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Role of Traditional Ethnobotanical Knowledge and Indigenous Institutions in Sustainable Land Management in Western Highlands of Kenya

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Additional information is available at the end of the chapter

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Abstract

The objective of this chapter is to elucidate the relevance of indigenous knowledge and institutions in natural resource management using western highlands of Kenya as a case study. The research design was a mixed method, combining qualitative and quantitative methods. A total of 350 individuals (comprising farmers, herbalists and charcoal burners) from households were interviewed using a structured questionnaire, 50 in-depth interviews and 35 focus group discussions. The results show that indigenous knowledge and institutions play a significant role in conserving natural resources in the study area. There was gender differentiation in knowledge attitude and practice (KAP) of indigenous knowledge as applied to sustainable land management. It is recommended that deliberate efforts should be put in place by the County Governments to scale up the roles of indigenous institutions in managing natural resources in the study area.

Keywords: indigenous institutions, Kakamega forest, Kenya, natural resources management

1. Introduction

At a global scale, available evidence points toward a direction of increasing relevance of Traditional Ethnobotanical Knowledge (TEK) as an invaluable, underutilized and under-documented knowledge pool [1]. This presents developing countries, particularly in Africa, with a powerful tool to address plant resource conservation challenges [2]. In 1992, the

Convention on Biological Diversity (CBD) was the first to develop measures for use and protection of traditional knowledge related to the conservation and sustainable use of biodiversity. Abiding countries are expected to (1) promote the use of indigenous knowledge (IK) systems in natural resource management (NRM), (2) embrace and scale up utilization of indigenous knowledge and (3) promote equity and access in benefit sharing accruing from utilization of indigenous knowledge systems [3]. For example, Chapter 26 of Agenda 21 reiterates the “involvement of indigenous people and their communities at the national and local levels in resource management and conservation strategies to support and review sustainable development strategies” ([4], 26.3c). The United Nations Scientific Conference Organisation (UNESCO) and the International Council for Science Union (ICSU) in their blueprint documents appreciate the role played by IK and plead for its application in all forms of humanity engagements [5]. In defining TEK, various authors focus on the attributes of perception, management and utilization of plant resource by local communities [6, 7]. In specific terms, research on TEK focuses on *“how people classify, identify and relate to plant resources, examining the interactions of plants and people, taxonomic identification of selected plants and biological as well as chemical analysis of their ingredients”* [6]. Put differently therefore, TEK encompasses the investigation of plants as used in indigenous cultures for food, medicine, rituals, building, household implements, firewood, pesticides, clothing, shelter and other beneficial purposes [8, 9].

Indigenous knowledge, defined by Masango [10], as *“the totality of all knowledge and practices established on past experiences and observations that is held and used by people,”* is the main reservoir of ethnobotanical investigations and is commonly referred to as TEK. However, changes in lifestyle brought about by globalization, particularly in Africa, have led to the negation of TEK in ongoing efforts to ensure sustainable management of resources with a concurrent loss of related knowledge [11, 12]. In particular, transmission of this knowledge between the older and younger generation is no longer connected [13].

In Kenya, for example, there is an apparent lack of practical recognition that indigenous technical knowledge is pivotal for sustainable utilization of environmental resources [6]. Further, TEK remains underdocumented in Kenya, particularly western Kenya [6]. Instead, there seems to be much focus on the “modern scientific knowledge.” In western Kenya, for example, researchers do not seem to have paid much attention to TEK and its role in sustainable plant resource utilization. For this reason, this study sorts to answer the following questions: (1) Which plant resources are perceived as resources in western highlands of Kenya? (2) What degree of knowledge do people of varied socioeconomic status living in different ecological zones in western Kenya have about indigenous plant resources? (3) How are indigenous plant resources defined and conserved in western highlands of Kenya? and (4) To what extent do traditional knowledge and indigenous institutions for natural resource governance remain relevant in resolving current land degradation issues and how are they integrated in formal policy process in western highlands of Kenya? This study attempts to fill these gaps in knowledge by using people within western highlands of Kenya as the micro-level unit of analysis examining how they exploit indigenous plant resources. We postulate that people’s management and utilization of plant resources are based on the knowledge, priorities and perceptions of the natural environmental resources and ecological processes involved. The study identifies the plant resources that are perceived by people as

resources and undertakes an evaluation of these resources. It documents and assesses the TEK associated with the utilization of plant resources and examines how the resources are defined by use and culture.

2. Literature review

2.1. Traditional ethnobotanical/ecological knowledge

There is a general consensus in the arena of NRM that traditional ethnobotanical/ecological knowledge of indigenous communities can positively influence sustainable land management (SLM) practices [14–17]. Further, TEK can widen the manner in which environmental challenges are conceptualized and addressed by communities, hence enhancing a socioecological system's resilience [18].

TEK has received much attention from several researchers, hence the myriad of definitions. Raymond et al. defined TEK as “a subset of indigenous knowledge that includes knowledge and beliefs handed down through generations by cultural transmission and which is related to human environment interactions” [19]. Fernandez-Gimenez describes TEK as “a system of experiential knowledge gained by continual observation, and transmitted among members of a community” [20]. In this study, we use a definition from [16]: “a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about relationship of living beings (including humans) with one another and with their environment.”

TEK is an important component of a number of concepts within community-based natural resource management (CBNRM) realm and related concepts, including resilience, community participation and stakeholder collaboration [16, 21, 22]. Sustainable land management more often than not requires sufficient collection, retention and transmission of knowledge gained through years of interacting with a landscape [23]. TEK transmission is the transfer of traditional knowledge between individuals of a particular indigenous group. The primary modes of transmission are dynamic, varying with place and across time, though it commonly occurs through direct interaction with one's environment [24, 25]. TEK is also often conferred during normal social interaction and by oral transmission through storytelling [16, 26].

Loss of TEK has been attributed in part to Western influences including formal education, medicine, political systems, religion and technology [12, 27–29]. These factors have been corroborated by the United Nations Environment Programme (UNEP) in 2006, which presented a list of 23 barriers to traditional knowledge in Africa, including loss of or dramatic change to ecosystems, poverty, climate change, emigrations, schools, urbanization, among others [26].

2.2. Empirical studies on determinants of sustainable utilization of plant resources

Many factors determine whether or not indigenous plant resources are to be used in a sustainable manner. **Table 1** summarizes the findings of empirical studies on determinants of sustainable utilization of plant resources.

Author	Objective	Method	Setting	Main findings
[17]	Examine the different species and uses of plant genetic resources	Literature review	South Africa	South Africa is a hot spot for biodiversity with more than 22,000 plant species that form 10% of the world species on only 1% of the earth. Plant genetic resources are used for four main purposes: (1) medicinal by 60% of people who engage in informal trade with threats of depletion of many indigenous species. (2) Few species are used as food: leaves and trees have high nutritional value and, hence, could play an important role in preventing malnutrition in rural areas. (3) Ornamental industry based on a plant kingdom called <i>flora capensis</i> with 8600 species that were collected by many European explorers to develop new horticultural products. The indigenous flower industry supports 20,000 people in South Africa. (4) Economic exploitation of aloe and the devil's claw that are exported for medicinal use
[56]	Explore the role of gender in sustainable utilization of environmental resources	Literature review	Mayan communities, Mexico, Africa and Bangladesh	Although women have always played a major role as food providers and plant domesticators, they were considered as ecologically naïve until the last decade when they were recognized as embodying environmental knowledge that could lead to sustainability since it is local, traditional, subsistence-oriented, contextual, communal and uncorrupted by the influence of the commercial market. However, gendered knowledge varies with the environment. For instance, out migration in Mexico pushes women into decision-making positions while in Bangladesh, women do not play a public role in agriculture but only preserve indigenous crops
	Assess the effect of ecotourism on retention of knowledge on wild medicinal plants	Literature review	Brazil-Bahia State	Knowledge of medicinal plants is declining in the face of habitat alteration and cultural decay. However, women are the primary health care providers in the family and older women know more medicinal plants than men do; elderly women constitute cognitive repositories of traditional ethnomedical knowledge. Younger women and men, especially those with the most education and travel experiences, show little interest in learning the identities and use of local plants, albeit having a strong general commitment to environmental conservation
[50]	Dependent on substance production of maize and b squash	Literature review	Mayan community in the Yucatan	Home gardens and agricultural field are complementary gendered domains for varietal maintenance for both maize and squash, while a new space of family allocated plots (terrenos) is a joint agricultural domain where both genders make decisions about crop diversity. Mayan women select maize based on factors such as processing, food preparation and preservation methods, while men select squash cultivars for the market value of their seeds
[15]	Examine the role of gender in conservation of plant resources	Field surveys	Central Mexico	Gender differences in knowledge of varieties of maize are related to divisions of labor, farming of separate plots and men's out migration for long periods. Women could remember a greater number of varieties of maize that were no longer grown and that they often grew small plots of traditional maize varieties for special dishes or to maintain a variety passed on to them by a parent or grandparent

Author	Objective	Method	Setting	Main findings
[69]	Assess the relationship between gender and the naming of plant resources	Field survey	West Africa-Ghana	Gender division of labor is extended to labeling certain crops as male or female depending on their role in the perfect meal. Stable root crops are considered to be "male," while the seasoning used with these stable roots are grown and collected by women. The introduction of soybean changes the gendered relationships with food crops. Soybeans are associated with female soup items and their introduction allows women to overcome the shortage of the traditional soup item, wild "dawadawa" seed, due to deforestation. Women are able to cultivate, process and market soybeans, but pesticides are considered. Male and women are not only excluded but refrain from the technology of plant protection for fear of being accused of witchcraft
	Identify the role of women in food conservation	Literature review	Uganda	Although women are sorghums' exclusive custodians, their lack of decision-making authority over allocation of productive resources, plus a labor shortage precipitated by HIV/AIDS, is making it hard for them to maintain crop biodiversity. Nevertheless, women's role in seed selection and seed conservation ensures the survival of many local varieties
[64]	Assess women's attitudes toward varieties of rice grown in Bangladesh	Field survey	Bangladesh	Seed management is an extension of women's domestic duties: women are responsible for all seed processing, storage and exchange for both field and home garden crops. Women are reservoirs of detailed and complex knowledge of seed selection, processing and storage that is vital for the survival of households and local culinary cultures and is a source of pride among women. Although rural women accept the necessity for growing hybrid rice in order to "fill the stomach," they regret the loss of traditional varieties that were used in special dishes and in ceremonies
[45]	Examine farmers' ethnobotanical knowledge and rural change	Field survey with 90 respondents	Bungoma, Kenya	Some farmers have started to domesticate some of the traditional plants and new crops which have been introduced associated with corresponding innovations in local agricultural systems. It is important to combine and intertwine modern and indigenous knowledge to produce a more realistic and sensitive understanding and management of natural environmental resources for sustainable development
[62]	Explores the dynamics of the production and marketing process of rooibos tea and the key variables involved	Field research 2004–2006	South Africa	Success in tea production has been achieved through active NGO support which focuses on the use of local skills and social capital. This has led to significant social and economic improvement among participating communities. The experience illustrates how, given the right conditions, poor communities in the South might participate successfully in global alternative food networks
[11]	Analyses of key decision points and critical emerging legal and policy issues that have an impact on utilization of plant resources	Literature review	Global documents	There are major issues that influence the use of plant resources such as the farmers' rights, the rights and interests of indigenous and local communities, benefit-sharing, access to genetic resources, patenting and industry trends and protection of plant varieties

Author	Objective	Method	Setting	Main findings
[75]	Assessment of the use of biotechnology in conservation of plant generic resources	Literature review	Kenya	Conservation and sustainable use of genetic resources is essential to meet the demand for future food security. Advances in biotechnology have generated new opportunities for genetic resource conservation and utilization. Techniques like in vitro culture and cry preservation have made it easy to collect and conserve genetic resources, especially of species that are difficult to conserve as seeds. While technologies like enzyme-linked immunosorbent assay (ELISA) and polymerase chain reaction (PCR) have provided tools that are more sensitive and pathogen specific for seed health testing, tissue culture methods are now widely applied for elimination of systematic diseases such as viruses for safe exchange of germplasm

Source: Author's synthesis of literature.

Table 1. Empirical studies on determinants of sustainable utilization of plant resources.

2.3. Land degradation and sustainable land management in western highlands of Kenya

An overwhelming number of smallholder farmers in western Kenya rely on subsistence farming as their main source of food and livelihood support. However, this resource base has experienced continuous widespread declining land productivity due to various forms of land degradation that include but not limited to: soil erosion, soil nutrient depletion, deforestation and biodiversity loss [30, 31]. This directly has concomitant negative effects on household food security, particularly for the resource-poor farmers. In a wider sense, this adversely affects the supply of a range of ecosystem services from the existing natural resources [32]. For instance, ecosystem services provided by tropical forests are becoming scarcer due to continued deforestation as demand for forest benefits increases with the growing population [33, 34], whereas land degradation is acknowledged as a key contributor to poverty and food insecurity [35]. SLM strategies have in recent years been a focus of the Government of Kenya, and numerous development partners, due to their potential to minimize degradation, rehabilitate degraded lands and increase food production (**Table 2**). Studies elsewhere have found that proper application of SLM practices reduces land degradation and improves productivity of ecosystem services within the targeted ecosystems [36, 37].

According to Ref. [39], SLM is “a knowledge-based [process] that helps integrate land,..., biodiversity and environmental management ... to meet rising food and fibre demands while sustaining ecosystem services and livelihoods.” SLM is necessary to meet the requirements of a growing population. Improper land management can lead to land degradation and a significant reduction in the productive and service functions.¹ For operational definition purposes, we considered SLM as the “application of a set of improved technologies and or better practices to enhance land productivity, increase on-farm returns and forest benefits than what is currently achieved” [40].

¹Numerous definitions of sustainable agriculture and natural resource management exist [54–56] that are equally applicable to land management. This chapter draws upon these in the definition provided *inter alia*.

Selected projects	Lead implementing agency	Location of implementation
1. Nitrogen to Africa—N2Africa	Centre for Tropical Agriculture—CIAT	Kakamega
2. Kenya Agricultural Production and Agribusiness Programme—KAPAP	Ministry of Agriculture	Kakamega, Siaya
3. Sustainable Intensification of Maize-Legume Cropping Systems for Food Security in Eastern and Southern Africa—SIMLESAs	Kenya Agricultural and Livestock Research Organization—KALRO	Bungoma, Siaya
4. Sustainable Community-based Input Credit Scheme	Kenya Forestry Research Institute—KEFRI	Siaya
5. Kenya Agricultural Carbon Project—KACP	Vi Agroforestry	Bungoma, Kakamega, Siaya
6. Strengthening Rural Institutions—SRI	World Agroforestry Centre—ICRAF	Bungoma

Source: Ref. [38].

Table 2. Some selected SLM projects implemented in western Kenya.

In the study area, the following SLM practices are ubiquitous: application of farm yard and compost manure, use of inorganic fertilizers and improved crop varieties, incorporation of crop residues and intercropping with legumes [41–44].

2.4. Conceptualizing indigenous institutions in soil land management

Institutions have been defined in various ways such as “rules of game in a society” [45], “regularized patterns of behaviour between individuals and groups in society” [46] and “structures of power” [47]. However, institutions can be simply understood as rules and norms framed by people, helping them in deciding what actions are required, permitted, or forbidden in society [48]. Institutions reflect power relations in community, which shape the ways in which differentiated actors access, use and derive well-being from environmental resources and services. They play a critical role in sustainable management of resources through defining property rights. For example, institutions ascertain who can graze cattle on a particular pasture and who cannot and also define one’s share [49]. Institutions promote stability of expectations *ex ante*, and consistency in actions, *ex post*, from different actors [50]. Hence, it is increasingly believed that “getting institutions right” is as important as and inextricable from “getting incentives right,” if sustainable resource development is to be achieved [48].

Like institutions, the term “indigenous institutions” has also been defined in many ways, which makes it difficult to understand what does it involve and what does it mean. Here for the sake of simplicity and clarity, a definition can be borrowed from [47], who defines indigenous institutions as “those institutions that have emerged in a particular situation or that are practiced or constituted by people who have had a degree of continuity of living in, and using resource of an area.” These indigenous institutions can be traditional and nontraditional, and formal and informal. Indigenous institutions have a number of positive characteristics, which

lead to successful natural resource management. Some of their characteristics are [50]: social embeddedness, flexibility, cost-effectiveness and ability to promote inclusive and holistic development.

3. Research methodology

3.1. Study area

The study area covered Vihiga County and subcounties and areas adjacent to Kakamega tropical rainforest in western Kenya (**Figure 1**). Subsistence agriculture is the mainstay of the inhabitants of the area. The Kakamega forest ecosystem is a major source of charcoal and firewood, livestock grazing, medicinal extracts and wild honey and provides ground for the local community to practice their cultural activities such as circumcision [51]. The prominent SLM practices include: planting of improved seed varieties, timely implementation of agronomic practices, mulching, contouring on slopes, planting multipurpose farm trees and livestock integration [43, 44]. The SLM strategies for conservation of Kakamega forest ecosystem include: the promotion of farm forestry, sustainable planting and harvesting regimes for plantations, rehabilitation of natural forest stands and protection of riparian vegetation [52].

3.2. Conceptual framework for the study

A synthesis of literature and theories led to the development of a conceptual model for the study as shown in **Figure 2**. The model emphasizes the pivotal role that ecological and socio-economic factors play in the utilization of plant resources. The relationships in the model are complex but linear. As shown in **Figure 2**, the level of TEK and utilization of plant resources are not arbitrary but instead, specific factors determine where, who, when and how plant resources are utilized by varied cultural identities, resulting into either sustainable or unsustainable utilization of plant resources and/or land management.

3.3. Sources of data

The study used both qualitative and quantitative data collection techniques. The data collection tools included:

3.3.1. Social surveys

In order to generate data about people's experiences of TEK, the first task was to investigate and analyze the socioeconomic/cultural and demographic profile of the respondents. To achieve this, a social survey was conducted on household basis, using mainly structured questionnaires. The questionnaires included both closed- and open-ended questions. Prior to the design of survey instruments, 2 weeks of reconnaissance were carried out in the study area to ascertain the population from which a sample would be drawn for data collection. Using a simplified formula for determining a sample size, $n = 1 + N(e)^2$, the sample size was

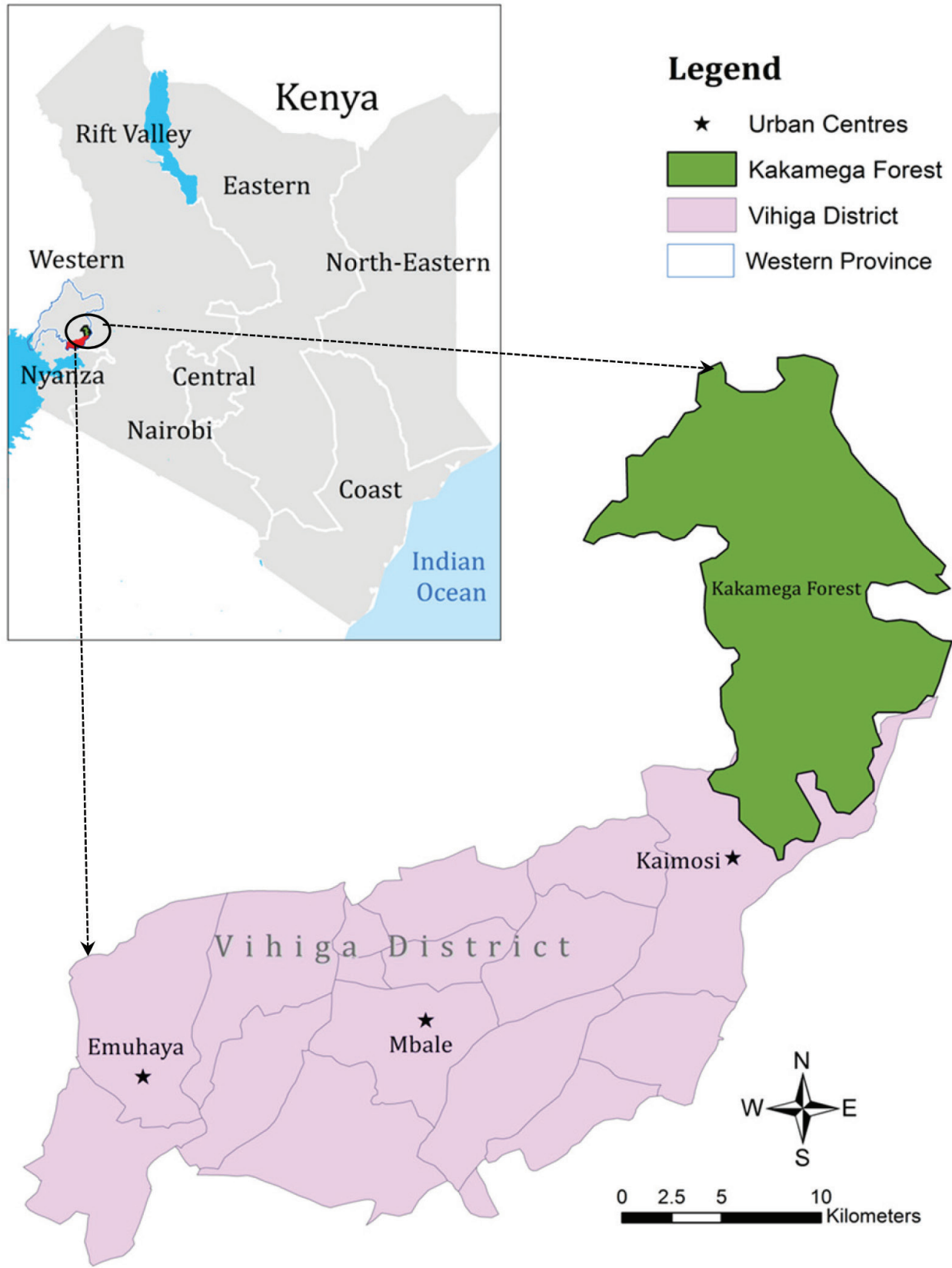


Figure 1. Map of Kenya (inset) showing the location of Vihiga District and Kakamega Forest that constitute the study area in the western highlands of Kenya (source: Ref. [53]).

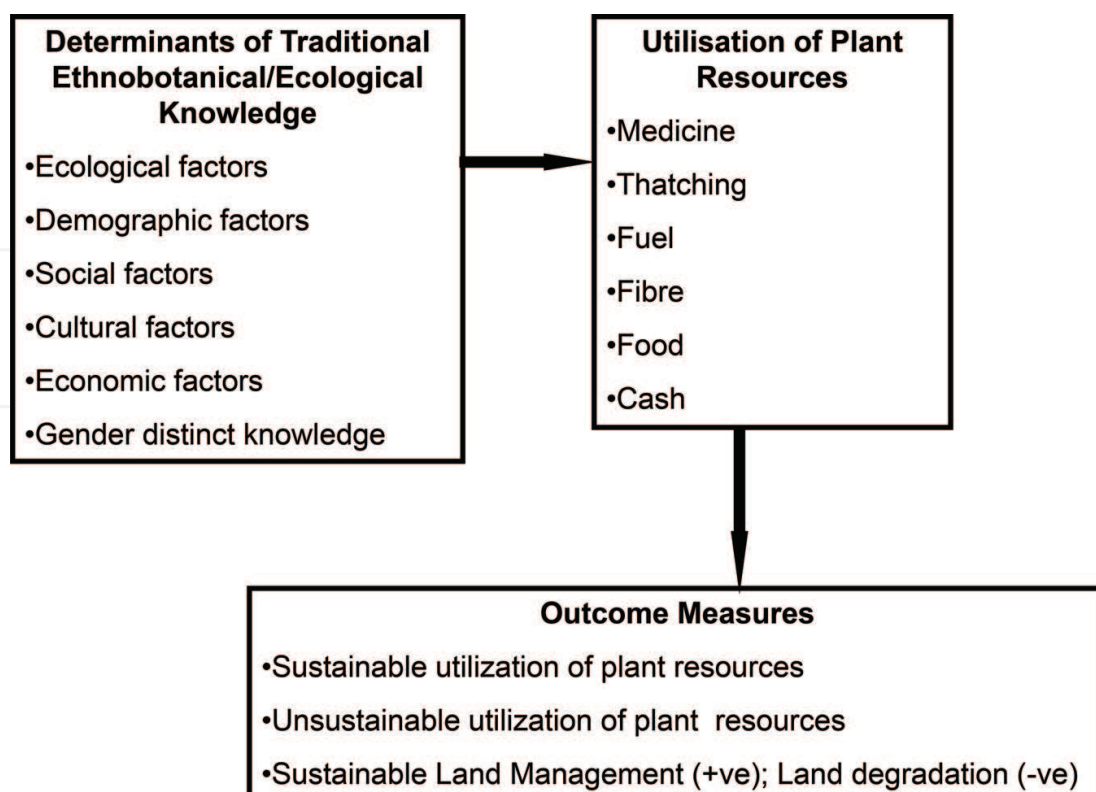


Figure 2. Conceptual model of the study (source: author's own conceptualization).

calculated from the target population with a 5% margin error [57, 58]. In the formula, n = the desired sample size, N = the target population and e = margin of error.

A reconnaissance visit was prudent to help gain basic understanding of the potential respondents for the study, and this helped in deciding what to include in the survey instruments. After the initial visit, a week was spent preparing questionnaires for the survey, and another week for training of research assistants on how to effectively administer the questionnaires and also iron out any challenges regarding translation of questions and responses (from English to the local languages and vice versa where applicable). The services of a translator were employed where necessary. A total of 30 questionnaires were piloted. The results of the pilot were used to improve the efficiency of the data collection instruments for the main survey. The study also employed ethnographic approaches such as participant observation, transect walks, key informant interviews and focus group discussions.

3.3.2. Participant observation

Participant observation is considered a primary method in anthropological research, especially for ethnographic studies. One of the first instances of its use is in the work of Frank Hamilton Cushing who spent four and a half years as a participant observer with the Zuni Pueblo people (northwestern New Mexico) around 1879 [59]. The aim of participant observation was to understand the social world from the subjects under investigation's point of view [60].

3.3.3. Key informant interviews

This is a qualitative and in-depth method of data collection with people who know at first-hand what is going on in a specific area of an activity [60]. It is carried out in the form of a loosely structured conversation with selected (nonrandom) group/individuals that have specialized knowledge about a topic one wishes to understand [61]. Key informants for this study were selected from Kakamega County based on consultations with other key informants as well as references from scholarly literature and official documents. Key informants outside the study area were also interviewed where necessary.

3.3.4. Focus group discussion

This is a research method in which a small group of participants gather to discuss a specified topic or an issue to generate data [62]. Focus groups can reveal a wealth of detailed information and deep insight. The discussion capitalizes on communication between the researcher and participants to generate data [63]. Participants for the focus group discussion (FGD) were drawn from the following groups: youths, women, men, traditional health practitioners, county officials, among others. The FGD participants were identified from prior data survey data collection. The discussions were recorded (audio and video) with consent from participants, and at the end of each FGD session, they were required to fill out an evaluation questionnaire.

3.4. Data analysis

Data analysis comprised both quantitative and qualitative techniques. Quantitative data on the one hand were cleaned, coded and entered into the Epidata 3 software prior to exporting it into the Statistical Package for Social Science (SPSS) version 16 for analysis. Descriptive and cross tabulations were carried out. On the other hand, qualitative data followed a four-point data analysis schema involving reading, coding, displaying and data reduction. The transcripts were entered into Nvivo 10 program (Scolari Inc., SAGE Publications) based on the template of topical categories drawn from questions and issues covered in the field guide and from the themes emerging from the interviews themselves. The program facilitated easy coding, displaying and data reduction.

3.5. Ethical considerations

Prior to participation in the study, an informed consent of all participants was sought. The researcher acknowledges that many of the cultures from which traditional knowledge is collected are more endangered than the ecosystems in which they reside. When their local knowledge and information is published or supplied to databases, industry or the general public, a unique opportunity exists for these communities to receive economic or nonmonetary benefits from its use. If this opportunity is missed, their knowledge, once published, becomes part of the public domain and it is no longer their own to monitor and control. Yet, ethnobotanical information is often recorded without fully explaining to communities how it will be used or how local rights to control its use might be affected. Similarly, biological samples are

sometimes collected from indigenous reserves without local communities' full consent. The ethical issues that were addressed by the researcher in consultation with Kenyatta University Directorate of Intellectual Property Rights (IPR) included:

1. Identifying the communities living in the study area.
2. Consultation with the communities to ascertain interest in the project in allowing access to their resources.
3. Negotiating agreement with potential users.
4. Providing copies of the report.
5. Third-party use of information.
6. Access to their genetic resources embodying their traditional knowledge.
7. Issues related to equitable benefit sharing.
8. Community intellectual property rights.

While systematic documentation captures and preserves orally transmitted knowledge for present and future generations, it exposes local farmers to the risk of losing their IPR through piracy and commercial exploitation. Cognizant of this, the research team strived to use creative ways of documenting oral ethnobotanical knowledge while protecting the IPRs of the community right at the beginning of the study. The provision of an explanation on the objective of the study hopefully led to a relaxed and positive attitude from the respondents to facilitate data collection. Additionally, field observations, photography, participatory resource mapping and transect walks were employed in data collection.

The inclusion of the community in the study by giving local people a chance to coordinate the study process enabled the research team to build linkages and ensured that the local community owned the work. The local community benefited in three ways:

1. The local steering committee that mobilized people were recognized as key people who had interacted with senior scientists and obtained knowledge on some aspects of indigenous ethnobotanical resources that they could cascade to other members in the community.
2. The youth who participated in the study as research assistants were not only remunerated for their services but also gained insight into ethnobotanical knowledge that they did not have previously.
3. Members of the research team were given seedlings by some herbalists who had preserved pivotal plant species in nurseries to plant in their homesteads for future use.

Such collaboration through an exchange of seedlings between the community and researchers as well as empowerment of the research team to cascade the gained knowledge about ethnobotanical resources enhanced the buy-in of study results and recommendations to improve the current environmental policy with a view to integrating indigenous ethnobotanical knowledge in development programs for sustainability.

4. Results and discussions

4.1. Awareness of traditional knowledge and practices

The results shown in **Table 3** indicate that most respondents (95%) were aware of these practices, whereas the remaining 5% were not aware. To establish the levels of understanding of TEK on SLM, respondents in the study subcounties were asked to state whether they were aware of the various TEK and practices related to SLM. Majority of the respondents (95%) were aware of these practices, whereas the remaining 5% were not aware (**Table 3**).

The level of awareness of traditional knowledge and listed practices of SLM was not significantly different among respondents across levels of education. Significant differences emerged between gender categories. Majority of male respondents (73%) were aware of the different traditional methods and practices of SLM compared to 27% among female respondents. This difference was statistically significant ($\chi^2 = 9.75$, $df = 2$, $p < 0.017$). Similar findings have been reported elsewhere [59]. This difference can be attributed to the fact that customarily, men are inheritors of ancestral land among communities inhabiting this region and hence are keener on conserving land than women. This was summarized as follows:

Women can never inherit ancestral land in this region. Land is inherited by sons of the home. Girls are expected to get married elsewhere when they become of age (in-depth interview).

Young respondents aged 18–25 years had limited knowledge about traditional methods and practices of SLM. Respondents aged 45 years and above appeared to be more aware of these methods and practices. Chi-square test confirmed that these differences observed were statistically significant ($\chi^2 = 14.143$, $df = 5$, $p < 0.001$). The differences in levels of awareness about traditional methods and practices of SLM between young and elderly were further emphasized by respondents in a FGD, thus:

Sub-county	Number of respondents	Aware of TEK of SLM	
		Yes	No
Luanda	50	100	0
Emuhaya	50	90	10
Hamisi	50	100	0
Sabatia	50	80	20
Ikolomani	50	100	0
Shinyalu	50	92	8
Malava	50	100	0
Total	350	94.6	5.4

Source: Field data, 2016 ($\chi^2 = 34.456$, $df = 12$, $p < 0.021$).

Table 3. Respondents' awareness of soil land management in the study area.

Only old men and women have same knowledge about indigenous plant resources and how they are used. As for young people, only few who go to the forest to harvest some species for use as medicine have some knowledge about indigenous plant resources. The reason that the youth lack such knowledge is that the elderly withhold a lot of information from the former so that they can continue reaping economic benefits from their knowledge of indigenous medicinal plants. (Male FGD, Malava Sub-county).

These above results corroborate results of other studies that younger people are less knowledgeable about indigenous plant resources. In Bahia State of Brazil for example, younger women and men, especially those with the most education and travel experiences, show little interest in learning the identities and uses of local plants, albeit having a strong general commitment to environmental conservation [64].

4.2. Current traditional knowledge and SLM practices in western highlands of Kenya

Some of the identified practices that address the myriad soil land management challenges (Plate 1) in the study area are elaborated here below.



Plate 1. Environmental challenges facing the people of western highlands of Kenya (source: Author, 2016).

Cultivation of ridges

The most popular practice used in the study area is the “*fanya-juu*” terracing. *Fanya-juu* terraces have had the positive effect of increasing crop yields in East Africa by about 25%, hence the high adoption rate by smallholder farmers (**Figure 3**) [65].

On the importance of *fanya-juu* terraces, respondents during in-depth interview were unanimous that:

Fanya-juu terraces help preserve valuable topsoil rich in soil organic matter, thus promoting the use of fewer chemical inputs to sustain yields, which have positive economic and ecological consequences for both farmers’ livelihoods and the environment.

Use of organic farmyard manure

This practice of using farm yard manure (FYM) (*imbolea*) in crop farming enterprises is common in the study area. Cattle manure is an integral component of soil fertility management in western highlands of Kenya, and its importance as a source of nutrients for crop production is widely recognized [66–68]. Field interviews showed that respondents rely on organic manures as low cost and easily available alternatives to inorganic fertilizers. The quantity and quality of manures available are the major factors limiting its contribution to increased crop yields.

The use of FYM requires that farmers own livestock as the market for it is thin because of inadequate amounts available partly because of inadequate knowledge on its benefits [69]. Respondents during FGD reported that they make their farm yard manure from a wide range

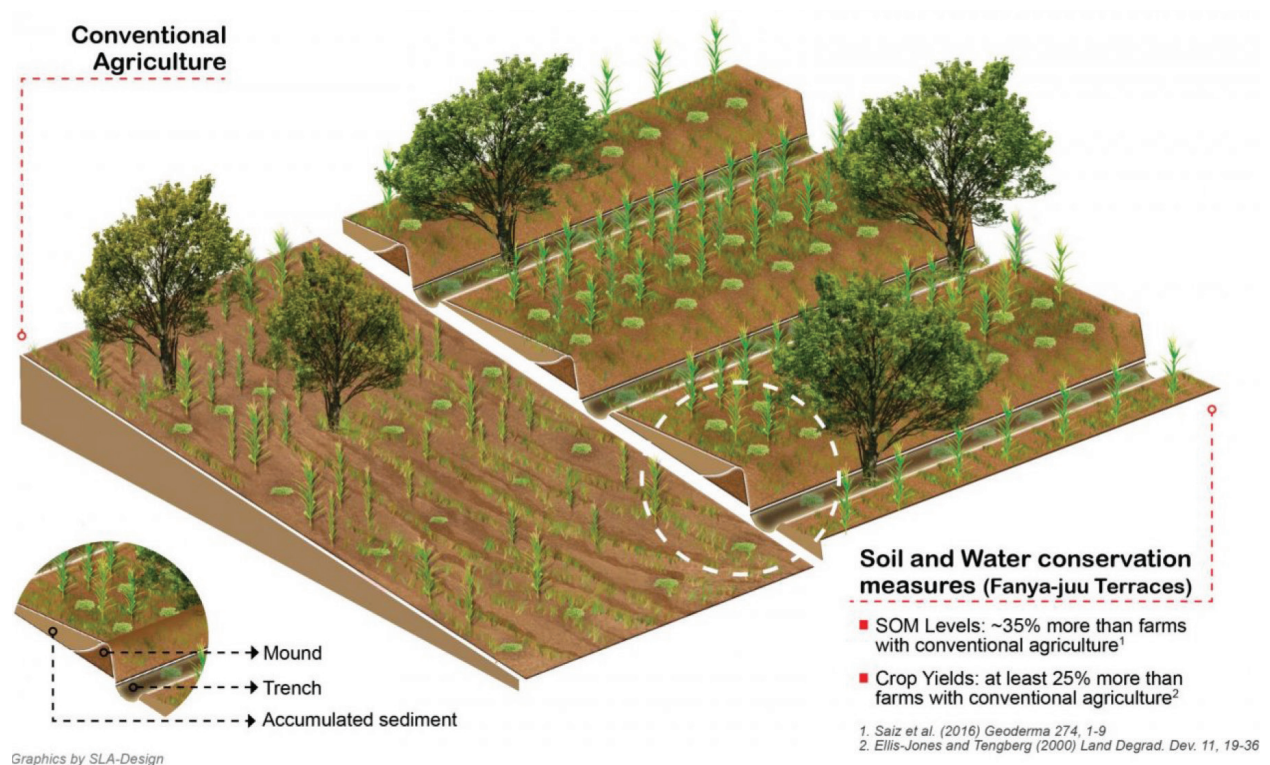


Figure 3. The architecture of *fanya-juu* terraces (source: Ref. [65]).

of organic materials including plant residues (maize stover, bean straw, grass trash, tree/hedge cuttings and banana pseudostems), animal manures and kitchen waste.

Mulching

Mulching is an effective method of manipulating crop-growing environment to increase yield and improve product quality by controlling weed growths, ameliorating soil temperature, conserving soil moisture, reducing soil erosion, improving soil structure and enhancing organic matter content [70]. Over 95% of respondents interviewed reported practicing mulching on their crop fields.

Protection of indigenous plant resources through religio-cultural beliefs and rituals

A herb called *Euphorbia tirucalli* (ingoi) was mostly used during rites of passage. Other ethnobotanical species that were mostly mentioned by respondents as instrumental in rites of passage include: *Musa acuminata* (amakomia) or bananas (315 respondents, 90%), *Trichilia emetica* (munyama) (315 respondents, 90%), *Tamarindus indica* (mukumu) (315 respondents, 90%) and *Ficus thonningii* (mutoto) (300 respondents, 85.7%).

FGD participants observed that an herb called *Euphorbia tirucalli* (ingoi) acts as a disinfectant/antibiotic and facilitates faster healing of wounds. This explains why the herb was applied on fresh wounds after circumcision of boys in the western highlands of Kenya. According to respondents:

When we were circumcised, there was something that was crushed called Euphorbia tirucalli (ny-ingwa or ingoi), mixed with water and applied on our fresh bleeding wounds to facilitate faster healing. (Male, FGD, Malava Sub-county)

The value of trees was equally mentioned during rituals related to child birth. According to a respondent, “the leaves of *Dioscorea villosa* (induma) or yams were boiled in water and used to bathe new born babies in order to neutralize their bad smell and wade off evil eyes of some people who could cause harm to the baby.” (Female, FGD with herbalists in Shinyalu subcounty). A species of a tree called *Markhamia lutea* (lusiola) was used during rites of passage, starting with birth, initiation, marriage and death. “Leaves of *Markhamia lutea* (lusiola) and another tree called *Plectranthus barbatus* (shiroko) were used with warm water to massage a child’s knees to enable them to walk faster.” (Female, FGD with farmers in Luanda subcounty).

The *Markhamia lutea* (lusiola) tree was also utilized during marriage rituals. According to a respondent, “during marriage arrangements, branches from *Markhamia lutea* (lusiola) tree were customarily used to shepherd cows during dowry delivery. This is because the tree was perceived to link the living dead and future generations.” (Male, FDG with farmers in Shinyalu subcounty). “A species of a creeping plant, *Cussonia arborea* (lirande), was used to determine whether or not a marriage deal would be successful.” (Male, FGD with herbalists, Ikolomani subcounty). When emphasizing how the success of a marriage was determined, a respondent noted that:

There is a root of a plant called Cussonia arborea (lirande). The Cussonia arborea (lirande) could be extracted and had to come out whole so as to give the expected result. If successful, a man went ahead to approach the girl. The girl could simply follow the man and accept all his wishes. (Male, FGD with farmers in Shinyalu Sub-county)

When death occurred, *Markhamia lutea* (*lusiola*) tree was used to light mandatory fires that were believed to unite the dead and living members of the community in the former Kakamega district. A respondent noted:

"Markhamia lutea (lusiola) tree was used to light mandatory sacred fires that are believed to link the living and the dead." (Male, FGD with charcoal burners, Shinyalu Sub-county)

The results also demonstrate that some indigenous tree species were used to demarcate sacred space such as graves of elderly and other respected people in the highlands of western Kenya. According to a respondent:

"Markhamia lutea (lusiola), Tamarindus indica (mukumu) and Croton macrostachyus (musutisi) trees were planted on graves of prominent people in the community." (Man, FGD with farmers, Ikolomani Sub-county)

Study participants mentioned that some trees such as *Markhamia lutea* (*lusiola*), *Mimusops bagshawei* (*lutori*) and *Diospyros abyssinica* (*lusuyi*) are perceived as symbols of power and authority in the western highlands of Kenya. This explains why "walking sticks for respected elderly people are made from trees called *Mimusops bagshawei* (*lutori*), *Markhamia lutea* (*lusiola*) or *Diospyros abyssinica* (*luswi*). Again, circumcision clubs for identifying initiates were derived from *Markhamia lutea* (*lusiola*) tree." (Male oral interviewee, Malava subcounty).

Some participants mentioned the value of indigenous plant resources to exorcize demonic forces from haunted people. A respondent observed that "the bark from *Vangueria apiculata* (*mukhaa*) is used to exorcise demons and evil spirits from a possessed individual." (Male, FGD with farmers in Ikolomani subcounty). *Spathodea campanulata* (*luviru*) is also used to exorcize demons and evil spirits. According to a respondent, "*Spathodea campanulata* (*luviru*), is burnt over fire and its ash licked by the affected person to neutralize demonic forces in him/her." (Male, FGD with herbalists, Ikolomani subcounty). A female herbalist reiterated, "the leaves and bark of *Rubia cordifolia* (*mulonda musala*) herb also block evil spirits and demons from attacking people." (Female, FGD with herbalists, Ikolomani subcounty). Results also revealed that some indigenous plant species were used to bind oaths. Such plant species were planted by participants after making oaths to seal intentions of keeping promises. According to a respondent, "*Tamarindus indica* (*mukumu*) and *Sesbania sesban* (*lukhuvu*) trees were used in administering oaths. A shrub species called *Sesbania sesban* (*lukhuvu*) was mostly utilized to seal oaths" (Male, FGD with herbalist in Shinyalu subcounty).

5. Recent changes in the use and conservation of indigenous plant resources

Distinct gender roles exist in western highlands of Kenya which have influenced utilization of indigenous plant resources over time. However, the onset of colonialism, missionaries, education and modernization introduced changes in the use of indigenous plant resources as shown in the succeeding section.

5.1. Enculturation, gender dynamics, utilization and conservation of plant resources

Field results show a change in the use of indigenous plant resources due to societal changes in the former western highlands of Kenya. They include cultural changes and gender roles as discussed below.

5.1.1. Changing culture and gender roles

Unlike in the ancient days when culture prohibited women from cultivating and utilizing some plant resources such as indigenous trees and banana fibers, there is a change in modern times because culture is no longer strictly upheld. The introduction of exotic plant resources such as *Cupressus lusitanica* (*mutarakwa*) or Cyprus trees and genetically improved *Musa acuminata* (*amakomia*) or banana fibers has benefited illiterate women who feel free to handle the new plant species unlike indigenous species that culture prohibits women from cultivating and caring for. A respondent reiterated this fact in the following excerpt:

*Beliefs and traditions used to demean women and prohibit them from planting trees and **Musa acuminata** (*amakhola*) banana fibres. However, times have changed leading to relaxation of stringent traditions and customs. Nowadays women do plant exotic trees and improved **Musa acuminata** (*amakomia*) banana fibres in women groups: something that was considered as a taboo in the olden days. (Female, FGD with farmers in Malava Sub-county)*

These changes have enabled women to play an important role in agro-biodiversity by cultivating, caring for and conserving plant resources by borrowing from traditional indigenous knowledge where women are well endowed as seen earlier. Women provide required food for households because they live in rural areas as spouses live in urban centers due to urbanization. Our findings corroborate with other studies [34]. The vital role played by women in the western Kenya resonates with the emphasis of the Rio Earth Summit that recognized and fostered the traditional methods and the knowledge of indigenous people and communities by emphasizing the particular role of women that is relevant to the conservation of biological diversity and sustainable use of biological resources [71]. Despite the engendered use of plant resources that has been enhanced by modernization and urbanization, there are specific indigenous plant resources that some illiterate women feel uncomfortable to plant due to cultural prohibitions. These include planting indigenous species of *Musa acuminata* (*amakomia*) or bananas, trees and fences, fearing that their spouses could die as elaborated by a respondent in **Box 1**.

There are some traditions that are still upheld, and these discourage women from planting indigenous plant resources such as *Musa acuminata* (banana) fibers and indigenous trees. Tradition demands that these crops be planted by men only. It is believed that men can die if women plant trees and bananas fibers. To this end, woman must rely on men to plant bananas fibers. If spouses are away, women request brothers-in-law to plant these species on their behalf. But in case the men decline, then bananas fibers and indigenous trees are not planted until when spouses return to villages to play their appropriate roles in homesteads. (Female oral interviewee, Shinyalu Sub-county)

Box 1. Some women not free to plant bananas and some indigenous trees.

5.1.2. New technology, utilization and conservation of indigenous plant resources

Agricultural technology could be perceived as both destroyer and conserver of indigenous plant resources. On the one hand, the introduction of technology has led to destruction of indigenous herbs/weeds that were resourceful to people. A case in point is where wastes from factories pollute rivers, leading to destruction of plant resources. When referring to this trend, a respondent noted, "Long ago, we had different varieties of indigenous plant resources in our river basin that served many purposes. But with the introduction of factories in this area, the waste is dumped in rivers leading to extinction of most indigenous plant resources along river valleys." (Male, Oral interviewee, Ikolomani subcounty)

Pollution of the environment negates Act 87 of the Environmental Management and Co-ordination Act [72] that prohibits discharge of wastes that pollute the environment. The Act expects owners of factories to minimize wastes through treatment, reclaiming and recycling: failure to which such individuals are guilty of an offence liable to imprisonment for a term of not more than 2 years or to a fine of not more than 1 million Kenya shillings or to both such imprisonment and fine. To this end, local people ought to be made aware of their rights under this Act so as to put pressure on factory owners to minimize wastes prior to discharging water into local rivers. On the other hand, the introduction of technology has enabled people to conserve some species such as *Aloe kedongensis* (likakha) or *aloe vera* whose economic value was unknown. These trends are further discussed below.

5.1.3. Modern technology as destroyer of indigenous plant resources and soil nutrients

The onset of modern agricultural practices such as tractors and power saws led to clearing of indigenous herbs/weeds thereby threatening their future existence. For instance, a species called *Mondia whitei* (mukombero) for increasing sexual libido and other weeds/herbs used to be found in bushes but are extinct because farms were cleared using modern technology to plant food crops as revealed in the following excerpt from the field:

Mondia whyttei (mukombero) used to be found everywhere when we [people in the western highlands of Kenya] had fallow land full of indigenous bushes and forests. But nowadays people use their land mainly for agriculture. Tractors or bulls are used to plough thereby destroying many indigenous weeds/herbs that existed in the past. If someone needs *Mondia whyttei* (mukombero,) these days, he/she must travel to Kakamega Forest to look for the species therein. (Male, FGD with charcoal burners in Malava Sub-county)

The results from FGD further show that the use of modern fertilizers is believed to have introduced new species of stubborn weeds/herbs that never existed in western highlands of Kenya before. All FGD participants mentioned a weed called *Tithonia diversifolia* (kayongo) as one of the stubborn new weeds that have been introduced by the use of modern fertilizers. The challenge of nuisance and invasive species that cause harm to the environment is increasing along with the increase in international trade. In order to address this challenge, the people in the highlands of western Kenya need to establish teams to research on such invasive species and advice the government on how to eradicate them as is the practice in the United States of America [60].

Again, modern fertilizers have led to extinction of some indigenous species as shown in the excerpt below:

*The use of new farm inputs such as pesticides and fertilizers have led to the disappearance of **Cupressus lusitanica** (inarutsaka) and even the leaves of that plant that was used to chase away birds in **Albizia coriaria** (mavere) or sorghum plantations. (Male, FGD with farmers in Ikolomani Sub-county).*

Key respondents further emphasized the role of technology in the extinction of indigenous herbs/weeds and vegetables as seen in **Boxes 2** and **3**, respectively.

People in this area have acquired knowledge regarding best practices in planting exotic species such as **Zea mays** (amatuma) or maize. They have knowledge about how and when to use varied forms of organic manure to plant **Zea mays** (amatuma). However, the people also know that continued use of modern fertilizers cause soil infertility and nothing can germinate unless the chemicals are added to the soil. This has led to reduced food production in this area and extinction of some valuable indigenous plant resources such as **Albizia coriaria** (shivembe or obusinde), **Ricinus communis** (amabono), **Cupressus lusitanica** (inabutsaka) and **Biden pilosa** (olukoye) or black jack that used to be common prior to introduction of modern fertilizers. Since many people lack cash to purchase the expensive fertilizers, they prepare composite manure in their homesteads to mix with modern chemicals to enhance productivity on their farms. (Male oral interviewee, Ileho Sub-county)

Box 2. Modern fertilizers' role in extinction of indigenous herbs/weeds.

Modern manure is responsible for loss of traditional vegetables. These vegetables cannot grow on the modern fertilizer. If an attempt is made, they merely wither away. For example, **Solanum nigrum** (lisutsa) and **Gynandropsis gynandra** (tsisaka) used to grow on uncultivated land. But these days, these vegetables together with **Amaranthus** (tsimboka) and **Portulaca oleracea** (inderema) are getting extinct due to the use of modern fertilizers. Whereas modern fertilizers increase the yield of **Zea Mays** (amatuma), the crop is very seasonal and very few people can afford the cost of fertilizer. On the contrary, indigenous food species such as **Ipomoea batatas** (lipwoni) or sweet potatoes were available throughout and enabled people to have food all the time. But the indigenous species of many crops are not available any more. (Female, oral interviewee in Shinyalu Sub-county)

Box 3. Modern fertilizers' role in extinction of indigenous vegetables.

FGD participants pointed out that agricultural inputs such as pesticides and fertilizers destroy nutrients in their farms. Farmers are forced to incur high costs to purchase farm inputs to improve ever-diminishing crop yields. One respondent stated that:

The use of fertilizer makes the soil very acidic and infertile. Previously, we just used organic manure for cultivating crops. We used to apply manure once for a whole season resulting to very good yields. But nowadays, our soils have changed. When you plant crops, with modern fertilizer, you must apply it again or top dress with ammonia before harvesting. Failure to constantly apply manure to food crops results to poor harvest. Again, nowadays, if you plant crops without fertilizer, you should not expect to harvest any crops. (Female, FGD with herbalists in Ileho Sub-county)

In order to improve the soil nutrients, FGD participants observed that agricultural officers encourage them to interplant **Grevillea robusta** (amapipilia) trees with food crops because the trees are friendly to the environment and to other crops. According to one participant:

*Nowadays, agricultural officers advice us to intercrop our food crops with **Grevillea robusta** (amapipilia) or gravellier trees to improve the fertility of our farms. Even long time ago, we used to inter crop **Tamarindus indica** (mukumu) tree, and **Olea capensis** (mukavakava), which shed their seeds and*

leaves to improve soil fertility. That is why we desire to have our indigenous plants to be returned to farmers so that we can bring back [revitalize] the soil fertility (Male, oral interviewee in Ikolomani Sub-county)

This finding shows that lack of adequate knowledge on ethnobotanical plant resources could lead to unsustainable utilization of the environment. Farmers who are unaware of how intercropping indigenous trees with food crops improve soil fertility are unlikely to plant indigenous trees on their farms. Fortunately, agricultural extension workers are sharing such information with farmers as they promote planting of *Grevillea robusta* (*amapipilia*) trees. In addition, agricultural extension workers disseminate information about the need to conserve genetic resources to meet the demand for future food security [73]. Our finding on the need to preserve indigenous plant species for sustainable use of the environment resonates with findings of other studies that new technology could be used to preserve indigenous plant resources and eliminate viruses for safe exchange of germ plasm using enzyme-linked immune sorbent assay (ELISA) and polymerase chain reaction (PCR) [73]. Ultimately, an integration of indigenous ethnobotanical knowledge with modern agricultural development will ensure sustainable use of the environment.

6. Importance of indigenous local institutions for natural resource management

Key informants were identified in consideration of gender balance, resource endowment and location in the landscape in order to examine the role of indigenous institutions for natural resource management in the study area. Diversity of indigenous local institutions identified is shown in **Table 4**.

The changes in importance for some of the local institutions shown in **Table 4** were also assessed. For example, rainmakers, devil cleansing, fortune-tellers and sacred areas for rituals are all becoming less important due to modern religion (Christianity and Islam),

Functional-based local institutions	Role in community
Land	Contracting and renting
Livestock	Regulating communal grazing
Labor	Collective action
Mutual assistance	Merry-go round “Chamas”
Health	Traditional midwives, traditional healers, devil cleansing
Traditional beliefs	Conservation of sacred trees/forests
Traditional leaders	Prescribing traditional community norms
Recreation	Traditional sports (wrestling, bull-fighting)
Conflict resolution	Council of elders

Source: Field data, 2016.

Table 4. Typology of indigenous local institutions for natural resource management in the highlands of western Kenya.

influx of outside cultures and government policies. The above changes do not significantly across the study sites. Traditional leadership structures have been replaced by a formal system under the devolved County government structure, where leaders are democratically elected. From the foregoing, it can be seen that a variety of institutions in the study area are involved in natural resource management. For successful engagement of local communities, there is need to recognize and work with local institutions. This is because their role as custodians of local knowledge [20], mobilizing collective action [74, 75] and connecting members of different communities [76] are all fundamental to effective natural resource management.

7. Conclusion

This study has demonstrated that inhabitants of western highlands of Kenya perceive most indigenous plant species as resourceful. For this reason, the inventory generated by this study ought to be printed and used to educate the younger generation about the varied types of plant resources and their uses. Such knowledge will empower local people to avoid unwanted destruction of resourceful resources out of ignorance. Indigenous institutions are evidently strong and effective in sustaining plant resources in the region. In order for the indigenous traditional knowledge to be better appreciated by the youth, the curriculum should be revised to integrate TEK. The possibility of being examined on indigenous plant resources will motivate the youth to be keen and even plant some of the species during agriculture lessons to better familiarize themselves with indigenous plant resources. Additionally, the study has shown that integrating new scientific knowledge with TEK can yield greater results in terms of sustainable development. A case in point is the *Jatropha curcus* (*amabono*) and *Aloe kedongensis* (*amakakha*) species that are now being conserved by some people in western highlands of Kenya for economic benefits. To this end, participatory research needs to be encouraged because it enables local people to benefit from their indigenous plant resources. Current trends of modernization of agriculture, land use and resource management systems have interfered with TEK through weakening the role of intergenerational experiences related to traditional SLM practices. The government has put a policy in place prohibiting cutting of trees. For this reason, someone needs authorization from the government prior to cutting down his/her trees. According to the permit, two trees should be planted to replace the one that is cut down. Although the policy is good, the government does not provide free seedlings to replenish the trees that are cut down. It is important for the government to provide necessary support in terms of seedlings to encourage sustainable utilization of plant resources. If seedlings are provided free of charge, many people will plant indigenous plant resources for use by future generations. Otherwise, there are many cases whereby the policy that requires replenishing of cut trees is not implemented due to lack of resources. Availability of seedlings could lead to a greener environment and conservation of indigenous plant resources in people's homes for future use. This practice will reduce the current pressure on forests to provide all required indigenous plant species. Government of Kenya also needs to address legal issues related to use of indigenous plant resources. As

mentioned earlier, the government needs to enforce laws that protect indigenous plant species in western highlands of Kenya to prevent overexploitation of indigenous plant resources for economic gains at the expense of conservation.

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