance is a proxy to income, this will contradict our findings in income variable. But this can be justified that only 1 out of 10 persons health insurance holdership therefore lack of variability in insurance data.

Age of household head, size of household, household income, distance to nearest medical clinic/hospital, social capital, perceived severity of disease, distance to herbal medicine source and location were found to be insignificant in influencing herbal medicine consumption, conventional medicine consumption, joint herbal and conventional medicine consumption. However, household income was against the expectation of joint positive relationship to herbal and conventional
medicine consumption. Though household income was not statistically significant, there was a negative and positive relationship between herbal medicine and conventional medicine consumption respectively. Mafimisebi et al., (2012) confirms that due to low incomes individuals consume herbal medicines. However this is contradictory to Eisenberg et al., (1999) and Goldstein et al., (2007) that the high the income the high the tendency to consume herbal medicine. This is plausible because they can afford processed herbal medicines with proven safety and well documented.

4.6 Economic Value of Medicinal Plants of Kakamega Forest

Total Economic Value (TEV) is the sum of direct use values (include consumption), indirect use values (include functional values such as erosion prevention) and non-use values (such as existence values and optional values). The WTP for herbal medicine collected from the Kakamega forest and WTP for herbal medicine cultivation measured direct use value of consumption and production respectively. WTP for herbal medicine aimed at capturing indirect use value. It is noted that while WTP for herbal medicine cultivation captured direct use value, it was also a subset of the existence value.
The following were the three hypothetical scenarios for asking WTP for herbal medicine in the last three months:

Scenario 1: If you collected medicinal plants from the Kakamega forest and/or you were given without pay, how much would you be willing to pay?

Scenario 2: Assuming that medicinal plants exist within a specific portion of Kakamega forest and that is the only place you can get it from. If you are willing to cultivate the medicinal plants, how much would you be willing to spend?

Scenario 3: If you planted medicinal plants for aesthetics, how much did you pay for the seedlings?

4.6.1 Willingness to Pay for Kakamega Forest Herbs

Table 4.5 presented the results for equation 3.20 estimate of willingness-to-pay for herbal medicine in Kakamega forest. The variable of interest was the economic value for Kakamega forest herbs, WTP for consumption of Kakamega forest herbs (direct use value), WTP for Kakamega forest herbs aesthetic value (indirect use value) and WTP for cultivation of Kakamega forest herbs (direct use and non use-existence value).

Willingness to pay for herbs was only considered from herbs sourced from Kakamega forest. By the TEV equation 3.20, the WTP for herbal medicine from Kakamega forest was estimated to average KShs 2,078.83 per three months. The
annual TEV estimate in equation 3.21 was KShs 2,968,569.24 which is about US$34,924.34 per annum. Herbal medicine cultivation influenced 72% of the total economic value. This total economic value is lower to Ruitenbeek (1989) finding of annual MPs genetic economic value of US$85,000 for Korup forest in Cameroon. This divergence in the study could be explained by the market value of the extracted genetic resource from medicinal plants. The study focused on raw MPs with no value addition and did not as well consider the market value for lack of market data. Different forests have variations on medicinal plants species biodiversity and hence economic value. However, the validity of WTP obtained in this study could be examined in a number of aspects. Such willingness to pay cannot be equated with the ‘value of life’. The WTP in a hypothetical situation differs from the actual amount paid. The WTP for herbal medicine is understated given that herbal cultivation provides source material for modern medicine which could have been best captured at the actual market value of the plants traded. This was not possible. Further, it was not possible to capture the ecosystem value of herbal medicine given the difficulty of quantifying the socio-economic benefits of conserving biological resources. However, the total economic value of Kakamega forest herbal medicine provides baseline information on the herbal medicine economic value. This would inform the need to document herbal medicines and focus resources to those with the high economic potential for trade.
Table 4.6: Results of Willingness–To-Pay for Herbal Medicine
(KShs per three month average)

<table>
<thead>
<tr>
<th>Statistics</th>
<th>TEV for Kakamega Forest Herbs per Annum</th>
<th>Total WTP for Kakamega Forest Herbs per household per quarter year</th>
<th>WTP for Consumption of Kakamega Forest Herbs per household per quarter year</th>
<th>WTP for Aesthetics of Kakamega Forest Herbs per household per quarter year</th>
<th>WTP for Cultivation of Kakamega Forest Herbs per household per quarter year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>2,968,569.24</td>
<td>2,078.83</td>
<td>211.81</td>
<td>366.75</td>
<td>1500.27</td>
</tr>
<tr>
<td>Median</td>
<td>785,400.00</td>
<td>550.00</td>
<td>100.00</td>
<td>150.00</td>
<td>300.00</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>357</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exchange rate as at August, 2014: 1US$=85KSHS

Source: Author’s Computation

4.7 Relationship of Medicinal Plants Consumption to Medicinal Plants

Availability in Kakamega Forest

4.7.1 An inventory of Herbal Medicine Consumed by Households Living Around Kakamega Forest

The most consumed herbals by households are marubaini, shikhuma, mgombero, shikakha, imbindi and alikhava at 20.6%, 17.4%, 16.1%, 13%, 10.2% and 10.2% respectively (See Appendix 3 Table A3). Marubaini is probably the leading consumed herbal because of the household perception that it treats forty diseases. Mgombero is perceived as an aphrodisiac while shikhuma, shikakha, imbindi and alikhava are perceived as antibiotics. Imbuli ya mdaka, muringa, enguu, shilokho,
*shikangania, lusiola, shituti* and *mpera* are the second level of herbal consumption at 7.8%, 4.9%, 3.9%, 3.4%, 3.1%, 2.9%, 2.6% and 2.3% respectively. Figure 4.1 reveals the preference for common herbal medicines.

![Figure 4.1: Inventory of Common Herbs Consumed by Households Living Around Kakamega Forest.](image)

Source: Author’s Computation

*Marubaini, shikhuma, mgombero, shikakha, imbindi* and *alikhava* high consumption are distinct from other herbal medicines. This inventory forms a major herbal remedies for the ailments for the communities around the Kakamega forest.

Table 4.7 presented the results for section 3.6. It is drawn from responses on perceptions from respondents on the relationship of herbal medicine consumption and herbal medicine availability in Kakamega forest.
Table 4.7: Summary Statistic of Herbal Consumption and Herbal Medicine Availability in Kakamega Forest

<table>
<thead>
<tr>
<th>Variable</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbal Knowledge</td>
<td>0.98</td>
</tr>
<tr>
<td>0: No</td>
<td>0.02</td>
</tr>
<tr>
<td>Forest Access under new Management</td>
<td>0.35</td>
</tr>
<tr>
<td>1: Improved</td>
<td></td>
</tr>
<tr>
<td>2: Remained Same</td>
<td>0.50</td>
</tr>
<tr>
<td>3: Worsened</td>
<td>0.15</td>
</tr>
<tr>
<td>Source Herbs out of Kakamega</td>
<td>0.31</td>
</tr>
<tr>
<td>0: No</td>
<td></td>
</tr>
<tr>
<td>1: Yes</td>
<td>0.69</td>
</tr>
<tr>
<td>Herbs not Effective as before</td>
<td>0.52</td>
</tr>
<tr>
<td>0: No</td>
<td></td>
</tr>
<tr>
<td>1: Yes</td>
<td>0.48</td>
</tr>
<tr>
<td>Herbs difficult to find</td>
<td>0.02</td>
</tr>
<tr>
<td>0: No</td>
<td></td>
</tr>
<tr>
<td>1: Yes</td>
<td>0.98</td>
</tr>
<tr>
<td>Reasons to difficulty in finding herbs</td>
<td>0.20</td>
</tr>
<tr>
<td>1: Climate change</td>
<td></td>
</tr>
<tr>
<td>2: Over harvesting</td>
<td>0.22</td>
</tr>
<tr>
<td>3: Forest land to agriculture</td>
<td>0.22</td>
</tr>
<tr>
<td>4: Climate change &amp; over harvesting</td>
<td>0.07</td>
</tr>
<tr>
<td>5: Climate change &amp; land for agriculture</td>
<td>0.05</td>
</tr>
<tr>
<td>6: Over harvesting &amp; land for agriculture</td>
<td>0.24</td>
</tr>
<tr>
<td>Herbal sources</td>
<td>0.44</td>
</tr>
<tr>
<td>1: Forest</td>
<td></td>
</tr>
<tr>
<td>2: Pharmacist</td>
<td>0.10</td>
</tr>
<tr>
<td>3: Herbalist</td>
<td>0.11</td>
</tr>
<tr>
<td>4: Forest &amp; Pharmacist</td>
<td>0.05</td>
</tr>
<tr>
<td>5: Forest &amp; Herbalist</td>
<td>0.30</td>
</tr>
<tr>
<td>6: Other unspecified source</td>
<td>0.01</td>
</tr>
<tr>
<td>Trends in forest cover</td>
<td>0.40</td>
</tr>
<tr>
<td>1: Declined</td>
<td></td>
</tr>
<tr>
<td>2: Increased</td>
<td>0.26</td>
</tr>
<tr>
<td>3: Not changed</td>
<td>0.35</td>
</tr>
<tr>
<td>Impact of forest decline</td>
<td>0.48</td>
</tr>
<tr>
<td>1: Lack of fuel wood</td>
<td></td>
</tr>
<tr>
<td>2: Lack of fodder</td>
<td>0.01</td>
</tr>
<tr>
<td>3: Lack of medicinal herbs</td>
<td>0.35</td>
</tr>
<tr>
<td>4: Lack of timber</td>
<td>0.07</td>
</tr>
<tr>
<td>5: Lack of other forest utilities</td>
<td>0.10</td>
</tr>
<tr>
<td>Number of Observation</td>
<td>292</td>
</tr>
</tbody>
</table>

Source: Author’s Computation

Out of the 384 households surveyed; 92 were omitted from the analyses due to incomplete information. The variables of interest were households with herbal knowledge, herbal medicine sources, access to forest products, trends in forest cover, impact of forest cover decline, proportion of households with difficulties in
herbal medicine access and; the reasons for Kakamega forest cover decline/difficulty in herbal access.

4.7.2 Household with Herbal Knowledge

Herbal knowledge was treated as binary with 1 yes for herbal knowledge and 2 no herbal knowledge. About 98% of households surveyed in Kakamega had herbal knowledge and only 2% had no herbal knowledge. This is because most of the interviewees were in a rural setup and more so being close to the Kakamega forest. Wiersum et al., (2006) confirms that communities living in their original habitat completely rely on plant medicine based on the long term ethno-medicine knowledge transfer.

4.7.3 Herbal Medicine Sources

Herbal medicine source was treated as a discrete variable with 1 Forest 2 Pharmacist 3 Herbalist 4 both forest and pharmacy 5 both forest and herbalist 6 other unspecified source. Major herbal source was Kakamega forest at 44% followed by a combination of the forest and herbalists at 30%. Herbalist, pharmacies, combined forest and pharmacy, and other unspecified sources were at 11%, 10%, 5% and 1% respectively. Forest as a source was leading because of the Kakamega community proximity to the Kakamega forest. This result is in agreement with Owuor et al., (2007); Mander and Le Bretton (2005) and Dold et al., (2002) that forests are major source of herbal medicine. Figure 4.2 provides a clear picture of the forests contribution to herbal medicine supply.
**Fig 4.2: Sources of Alternative Medicine**

Source: Author’s Computation

4.7.4 Access to Kakamega Forest Products

Access to Kakamega forest products under new forest management was treated discrete as improved, 2 remained same and 3 worsened. 35%, 5% and 15% indicated that forest access improved, remain the same and worsened respectively. The forest access is probably high because of new policy consideration of those living within and without the forest.

4.7.5 Trends in Kakamega Forest Cover

Trends in forest cover were measured discretely as 1 declined, 2 increased and 3 not changed. 40% indicated that the Kakamega forest cover had declined. While 26% and 35% had indicated the forest cover increased and not changed
respectively. The decline in the Kakamega forest cover is due to the increase in the Kakamega forest access.

4.7.6 Impact of Decline in Kakamega Forest Cover

Impact of forest cover decline was heavily realized due to lack of fuel wood and lack of herbal medicine at 48% and 35% respectively. Lack of herbal medicine is confirmed by Mander and Le Bretton (2005) and Dold et al., (2002) as being due to indiscriminate harvesting of herbal medicine from the forest. Other impacts were lack of fodder, lack of timber and other forest utilities at 1%, 7% and 10% respectively. Increased forest access and probable increase of conversion of forest land for agriculture could have led to decline in the Kakamega forest products. The impact of forest cover decline was discrete with 1 lack of fuel wood, 2 lack of fodder, 3 lack of medicinal herbs 4 lack of timber and 5 lack of other forest utilities.

Figure 4.3 clearly shows that lack of fuel wood and lack of medicinal herbs in that order are the major challenge resulting in the Kakamega forest cover decline. Therefore herbal medicines are endangered in the forest.
4.7.7 Households Indication of Difficult Access to Herbal Medicine

Though there is a perceived decline in herbal medicine access in Kakamega forest, 31% of the interviewees still access the herbal medicine within the forest. About 69% indicated they sourced herbal medicine out of Kakamega forest. This means that the forest herbal medicine biodiversity has tremendously declined. However, 98% indicated that they were difficult to find within the Kakamega forest and only 2% reckon ease to find the herbals within the forest. This is because of the Kakamega forest cover decline.
4.7.8 Reasons for Kakamega Forest Cover Decline/ Difficulty in Herbal Access

The reasons for difficulty in finding the herbal medicine within Kakamega forest were treated discrete as 1 climate change 2 over harvesting 3 forest land to agriculture 4 both climate change and overharvesting 5 both climate change and forest land to agriculture 6 both over harvesting and forest land to agriculture. Climate change and forest land to agriculture were the leading reasons to difficulty of finding herbal medicine within the forest at 48% and 35% respectively. The next cause was overharvesting and forest land to agriculture at 10%; climate change and forest land to agriculture at 7% and overharvesting at 1%.

Figure 4.4 provides a better insight to the challenges in accessing herbal medicine that were prior available for consumption and now not easy to find. Climate change not only affected the ease to finding herbal medicine, but also the effectiveness of the herbal medicine from the forest. Only 48% indicated that the herbal medicine were effective as before against 52% who reckoned that they are not effective as before. This may mean changes in the active medicinal substance in the herbals following changes in the Kakamega forest ecosystem brought about by climate change and conversion of forest land to agriculture.
Fig 4.4: Challenges to Access Prior Existing Herbs in Kakamega Forest

Source: Author’s Computation
CHAPTER FIVE
SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Introduction
This chapter presents the summary, conclusions and policy implications of the study findings, and areas for further research. The chapter is divided into four sections; Section 5.2 presents the summary of the study, section 5.3 conclusions, section 5.4 policy recommendations arising from the study findings, and section 5.5 presents areas for further research.

5.2 Summary
This study modeled the drivers of demand for herbal medicine, conventional medicine, joint demand for both conventional and herbal medicine, economic value of herbal medicine and; herbal consumption relationship to herbal medicine availability in Kakamega forest. The study found that consumption of conventional medicine and herbal medicine was indeed inter-dependent. The hypothesis testing revealed a strong negative relationship between herbal medicine and conventional medicine consumption (rho=-0.96). Meaning herbal medicines and conventional medicine are substitutes. Gender, education, price of conventional medical treatment, distance to medical facilities, health insurance cover was found to influence the conventional and herbal medicines consumption decisions.
It was established that male gender of household head reduced probability of conventional medicine use but increased the probability of herbal medicine use. This was found not to be consistent with literature (Kennedy, 2005 and Goldstein et al. 2007). However, it is probable because herbs are mainly extracted from forests. It is also possible that it would be more convenient and easier for men to travel longer distances in rural settings in search of herbal remedies because in such settings women are more occupied with domestic chores.

Education increased the chance of conventional medicine consumption and joint consumption of conventional medicine and herbal medicine. Relative to one without education at all, a person with secondary school level of education, college level of education and university level of education had higher probability to use conventional medicine. On herbal medicine consumption, those with university education had lower chance than their counterparts without education; while for joint herbal and conventional medicine consumption, those with high college level of education had higher chance than their counterparts without education. This indicates that better educated people have inclination towards medicine whose efficacy is proven and well document.

Price of conventional medicine was positively correlated with joint consumption of herbal and conventional medicine. The price of conventional medicine did not influence consumption of herbal and conventional medicine. This finding was consistent with Mwabu et al., (1993) and Eisenberg et al., (1999) that
consumption of conventional medicine is a matter of choice rather than cost. However, Birhan et al., (2011) contradicts the findings that the dissatisfaction with modern medicine is prohibitive cost of treatment resulting to herbal medicine consumption.

Distance to nearest clinic/hospital increased the possibility of joint consumption of conventional medicine and herbal medicine. This is understandable because distance to medical facilities and price make conventional medicine less accessible and consumers may be motivated to supplement them with herbal remedies, especially when the latter is either more affordable or more easily accessible.

Medical insurance cover reduced the probability of conventional medicine use but increased the probability of herbal medicine use. However, this effect is not consistent with consumption of medicinal plants. This is probably because there was not data variability in insurance holdership since only 0.09 % had health insurance.

The findings on economic value of medicinal plants, established an annual total economic value of KShs 2,968,569.24. Herbal medicine cultivation influenced 72% of the total economic value. The study has revealed a considerable monetary value of MPs of Kakamega forest. Although willingness to pay measurement is criticized frequently for their validity and reliability, they are still useful for
determining the economic value of medical services. However, the established economic value of herbal medicine of Kakamega forest, mean the herbal medicines economic value can be tapped.

The findings on the effect of medicinal plants consumption on their availability and by extension depletion of forest cover revealed that fifty four (54) MPs are consumed by households living around Kakamega forest (Appendix 3, Table A3). With respect to herbal knowledge, 98 % of the household surveyed had herbal knowledge. About 44 % indicated that Kakamega forest was a major source of medicinal plants for the community living around. Access to Kakamega forest products improved under new forest management as indicated by 35 % of household surveyed. While 40 % of the households indicated that Kakamega forest cover had declined. About 48 % and 38 % of the households stated that the decline impact was lack of wood fuel and herbal medicine respectively. A decline in the forest cover was indicated by 48 % and 35 % of the households to result from climate change and conversion of forest land to agriculture respectively. The effect was that 69 % of the households indicated that they sourced some herbal medicine out of Kakamega forest. Medicinal plants over-harvesting, was second to conversion of forest land to agriculture in reducing the medicinal plants availability at 21.6 and 21.9 % respectively. Lastly, consistent with literature, it was revealed that over-harvesting medicinal plants from the forest reduced their availability. Meaning herbal medicine consumption is surging and the herbal medicines in the forest are constrained in meeting the demand.
5.3 Conclusions

It would be expected that as a country develops and modern medical facilities are taken closer to the people, demand for alternative medicine would shrink in favour of modern medicine. However, in Kenya, demand for herbal remedies has been growing over the years. Thus, this study sought to understand the drivers of demand for conventional medicine, herbal medicine, joint demand for both conventional and herbal medicine, economic value of herbal medicine and; herbal consumption relationship to herbal medicine availability in Kakamega forest. To control for unobserved household heterogeneities in consumption decisions, the study adopted bivariate probit approach, while willingness-to-pay approach was adopted to determine the economic value of herbal medicine. Descriptive analysis was adopted in explaining the herbal medicine consumption relationship to herbal medicine availability in Kakamega forest.

The study found that decisions to consume conventional medicine and herbal medicine are inter-dependent. It further established that male gender of household head reduced probability of conventional medicine use but increased the probability of herbal medicine use. Education increased the chance of conventional medicine consumption and joint consumption of conventional medicine and herbal medicine; price of conventional medicine and distance to medical facilities increased the possibility of joint consumption of conventional medicine and herbal medicine. The study further revealed that household heads with medical cover reduced the probability of conventional medicine use but
increased the probability of herbal medicine use. It also established a potential economic value of Kakamega forest herbs. This was consistent with literature that medicinal plants have economic value. Lastly, in agreement with literature, it was revealed that overharvesting medicinal plants from the forest reduced their availability.

5.4 Policy Implications

The above findings have important policy implications. Foremost, the role of herbal medicine cannot be dismissed. It is used either singly or in combination with conventional medicine. This means there is a constituency, both educated and uneducated, that believes in it either because of their own experiences or the experiences of their friends and/or relatives. What needs to be done, therefore, is to device and implement mechanisms to ensure that providers of herbal medicine do not take advantage of the unsuspecting clients. The efficacy of their services should be verified, regulated and accurately communicated to the potential clients by the government of Kenya through the Ministry of Health, Department of Public Health and the Pharmacy and Poisons Board. Where quality is in doubt, it is important to educate the potential clients on the possible dangers.

To counter the dangers of people resorting to unproven herbal remedies or combining them with conventional medicine just because conventional medicine is too expensive or medical facilities are too far, it is important to map out the common ailments usually targeted. That way, it is possible to offer and correctly
target subsidies on health care. The ultimate solution, however, lies in ensuring spatial justice in setting up medical facilities.

There is no doubt that herbal medicine has an economic value. This means there are those that can be directly traded for economic benefit for Kenya. It is important, therefore, to keep an inventory of herbal medicines by the government of Kenya through the Ministry of Sports, Culture and Arts, Department of Culture and the Ministry of Environment and Natural Resources. Those traded, that is exported or consumed within the country, and their trade value should be ascertained for economic planning for herbal medicine health sub-sector to encourage consumption. The government and non-governmental organizations should implement incentives that will encourage the production of herbal medicines with proven safety, efficacy and ascertained economic value. This will not only generate revenue for the government but also support livelihoods in both rural and urban economies.

To counter the dangers of over exploitation of medicinal plants of Kakamega forest, the government and non-governmental organizations should implement incentives that will encourage production of herbal medicines with proven safety and efficacy. This will reduce over reliance on the forest as source of herbal medicine. It is important for the government of Kenya to keep an inventory of endangered medicinal plants. This will not only facilitate monitoring and control of medicinal plants harvesting but restocking of the endangered medicinal plants.
in their habitat. Herbal medicine consumption and trade should be regulated for sustainable medicinal plants harvests.

5.5 Areas for Further Research

The survey did not cover the type of health products covered by health insurance facility held by households. There is need for this to be ascertained following the contradictory outcome that the more the number of health insurance holders, the more the medicinal plant consumption. Adequate data on medical cover ownership is necessary to establish the effect on herbal medicine consumption. The data on insurance holdership exhibited non-variability leading to this result. Thus insurance holdership on medicinal plant consumption needs to be established with adequate data on insurance holdership.

The TEV estimate was a basket for all MPs. Probably; specific MPs would have shown high economic value. Secondly, the economic value estimate could be low compared to nature of illness treated by the MPs. Therefore it is necessary to determine economic value for specific MPs commonly used. This will help ascertain the need to cultivate or to further tap the herbal medicine market.

This study did not look into specific medicinal plants but generalized the consumption for all herbal medicines. The specific MPs that is difficult to find in the forest due to over-harvesting needs to be established. This would provide individual MPs policy intervention on use and or production.
REFERENCES


APPENDIX 1: QUESTIONNAIRE FOR HOUSEHOLD HEADS

<table>
<thead>
<tr>
<th>HOUSEHOLD CONSUMPTION OF MEDICINAL PLANTS OF KAKAMEGA FOREST IN KENYA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questionnaire for Household Heads on Households Consumption of Medicinal Plants</td>
</tr>
</tbody>
</table>

**Introductory Statement:** Start with greetings and self introduction and ask the respondent to be part of the survey.

“This survey is carried out by Ombok Maurice Ochieng, PhD candidate at the School of Economics, Kenyatta University. The aim is to assess various factors influencing the consumer choice of herbal medicine; and true economic value of the herbal medicine. At the end of it all the analysis will assist government, county governments, Kenya Medical Research Institute and potential investors in the pharmaceutical plants industry make informed decisions regarding medicinal plant resources. This study is conducted in Kakamega county for households living around Kakamega forest and i have selected 384 households. Your household was selected as one of those to which these questions will be asked. You were not selected for any specific reason. Simply your name appeared on a listing of all households in this area, and your name was chosen randomly.

Your response to these questions will be held in confidence and used only for research purposes. Neither your name nor those of your household shall be mentioned. However, if you agree we will write down your contact information in case some issues in the questionnaire are unclear. Before I start do you have any questions or issue that needs further clarification?

Thank you for your kind co-operation.”
Section 1: General Awareness of Medicinal Plants Consumption

1. Are you aware of medicinal plants use in humans and animals treatment? Yes [ ] No [ ]

2. If yes in 1 above provide a list of names for medicinal plant known to you.

.................................................................
.................................................................

Section 2: Individual Status of Medicinal Plants Consumption

3. Have you ever used alternative medicine? Yes [ ] No [ ]

4. If yes in 3 above, where did you get them from? Forest [ ] Pharmacist [ ] Herbalist [ ] other (specify).................................................................
5. What informed the use?  **Expensive conventional** [ ] **Not available drug** [ ]

   *Nature of disease (specify if serious or not)*: ................................. [ ]

   *Medical doctors* [ ] *Parents* [ ] *Friends* [ ] *Other (specify)*: ..............

6. How much did you pay for it in the **last 3 months**?

   - [ ] **Other, Specify**: .................................................................

7. If no in 3 above, where did you seek treatment from?

   - **Referral/specialized hospital** [ ] **Dispensary/health centre** [ ] **District hospital** [ ] **Village health post (worker)** [ ] **Pharmacy** [ ] **NGO** [ ]
   - **Other, Specify**: ........................................................................

8. Would you have used medicinal plants if that treatment was not readily available? **Yes** [ ] **No** [ ]

---

**Section 3: Individuals Assessment of Medicinal Plants Consumption**

9. In your own assessment, should medicinal plant consumption be integrated in formal healthcare delivery system? **Yes** [ ] **No** [ ]

10. If yes in 9 above, state the reasons

    ........................................................................................................

    ........................................................................................................

    ........................................................................................................

    ........................................................................................................
11. In your own assessment, are there medicinal plants earlier considered effective in treatment but not now? Yes [ ] No [ ]

12. If yes in 11 above, state the reasons

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

13. Are there medicinal plants sourced out of Kakamega County? Yes [ ] No [ ]

14. Are there some household members engaged in medicinal plants cultivation? Yes [ ] No [ ]

15. If yes in 14 above, state the members and approximate income

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

Section 4: Benefits and Costs from Forest Resources

16. Do you obtain any of these products/benefits listed below from Kakamega forest? Yes [ ] No [ ]
   Firewood, Charcoal, Farmland, Timber, Medicinal herbs and aromatic plants, Water, Recreation, Other (Specify)
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

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17. If yes in 16 above, what are the **main benefits** that you get from this forest?

*List the most important first*

------------------------------------------------------------------------------------------------------------------------

------------------------------------------------------------------------------------------------------------------------

------------------------------------------------------------------------------------------------------------------------

18. Do you pay any fee to use these forest resources? **Yes** [ ] **No** [ ]

19. If PAY=**Yes** how much did you pay for this benefit in the past **one year**?  
(KShs)  

------------------------------------------------------------------------------------------------------------------------

20. What **main** constraints/problems do you encounter in accessing the resources? **Distance to forest** [ ] **Forest degradation** [ ] **Bad relation with forest authority** [ ] **Lack of support from local leaders** [ ]

**Hostility with/from neighbours** [ ] **other (specify)**

------------------------------------------------------------------------------------------------------------------------

21. Do you incur any costs related to conserving the forest? **Yes** [ ] **No** [ ]

22. If yes, what are the costs?

*Time spent attending forest related meetings* [ ] *High labour and other costs of forest establishment* [ ] *High labor and other costs of forest maintenance* [ ] **other (specify)**.................................................................

(List the most important first)  

------------------------------------------------------------------------------------------------------------------------
23. In your opinion, what has been the general trend in forest cover in this area in the last 5 years? Declined [ ] Increased [ ] Not changed [ ]

24. If declined, how has it impacted on your livelihood?

- Lack of fuel wood [ ]
- Lack of medicinal herbs [ ]
- Lack of timber [ ]
- Other (specify) ........................................................................................................

(List the most important first) .................................................................

25. What are the coping strategies taken by the households for impact?

- Buy fuel wood [ ]
- More time to collection [ ]
- More labour in fetching forest products [ ]
- Planting herbal medicines [ ]
- Buy herbal medicine [ ]
- Other (specify) ........................................................................................................

Section 5: Information on Household Access to Health care Services

26. Did any member of the household visit a health care centre in the last 3 months? Yes [ ] No [ ]

27. If Yes in 26 above, what was the reason? Treatment [ ] Other (specify) ........................................................................................................

..........................................................................................................................

28. What type of health provider was visited? Referral/specialized hospital [ ]
- Dispensary/health centre [ ]
- District hospital [ ]
- Village health post (worker) [ ]
- Pharmacy [ ]
- NGO [ ]
- Other, (specify)

..........................................................................................................................
29. How did you pay for the health service?

- **Free treatment** [ ]
- **Health insurance** [ ]
- **Own cash** [ ]
- **had to work for provider** [ ]
- **Use of own asset** [ ]
- **Took loan** [ ]
- **Family/friends assistance** [ ]
- **Other** (specify)

……………………………………………………………………………………………………

……………………………………………………………………………………………………

30. What amount did you approximately pay? (KShs)……………………………………..

31. What is the distance to nearest health centre? (Km)……………………………………

there a sick member of the household who has not sought treatment?

Yes [ ] No [ ]

---

**Section 6: Valuation of Alternative Medicine**

Assuming that herbs exist within a specific portion of Kakamega forest and that is the only place you can get it from.

32. How much would you be willing to pay for it? (KShs)

- **1000** [ ]
- **2000** [ ]
- **3000** [ ]
- **4000** [ ]
- **5000** [ ]
- **Other** (specify)

……………………………………………………………………………………………………

……………………………………………………………………………………………………

33. In your own assessment, are there some medicinal plants that were earlier easy to get in the forest but now not easy to find.

Yes [ ] No [ ]
34. If yes, state the reason.

  Climate change [ ] Over harvesting [ ] Converting forest land to agriculture [ ] other (specify) .................................................................
  ........................................................................................................................................................................

35. Would you be willing to cultivate the medicinal plants? Yes [ ] No [ ]

36. If yes in 35 above, how much would you be willing to spend. (KShs)

  1000 [ ] 2000 [ ] 3000 [ ] 4000 [ ] 5000 [ ] Other (specify)
  ...............................................................................................................................}

37. If you collected medicinal plants from the forest and or given without pay, how much would you be willing to pay for them in the last 3 months? (KShs)

 ..............................................................................................................................

38. If planted medicinal plants for aesthetics, how much did you pay for the seedlings in the last 3 months? (KShs) ..........................................................

39. If the seedlings were given free, how much would you be willing to pay for them in the last 3 months? (KShs) ..........................................................

40. If consumed alternative medicine out of Kakamega, what distance did you cover in the last 3 months? .................................................................
**Section 7: Household Roster-Members of Households, Education, and Employment**

Please list all household members (All those who are under the care of household head in terms of food and shelter provision).

<table>
<thead>
<tr>
<th>Household member</th>
<th>Relationship to Household head</th>
<th>Sex (M = 1; F = 2)</th>
<th>Age</th>
<th>Level of schooling</th>
<th>Marital Status</th>
<th>Main Occupation</th>
<th>Monthly income from Occupation (Ksh)</th>
<th>Participate in farm work (Yes = 1, No = 0)</th>
<th>Other occupation</th>
<th>Monthly income from other occupation (Ksh)</th>
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<tbody>
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<td></td>
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</table>

*Relationship with household head*  

<table>
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<tr>
<th>Relationship with household head</th>
<th><em>Marital status</em></th>
<th><em>Occupation</em></th>
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<tr>
<td>Head</td>
<td>Step children</td>
<td>Married</td>
</tr>
<tr>
<td>Son/daughter</td>
<td>Father/Mother-in-law</td>
<td>Divorced/separated</td>
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<tr>
<td>Father/mother</td>
<td>Sister/Brother-in-law</td>
<td>Widow/widower</td>
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<td>Sister/brother</td>
<td>House girl</td>
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<td>Grandchildren</td>
<td>Farm labourers</td>
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### APPENDIX 2: DIAGNOSTIC TESTS

#### Table A1: Correlation Matrix for Independent Variables

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<th>Age</th>
<th><em>Iprimary</em></th>
<th><em>Iseconda_ry</em></th>
<th><em>Icollege</em></th>
<th><em>Iuniversity</em></th>
<th>Household size</th>
<th>Herbal Price</th>
<th>Pharmacy Price</th>
<th>Distance Clinic</th>
<th><em>Iinsurance</em></th>
<th>Information</th>
<th><em>Idoctoradvise</em></th>
<th><em>Isevere disease</em></th>
<th>Source out Kkmg</th>
<th><em>Ilocation</em></th>
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Figure A1: Kernel Density Estimate for Normality Test
Source: Author’s Computation

Table A2: Logistic model for herbal use, Hosmer-Lemeshow goodness-of-fit test

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<tr>
<th>Group</th>
<th>Prob</th>
<th>Obs_1</th>
<th>Exp_1</th>
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Number of observations 357
Number of groups 10

*Table collapsed on quantiles of estimated probabilities
Source: Author’s Computation
APPENDIX 3: HERBAL MEDICINE INVENTORY

Table A3: Herbal Medicines Consumed by Households in Kakamega

<table>
<thead>
<tr>
<th>Local Name (Luhy)</th>
<th>Scientific Name</th>
<th>Freq.</th>
<th>%age use</th>
</tr>
</thead>
<tbody>
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<td>Indandalwa</td>
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<td>Munyama Kwebugawda</td>
<td><em>Khaga anthotheca</em></td>
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<td>7.0</td>
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<tr>
<td>Mukhuma</td>
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<td>2.1</td>
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<td>Mukombera</td>
<td><em>Mondia whytei</em></td>
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<td>16.1</td>
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<td>Marubaini</td>
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<td>Murembe</td>
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<td>Not established</td>
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<td>1.0</td>
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<td>13.0</td>
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<td>Mwiritsa</td>
<td><em>Prunus africana</em></td>
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<td>1.0</td>
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Source: Author’s Compilation and Computation
APPENDIX 4: STUDY AREA

Figure A2: Kakamega Forest Map

Source: Otieno et al., 2012