WILD EDIBLE PLANTS (WEPS) AND THEIR CONTRIBUTION TO FOOD SECURITY: AN ANALYSIS OF HOUSEHOLD FACTORS, ACCESS AND POLICY IN THE SEMI-ARID MIDLANDS OF KENYA

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April 2013

A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of M.Sc. Natural Resource Sciences

English Abstract

Food insecurity and malnutrition are issues that affect approximately one in seven people worldwide and climate change threatens to increase those risks in the future. Many of the policies that address future food systems emphasize resilience - a combination of flexibility in the face of disturbance and the capacity to adapt to change. In Sub-Saharan Africa many households employ livelihood systems that are highly sensitive to change and cannot adapt well to changing environmental conditions, leaving them vulnerable and reliant on coping strategies. Wild edible plants (WEPs) are a particularly common and effective strategy for coping with food insecurity. This research, conducted in rural Eastern Province, Kenya, suggests that certain demographic characteristics and access conditions are correlated with greater use of WEPs. Food insecure households, and those families lacking off-farm income or with lower levels of assets were found to consume WEPs with greater frequency. Access to WEPs was also a major factor, with smaller farm sizes and increased distance to harvest areas correlated significantly to lower levels of WEP use. After reviewing the existing laws pertaining to State forests, privatization trends of communal land and an increasingly formalized management regime for private land tenure, I find that access to WEPs is declining. Development practitioners', governments' and donor organizations' focus on commercialization and commodity value has led extension agents and land owners to ignore the subsistence value of WEPs, especially for poorer populations. The household characteristics identified in this study are specific enough that they can be used to determine the demographic groups that rely heavily on WEPs, and the access conditions that are likely to increase the ability of those vulnerable groups to employ WEPs as a coping strategy to increase system resilience. Protecting and promoting sustainable use of WEPs could increase the current contribution of these valuable resources to household food security, especially if policies can be tailored for the groups that depend on them the most.

French Abstract (Abrigé)

L'insécurité alimentaire et la malnutrition affectent environ une personne sur sept à travers le monde et le changement climatique menace d'accroître ces risques à l'avenir. La plupart des politiques qui concernent les systèmes alimentaires futures mettent en relief la résilience - une combinaison de flexibilité face à la perturbation et la capacité de s'adapter au changement. En Afrique sub-saharienne de nombreux ménages utilisent des stratégies de moyens de subsistance qui sont très sensibles aux changements et ne peuvent bien s'adapter aux conditions environnementales, ce qui les rendent vulnérables et dépendants des stratégies de survie. L'utilisation des plantes sauvages comestibles (WEPs) représente une stratégie particulièrement commune et efficace. Cette recherche réalisée dans la Province de l'Est du Kenya suggère que certaines caractéristiques démographiques et conditions d'accès sont en corrélation avec une augmentation de la consommation de WEPs. Les lois forestières dans les zones de conservation, la privatisation des terres communales, et la formalisation des régimes de gestion contribuent à la réduction d'accès aux ressources WEP, tout en mettant l'accent sur la commercialisation et la valeur de ces produits pour l'export, ce qui a provoqué les agents de vulgarisation et les propriétaires fonciers à ignorer la valeur substantielle des WEPs, en particulier pour les populations les plus pauvres. La protection et la promotion de l'utilisation durable des WEPs pourraient augmenter la contribution actuelle de ces ressources importantes à la sécurité alimentaire des ménages, et d'autant plus si les politiques peuvent être adaptées pour les groupes qui dépendent le plus sur les WEPs.

Acknowledgements

Logistical support and assistance for this project were provided by the Kenya Agriculture Research Institute (KARI) in the field, especially Fridah Kawira, Samuel Kimanthi and Ester Njuguna. Many thanks to the communities of Gantundu and Nyukani in Tharaka for all of your cooperation, especially Paul Muriungi, Rufus Safari and Madrina Kyoko. This work would not have been possible without Dr. Patrick Maundu of the East Africa Herbarium who did much of the species identification. This study was conducted as part of a research partnership between KARI and McGill University, led by Dr. Lutta Mohammad and Dr. Gordon Hickey. I would also like to acknowledge the Kenyan field assistants, translators and especially the anonymous participants for donating their time and expertise to this study.

I truly appreciate the support the entire Sustainable Futures Lab and the other students working on the KARI-McGill project in Kenya, your support was so valuable. Thank you also to Dr. Tim Johns, Dr. Bernard Pelletier, and the rest of the KARI-McGill project team. Finally, Dr. Gordon M. Hickey was instrumental throughout the proposal, research, writing and analysis process, as a mentor and an incredible supervisor.

This project was generously funded by the Canadian International Development Agency (CIDA), the International Development Research Centre (IDRC), and the Social Sciences and Humanities Research Council (SSHRC).

Finally, I am so grateful for the support of my parents, Andrew and Debbie and my siblings for traveling the world to visit and helping me through the toughest times. My beautiful roommate Sarah Peters has been there every step of the way, this never would have happened without her. Special thanks to the rest of the Shumsky family, all of my lovely friends and my Montreal family! Hurrah!

Thesis Style and Contribution of Co-authors

This is a manuscript-based thesis, thus some repetitions are necessary between sections. Literature citations can be found in the reference sections at the end of the chapter in which they are mentioned. Chapter 1 provides an introduction to the material covered in subsequent chapters, as well as some background on the study location. The motivations and purpose for this study are described, followed by the methodological framework and techniques for data collection and analysis. Chapter 2 identifies the demographic groups that rely heavily on wild edible plants (WEP) in the study area and the contribution that those resources make to household food security. The influence of access conditions are also discussed, specifically as they relate to utilizing WEPs as a coping mechanism to increase socio-ecological resilience. Chapter 3 builds on the findings in Chapter 2 to better understand the institutional dimensions affecting the use of WEPs. This includes an analysis of Kenya's Forest Laws and their implementation, the role of private property rights and community-managed resources to assess how WEP harvest is regulated in different land tenure situations. Both Chapters 2 and 3 will be prepared as manuscripts for submission to peer-reviewed journals, and may include sections of Chapter 1 to provide context.

The candidate is the senior author of both manuscript chapters, 2 and 3. I was responsible to the design of the research, planning and execution of data collection and analysis. Field research was conducted with support from the Kenya Agricultural Research Institute (KARI) and field assistants who reported to me.

I wish to acknowledge the support and guidance of the co-author for Chapters 2 and 3, Dr. Gordon Hickey. He has contributed countless hours, expertise and insight into the research process at every stage as a thesis supervisor, especially during the preparation of the resulting manuscripts.

List of Abbreviations

ASAL	Arid and Semi-Arid Lands
CFA	Community Forest Associations
FAO	Food and Agriculture Organization of the United Nations
KARI	Kenya Agriculture Research Institute
KFSSG	Kenya Food Security Steering Groups
KSH	Kenya Shilling (Currency exchange 1CAD = 84.02 KSH)
LEK	Local Ecological Knowledge
NTFPs	Non-Timber Forest Products
NGOs	Non-Governmental Organizations
OLS	Ordinary Least Squared Regression
WEPs	Wild Edible Plants

Table of Contents

List of Tables

List of Figures

Chapter 1. General context and motivations for the study

1.1 Food security

Food insecurity and malnutrition are issues that affect approximately one in seven people worldwide, while population growth, rising consumption and climate change threaten to increase the risks of hunger in the future (Godfray, Crute *et al*. 2010). Sutherland and colleagues (1999) have suggested that the best method of improving household food security focuses on natural resources in conjunction with improving food production technologies. This recommendation takes into account the substantial contribution of wild products to the global food basket, as well as their potential to continue to provide nutrition and income for the groups that are most vulnerable to food insecurity (Bharucha and Pretty 2010). Concentrating on existing food resources can also mitigate the environmental consequences of increasing agricultural production and transporting more food further, such as loss of habitat for conserving biodiversity, nutrient runoff, sedimentation of waterways, pesticide poisoning of humans and non-target species (Zhang, Ricketts *et al*. 2007) and increased carbon emissions (Godfray, Crute *et al*. 2010).

1.1.1 The food security challenge in Sub-Saharan Africa

Smaller countries, without sufficient food stocks or monetary resources, bore the brunt of the food and economic crises that dramatically raised commodity prices between 2006 and 2008, especially the import-dependent countries of Africa, where there was an 8 per cent increase in malnutrition rates over just two years, as higher prices drove reductions in food imports and availability (FAO 2011). The 2006-2008 food price shocks are estimated to have affected 12 million people in Sub-Saharan Africa, killing between 50,000 and 100,000 people, most under 5 years of age (Moseley 2012).

Cereal markets are expected to continue price increase and volatility trends into the future, as commodity trade becomes increasingly complex and important to maintain global food availability (Headey 2011). In Sub-Saharan Africa, one third of all children experience hunger on a daily basis, a figured expected to rise in the next 20 years as a result of limited food supplies

and rising demand, suggesting that this region will remain a global "hot spot" of hunger and malnutrition into the foreseeable future (Rosegrant, Paisner *et al*. 2001).

In addition to the prevalence of food insecurity, land degradation affects Africa more than any other continent (CIDA 2004). 66 per cent of the total African land area is classified as 'dry land' or 'desert' and 73per cent of those areas under cultivation are considered degraded, due mostly to unsustainable resource exploitation and poor farming practices (Darkoh 1998). Land degradation rates are higher in environmental fragile areas, with crop yield declines due to soil erosion averaging 8.2 per cent, and with some countries reporting agricultural productivity losses of over 40 per cent between 1981 and 2003 (IFAD 2009). Increased agricultural production and global climate change are expected to exacerbate this situation (Hulme and Kelly 1993).

1.2 Resilience

Resilience, the capacity to adapt to changing conditions and reduce vulnerability in the event of dramatic disturbances, has become a major focus of programmes and policies designed to address the food production consequences of global environmental change (Speranza 2010). System sensitivity, or vulnerability, is the likelihood of experiencing negative effects from environmental change or social disturbances (Dilley and Boudreau 2001). Previous studies have identified household characteristics, such as food insecurity, off-farm employment income and other assets, as indicators of vulnerability (Kelly and Adger 2000; Eriksen, Brown *et al*. 2005). Adaptive capacity is a measure of the ability to overcome system instability by employing alternative livelihood strategies and working within the existing framework (Eriksen, Brown *et al*. 2005; Nelson, Kokic *et al*. 2010).

Understanding adaptive capacity is particularly important in Africa, where extreme poverty, natural disasters and minimal infrastructure has generally resulted in in a system lacking adaptive capacity, thus increasing the vulnerability of many residents to climate change (Easterling 2007; Müller, Cramer *et al*. 2011). Other researchers have demonstrated the importance of adaptive capacity in farming systems (Adger and Vincent 2005; Below, Mutabazi *et al*. 2011), particularly through socio-economic and government variables at the national scale (Brooks, Neil Adger *et*

al. 2005) and concerning natural disasters (Yohe and Tol 2002), yet many questions remain regarding the role of existing coping strategies.

1.2.1 Contribution of wild edible plants[1]

Communities that are vulnerable to changing conditions tend to rely on coping strategies to minimize system sensitivity (Davies 2009). Wild edible plants (WEPs) are known to be used by over one billion people (Burlingame 2000) as a means to supplement protein and vitamins, improve palatability of staple foods and generate income (Arnold and Perez 2001). Communities in Africa have strengthened immune systems and stayed healthy using WEPs for centuries (Grivetti and Ogle 2000), especially in poorer households in rural areas where limited cash resources need to go towards energy, shelter, and medical needs (Shackleton and Shackleton 2004). During times of critical food shortage, consumers of wild edible plants are able to diversify food sources, mitigate malnutrition, and generate alternative incomes (Gordon and Enfors 2008). Wild foods are often available when harvests fail and offer a range of nutritional benefits with minimal processing, which becomes tremendously important during natural catastrophes like droughts, as well as during famines brought on by market fluctuations, political unrest and military conflicts. (Fentahun and Hager 2009)

1.2.2 Maintaining access to wild edible plants

WEPs have been promoted as a solution to improving livelihoods and food security without harming the environment (Kusters 2006), often accompanied by the suggestion that conservation models must include some kind of compensation to encourage local resource users to avoid activities that cause degradation and compromise future harvests (Ticktin 2004). The degree to which the goals of improved food security can be achieved through the sustainable harvest of wild foods is related to the creation of rules that regulate common pool resource usage, monitor

[1] The Food and Agriculture Organization of the United Nations defines non-cultivated plants as: *"plants that grow spontaneously in self-maintaining populations in natural or semi-natural ecosystems and can exist independently of direct human action"* (Heywood 1999). For the purposes of this study all plants that are gathered (not cultivated) are considered wild, including species harvested in agricultural areas as well as uncultivated or forest land. Non-timber forest products (NTFPs) are defined mainly by harvest area, and are also sometime classified as WEPs (c.f.Termote 2011) – See Figure 1.1.

compliance and punish deviants (Ostrom, Burger *et al*. 1999). These rules can be informal understandings between villagers, regulation by local institutions that affect harvesting activities, or more formal government interventions, such as conservation zone designations (Widayati, Jones *et al*. 2010). Pandit and Thapa (2003) found that resource degradation occurred when harvesting behaviours were not controlled or monitored by institutions, allowing open access to collectors who can exploit resources unsustainably at their personal discretion.

1.2.2.1 Formal and informal policy

Despite the benefits derived from non-cultivated plants, their role is "little appreciated by planners and decision-makers," and policies regulating access, extraction and sale are often based on national directives that lack understanding of local conditions (Shackleton and Shackleton 2004). The ecosystems and local knowledge frameworks that produce and sustain wild edible species are in danger of neglect when policies do not take into account the significance of their contribution to local food baskets (Bharucha and Pretty 2010). Policies created by formal institutions have been shown to affect the extraction of common property resources in different ways, from poor government decisions that nearly overexploited the African Cherry *(Prunus africana)* to extinction (Stewart 2003), to sustainable harvest in conservation areas as a result of strict regulations (Robinson and Lokina 2011). Informal policy can also have an impact on the collection and use WEPs, such as the successful regulation of Marula harvest through customary laws in Southern Africa (Wynberg and Laird 2007). In other communities, however, a lack of local institutional frameworks and privatization of common lands have resulted in harvest declines and ecosystem degradation (Falconer 1990; Brooks and Tshering 2010).

1.2.2.2 Non-institutional factors affecting contribution to household food security

Widayti (2010:743) examined the factors influencing rattan cane harvest in Indonesia and found that the "existence of conservation areas may not be a strong constraint on harvesting activity." He instead identified resource location, abundance and local topography as factors outside of formal regulation and informal institutions that might influence extraction. Several other studies

have also indicated that the availability of WEPs often motivates their use, with the most popular species being those growing in the vicinity of the village (Pardo-De-Santayana, Tardío *et al*. 2005; Arenas and Scarpa 2007). Aside from physical constraints like location and availability, Dansi *et al* (2008) found that taste, ease of preparation, and quantity of condiments required were the among the most important factors affecting preference for wild foods. This same study, conducted in Benin, found differences in collection and consumption of WEPs between ethnic groups, based on variation in the cultural background, local belief systems and superstitions of these communities.

While it is tempting to generalize all users of natural resources as having similar motivations and reasons behind adopting a livelihood strategy based non-cultivated products, this is simply not the case. One way to consider the different types of users is a spectrum (Figure 1.2), where the profitability and viability of a particular harvest, community culture and availability of other options influence the decision to rely of natural resources. The fundamental differences between ecosystems and target products, cultures, and alternatives available in a community all have an effect on the desirability of relying on the gathered species to make a living. For many users, emergency situations, often created by unemployment or crop failures, force gathering and sale of common pool resources to provide an immediate safety net function, which can become a permanent option if conditions do not improve (Shackleton and Shackleton 2004).

1.3. Rationale and motivations for the research

Wild edible species can comprise a significant proportion of food baskets, fulfill energy, medical and shelter needs, and provide opportunities for income generation. Unless the systems that make gathering these resources possible are protected and well managed, the cost of meeting the population's basic needs falls to the government, at a much increased cost (Shackleton and Shackleton 2004). Furthermore, effective valuation of wild edible species is necessary to ensure fair market pricing and incorporate the true harvest costs, environmental and otherwise, to discourage overexploitation (Feyssa, Njoka *et al*. 2011). In addition to the potential costs to the government and local ecosystems, inappropriate regulation could negatively affect the status quo

contribution of wild edible species during famine situations, increasing the food deficits that international aid systems already struggle to overcome (Muthoni and Nyamongo 2010).

According to Dansi *et al* (2008), the exclusion of wild edible species from scientific research, development and policy creation will have a detrimental effect on household nutrition as production, consumption and diversity of these products decline. This is a time sensitive process, requiring that policy incorporates the indigenous knowledge that informs collection and use of wild foods before it is lost (Feyssa, Njoka *et al*. 2011). Time is also an issue when considering global climate change and its implications for food security, particularly the exotic staple crops grown in low input systems (Fuhrer 2003; Long, Ainsworth *et al*. 2005). The "innate resilience of wild species to rapid climate change" could lessen food stress from climate events if policy exists to support these alternative food sources (Fentahun and Hager 2009:208)

Local institutions, and all the adaptations for knowledge generation, sharing and implementation that create them, are integral to the sustainability of any resource regulation system (Berkes 2000) . Well-defined property rights can also dictate which portions of the population has access wild edible species, but only when certain conditions are met by both the populations and the frameworks themselves (Mutenje, Ortmann *et al*. 2011).

Recognizing these important issues, I sought to better understand the community and environmental variables that affect WEP species access and use in the food insecure semi-arid region of Kenya, and assess the challenges and opportunities for formal and informal regulation of these activities. Through this research, I hoped to contribute to an overall understanding of the complex relationship between rural community members and their natural environment, between policy and its implementation, and give some indication of how food security is attained at a household level in semi-arid Kenya.

1.4. Research questions, objectives and methodological overview

1.4.1 Research questions and objectives

The central objective of the proposed research is to generate knowledge about wild edible plants as a means of improving household food security in Kenya. In order to better inform policy makers and institutions that manage the common areas where these products are generally found, this study will provide information on: 1) the user groups and access conditions that allow households to depend on wild foods to meet daily and emergency nutrition needs; and 2) institutional frameworks, policy interpretation and community relations that currently regulate access to these products. Ultimately, the aim was to provide evidence that may assist government officials, formal and informal institutions to better achieve goals of improved food security by managing resource extraction sustainably and equitably over time.

The central research question was: *"What are the factors affecting access to WEPs and their contribution to household food security in the semi-arid midlands of Kenya?"*, In order to address this broader question, I broke down my research into the following sub-questions:

I. What is the effect of household characteristics and access conditions are on wild edible plant (WEP) consumption, as related to adaptive capacity and increasing resilience?
II. How are institutional factors affecting the contribution of wild edible plants (WEPs) to sustainable food security outcomes in semi-arid Kenya?

1.5. Methodology Overview

This project was conducted as part of a multi-disciplinary research partnership between the Kenya Agricultural Research Institute (KARI) and McGill University[2]. The main objectives of this larger project are to improve the food and nutritional security of rural households in semi-

[2] "Innovating for Resilient Farming Systems in Semi-Arid Kenya," funded by the Canadian Food Security Research Fund (CFSRF) (106515) through the Canadian International Development Agency (CIDA) and the International Development Research Centre (IDRC).

arid Kenya by further encouraging the adoption of techniques that enhance resilience in farming systems. Recognizing this objective, my research examines the role of WEPs and their supporting institutional and policy frameworks in determining household food security, with a view to informing resiliency-focused agricultural policy and practice in Kenya.

Qualitative and quantitative methods were integrated during the course of this research to investigate the issue at various scales and from different perspectives. Mixed methods were employed to minimize the limitations and biases inherent within each type of research, and develop accurate results through triangulation of many data sources (Creswell 2003). This study applied these approaches simultaneously, using quantitative survey results and regression analyses to identify factors of possible interest and theories that could then be investigated during case studies using qualitative techniques such as focus groups, participatory mapping and interviews, which were then integrated back into survey questions.

The contemporary nature of this project made using a case study research approach the logical choice, allowing for the inclusion of diverse evidence from observation, documentation and interviews (Yin 2009). Baxter and Jack (2008) explained how case studies are particularly useful when investigating the context and research question simultaneously, using a variety of data sources and multiple perspectives.

Participation from community members was instrumental in determining which factors influenced their collection of WEPs. Methods that prioritize local knowledge were particularly useful for this research since local communities understood the complex issues at hand and were motivated to find more effective management strategies because their livelihoods were strongly linked to the resources (Belcher and Schreckenberg 2007). This research approach requires that local knowledge be considered as important as other forms of information and cooperatively incorporated into the final results (Cornwall and Jewkes 1995).

1.5.1 Study area

The focus area of the larger KARI-McGill partnership project is the semi-arid regions of the Eastern Province of Kenya, specifically the Makueni, Machakos, and Tharaka Distrcts (Figure

1.3). The arid and semi-arid lands (ASALs) of Kenya have been classified as food insecure due to insufficient rainfall to sustain crop production and lack of alternative incomes (Nyariki, Wiggins *et al*. 2002) in addition to low rates of technology adoption by locals (Mugwe, Mugendi *et al*. 2009).

My research was conducted in Tharaka, a district in the semi-arid region of Eastern Province, Kenya (Table 1.1). Food insecurity is prevalent in this area, with near total crop failures during the short rainy season, leading to limited household stocks of food and purchasing power (KFSSG 2010). Compared to the other two study districts in the project, Tharaka is more isolated from markets due to larger travel distances to cities and poor transportation infrastructure, and residents have difficulty accessing formal sector employment and off-farm incomes that might otherwise increase resilience (Odumbe, Mwangi *et al*. 2007). Working within Tharaka, two study communities were purposely selected (Figure 1.4) based on the prevalence and intra-community variation of WEP consumption, diversity of livelihood strategies and proximity to harvest sites covering a spectrum of access conditions (Personal communication, Dr Patrick Maundu, June 11, 2012). These communities, Nyukani and Gantundu, are located fairly close to one another, and to the KARI Embu office which was instrumental to completing the field research.

Further discussion about the size, location and characteristics of each community will be covered in later chapters, using data collected through household surveys, focus groups and observation. Both villages are ethnically Kitharaka and speak a language of the same name, with similar livelihood strategies and dependence on a mix subsistence agriculture and livestock herding for food security and income generation (Table 1.1).

1.5.2 Data collection and analysis

A wide variety of data collection methods were used to gather information on the WEPs being collected in the study area (Figure 1.5). For each research question, we used a combination of qualitative and quantitative data collection techniques, which are briefly detailed below, and more specifically described in the results chapters that follow. Background information on the study areas, communities and historical context was gathered during preliminary focus group

discussions to provide context and illustrate how the area has changed over time (Gordon and Enfors 2008).

WEP species were identified during community free-listing and preference ranking sessions (Maroyi 2011; Termote 2011), and collected with help from local field assistants and participants. Plant samples were collected in the field and preserved (Alexiades and Sheldon 1996; Martin 2012), and when possible identified on site (Maundu, Ngugi *et al*. 1999), then confirmed with help from specialists at the East Africa Herbarium, in Nairobi (Appendix I).

Household surveys were conducted to obtain statistical data while also focusing on "the nature and importance of forest products and activities in meeting household needs, and not just numbers involved" (Byron and Arnold 1999). Cleophas (2004) conducted surveys similar in design to the questionnaire (See Appendix II), comprised of both structured and unstructured questions posed in the local language by host country nationals employed as research assistants. The questions were designed to elicit information on local ecological knowledge, like wild food harvest and use, in addition to local viewpoints on demographic differences, agricultural innovations and vegetation in the study area, much like those used by other researchers (High and Shackleton 2000).

At the conclusion of each survey, a semi-structured interview was conducted with the respondent to gain deeper understanding of WEP access conditions and availability over time (Keller, Mndiga *et al*. 2005). Thirty households were randomly selected from a list obtained from the village elders in each study site. The population included a mix of male and female-headed households from diverse age groups, occupations and locations within the community.

Participatory activities were chosen based on precedents in recent scientific studies (Herlihy and Knapp 2003; Fentahun and Hager 2009) and conducted with assistance from experienced locals and community input. These meetings took place over the duration of the field season, providing an opportunity for community input on the research design and up to date results dissemination. Two recent publications (Sutherland, Irungu *et al*. 1999; Günther and Vogl 2010) were instrumental in the design and implementation of seasonal mapping, participatory mapping and

other group activities.

Key informant interviews were also conducted with representatives from the Kenyan Forest Service, Ministry of Agriculture and elders within each community. Similar techniques are used in much of the literature on community institutions and government bodies regulating natural resource use (Pandit and Thapa 2003). Most interviews were conducted in English and digitally recorded for transcription, while the interviews with community members were facilitated with assistance from interpreters in the local language of Kitharaka and immediately transcribed.

The data collected during the household surveys were quantitatively analyzed using STATA (2011). Descriptive statistics were used to identify areas of interest, and ordinary least square (OLS) regressions and other statistical tests were used to determine significant factors affecting the frequency of WEP consumption and species diversity of WEPs used by each household.

Qualitative data from interviews with survey participants and key informants, focus group discussion and participatory activities were analyzed using the constant comparison technique (Glaser and Strauss 1967). Coding was used to identify emergent themes (Auerbach and Silverstein 2003), a common qualitative data analysis technique in case study investigations (Patton 1980).

1.6 Validity and reliability

Bryman (2007) explains the benefits of mixed methods research, namely results that are "more than the sum of the individual quantitative and qualitative parts." However, combining different approaches does have limitations, particularly the difficulty in transforming results in order to effectively analyze everything within the same framework (Creswell 2003). Although discrepancies can occur, the rich and varied nature of the data is the intended result, drawing conclusions that may or may not be generally true for the entire population. Much of the validity and trustworthiness of the results obtained in this study comes from this data triangulation, which aids in obtaining results convergence and verification (Thurmond 2004). Whittemore and Chase *et al* (2001) outlined a number of other measures of validity in qualitative research which were

considered throughout the research process, with special focus on length of engagement in the field, consideration for disenfranchised groups, and member checking at the conclusion of interviews and the study as a whole. The understanding that comes from intense scrutiny of case studies have been shown to be critical for solving real world problems like persistent food insecurity (Flyvbjerg 2006).

Participation by community members also lends credibility to this study, as it is precisely their perceptions of the environment and its use that are under investigation (Gould and White 2004). Such activities have been used in the past by academics, NGOs and other groups to include public opinion of policy decisions (Beverly, Uto *et al*. 2008), without negative effects on scientific rigour (Herlihy and Knapp 2003). There are drawback, such as the skewing effect participant recruitment can have on results (Parker 2006; Sletto 2009) and oversimplification of the issues during research design which can lead to limited applications of the study conclusions (Dunn 2007).

Much of the available literature on the topic of WEP use by rural communities has been conducted using case studies; however, this does not imply the method is without limitations. The concentration on just a few samples makes generalization of findings difficult, while establishing causal relationships on the basis of comparisons between sites is indirect at best (Yin 2009). Recall bias is a significant issue when participants are asked to remember routine activities over long periods of time. Delang (2006) acknowledges this limitation, especially with regard to quantitative harvest data, but rationalizes the continued use of such surveys as one of many consequences of limited time and resources for academic research. Although there are drawbacks to any approach, the strengths of participatory activities, repeated interviews and length of time in the field are combined with the statistical rigour of the baseline questionnaire to obtain large-scale and community-level data in order to address the research questions.

1.7 Expectations for the following chapters

This chapter has presented a brief overview of the objectives of this thesis, the methodological framework and some context for the following chapters. The results will be presented in two chapters as manuscripts, with more specific references to previous studies and existing literature, research methods and conclusions.

Chapter 2 investigates the specific household characteristics and access conditions that are related to increased consumption of WEPs for household food security using information collected in the household survey and participatory activities in both study sites, Gantundu and Nyukani.

Chapter 3 qualitatively analyzes data gathered from the 2005 Kenya Forest Law, key informant interviews, participatory mapping exercises and thirty semi-structured interviews in each study site to investigate current regulations governing WEP harvest on public and private lands, the application of those rules and related knowledge extension activities.

Chapter 4 presents the broad conclusions of the thesis, including its contribution to knowledge, directions for future research and possible applications.

1.8. Figures and Tables

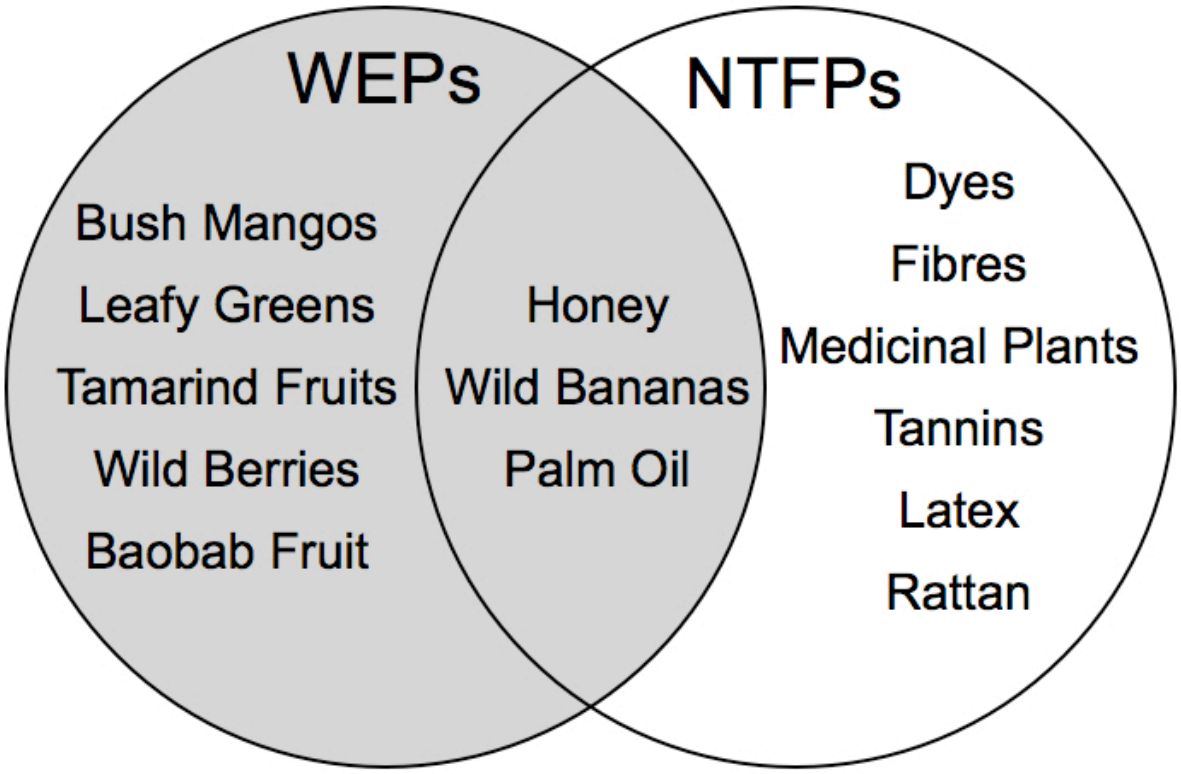

Figure 1.1. Venn Diagram comparing examples of Wild Edible Plants (WEPs) and Non-Timber Forest Products (NTFPs).The Food and Agriculture Organization of the United Nations defines non-cultivated plants as: "plants that grow spontaneously in self-maintaining populations in natural or semi-natural ecosystems and can exist independently of direct human action" (Heywood 1999). For the purposes of this study all plants that are gathered (not cultivated) are considered wild, including species harvested in agricultural areas, uncultivated or forest land. While NTFPs are defined by habitat, the forest, and can include edible and non-edible products. WEPs are limited to only those plants that can be eaten (c.f.Termote 2011).

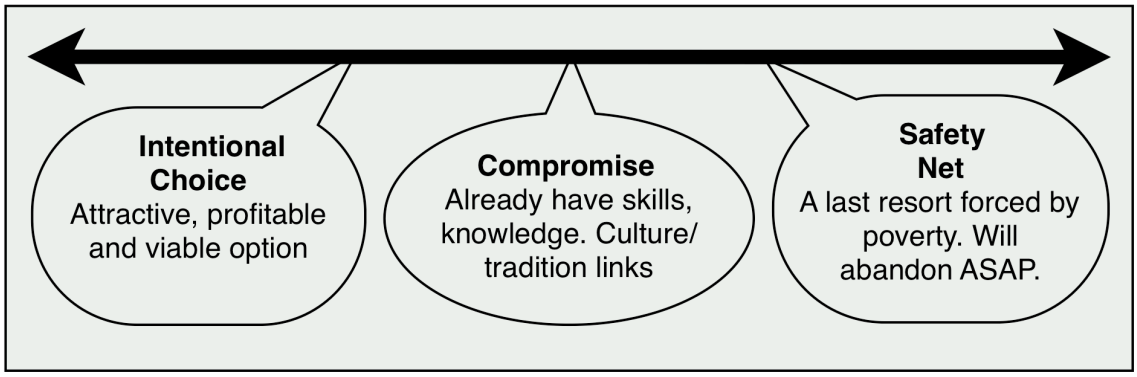

Figure 1.2. Spectrum of Types of Forest Users**.** The motivations for consuming WEPs can vary, from eating wild foods as a tasty, easy to collect and culturally relevant meal addition to harvesting WEPs that are only eaten when no other options are available - due to their poor taste, extensive preparation requirements, long distances to harvest sites and lack of traditional associations.
(Author, compiled from (Byron and Arnold 1999; Shackleton, Shanley *et al*. 2007)

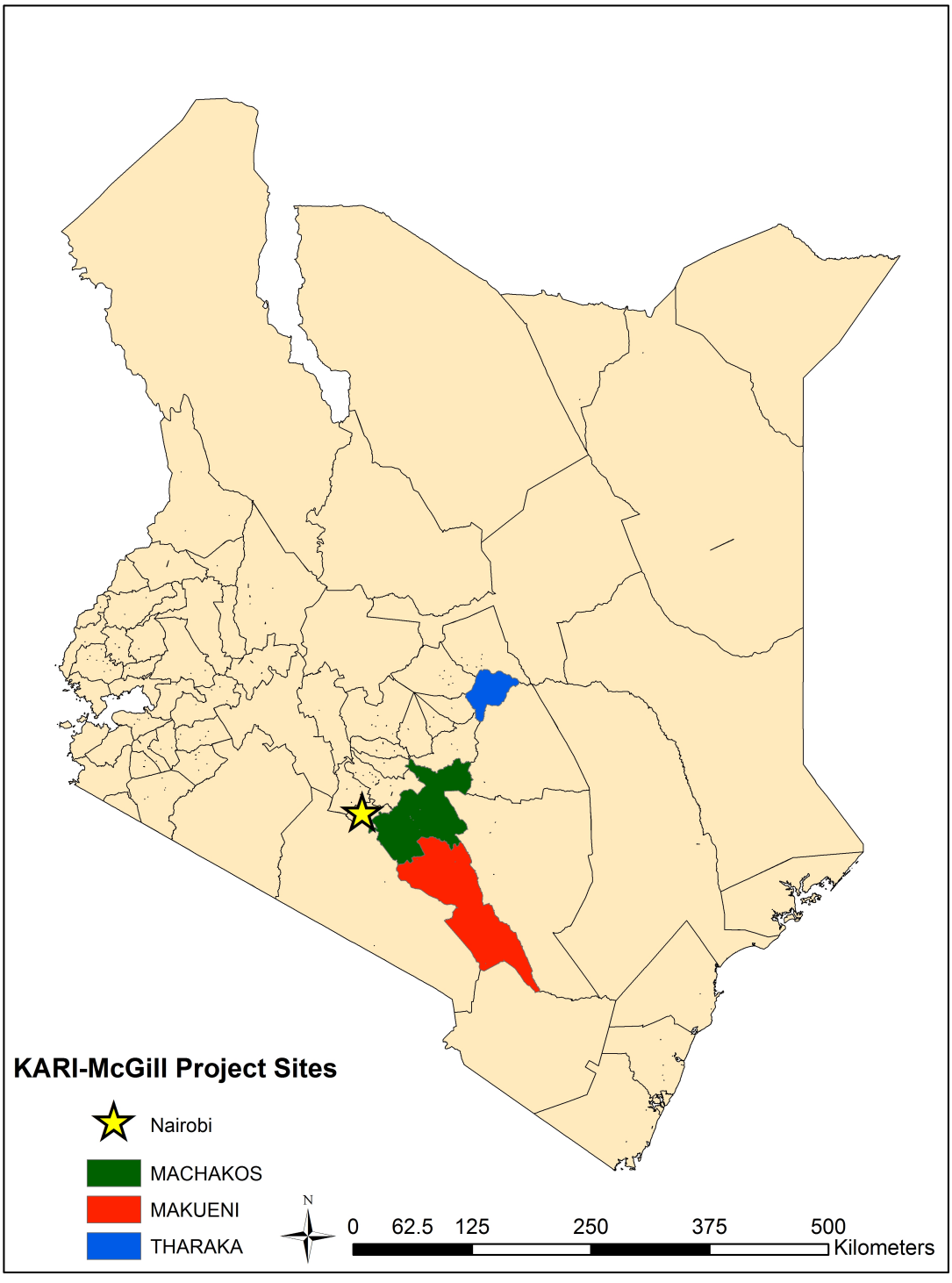

Figure 1.3. Study Constituencies for the KARI-McGill Project, Author.

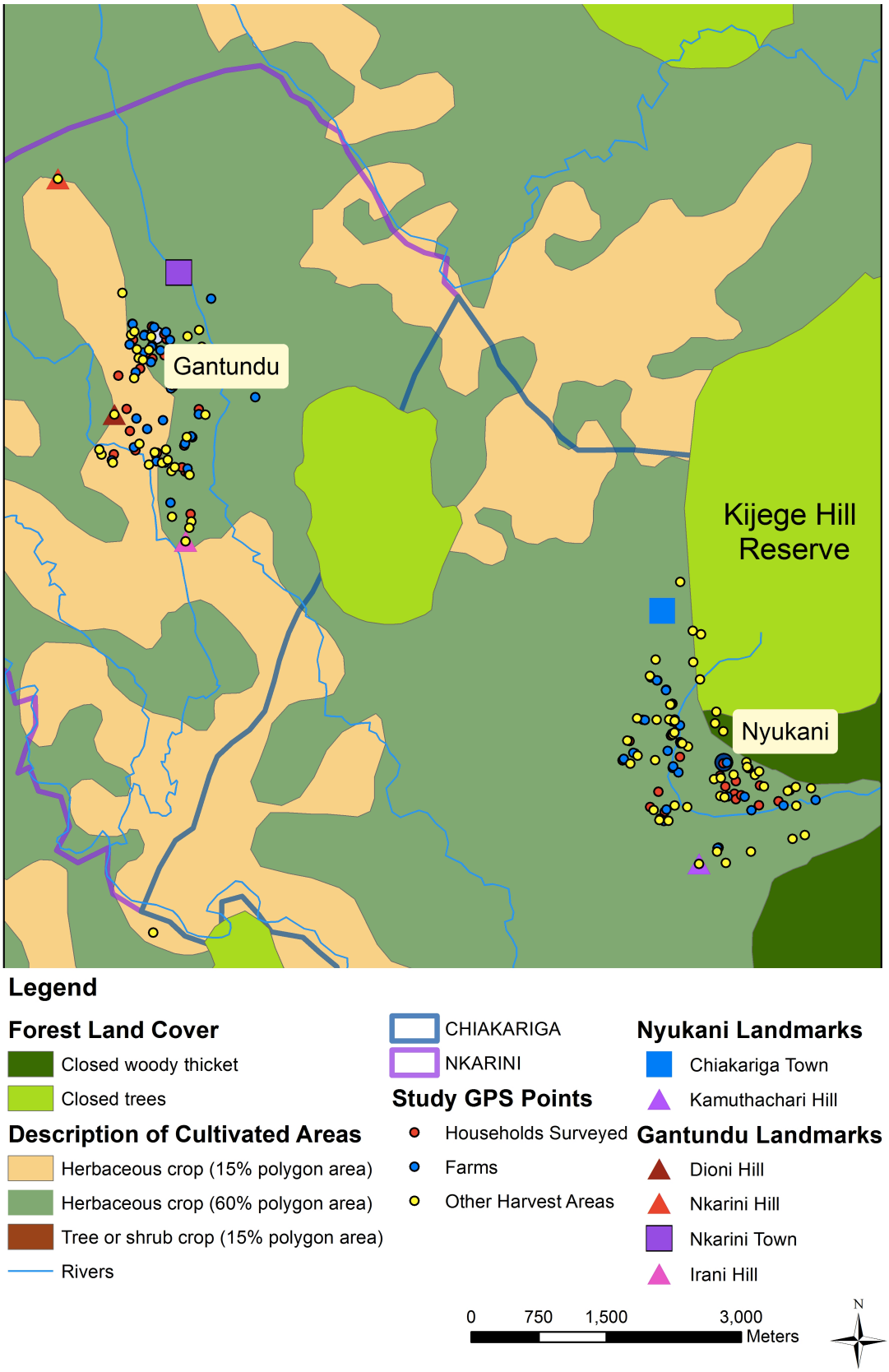

Figure 1.4. Study locations in Tharaka Constituency, Eastern Province, Kenya, Author.

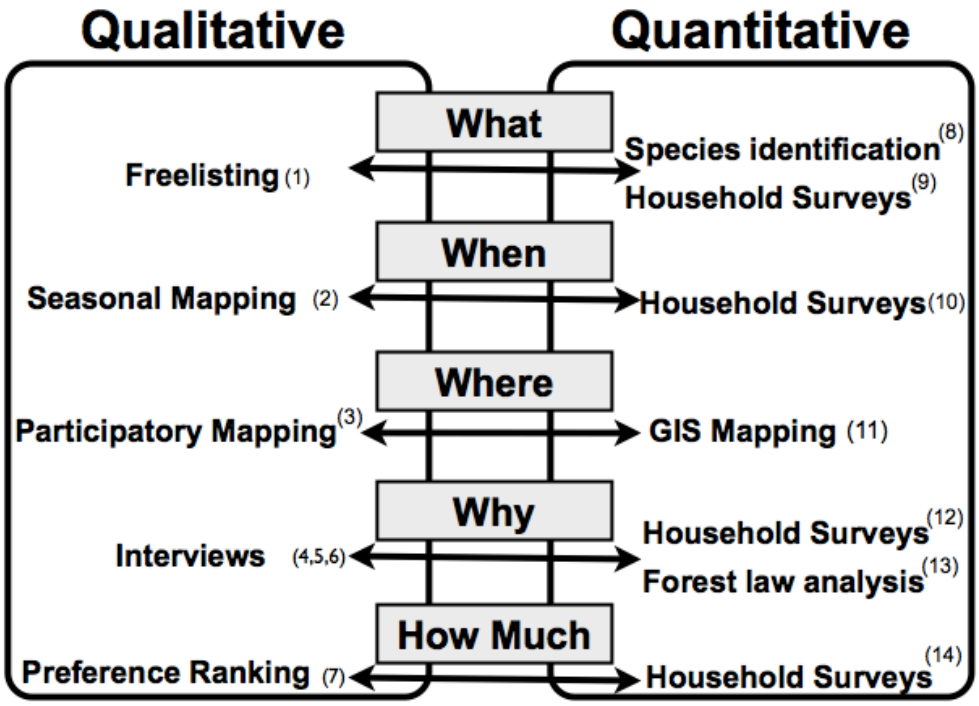

Figure 1.5. Qualitative and quantitative methods used to collect and analyze data. (See below for references)

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Socio-economic, biophysical conditions	
Population (m:f)	365,330 (48:52)
Pop. Density	138 people / km^2
Households	88,803
Age Distribution	0-14 (39.1%); 15-64 (55.5%); 65+ (5.3%)
Temperature	11 – 25.9 *C
Rainfall	200 mm - 800 mm
Altitude	500-5,000 m
Poverty Level	65%
Under-5 mortality	76/1,000 births

Food security and farm conditions	
Local Conditions:1) Livestock influx causes resource conflicts; 2) Increased cost of water.	
Food Security Classification	Mostly stressed
Livelihood mix (mixed farming: marginal farming)	65 : 26
Income sources (Farm : Livestock : Formal sector)	40 : 35 : 25
Industries	Farming, pastoralism, gemstones, sand, stone
Agricultural products	Livestock, tea, coffee, horticulture, cotton, millet, maize, sorghum, cowpeas, cassava
Recent Market Conditions	Increased price (140 % above 5 year avg.)
Emergency Coping Strategies	Distressed sale of livestock

Table 1.1 - Conditions in Tharaka (Kenya Food Security Steering Group KFSSG 2011)

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Preface to Chapter 2

Chapter 1 provided an overview of food insecurity, resilience and WEPs as a coping strategy for rural households, and outlined the motivations for this thesis. It also briefly identified several household, environmental and cultural factors that are known to affect household reliance on WEPs, and the management regimes that often regulate their use. This distinction has led to the separation of this thesis into two manuscript-based results chapters. Chapter 2 investigates which household characteristics and access conditions affect the access and use of WEPs in semi-arid Kenya, using the villages of Nyukani and Gantundu as a combined case study.

Chapter 2. Understanding the effect of household characteristics and access conditions on wild edible plant (WEP) consumption in the semi-arid midlands of Kenya

2.1 Abstract

Food insecurity and malnutrition are issues that affect approximately one in seven people worldwide, while population growth, rising consumption and climate change threaten to increase risks of hunger in the future. Recently, interventions and policies designed to address future food systems have begun to move away from traditional agricultural intensification and development by starting to discuss resilience - a combination of flexibility in the face of disturbance and the capacity to adapt to change. Unfortunately, much of the world population relies on vulnerable livelihood systems which lack resilience and also tend to be highly sensitive, forcing communities to use coping strategies of varying effectiveness. Wild edible plants (WEPs) are one such coping strategy, shown in other studies to supplement protein and nutrients, improve palatability of staple foods, reduce spending of limited cash income and provide a safety net function in times of drought or famine. This research, conducted in rural Eastern Province, Kenya, suggests that certain household types rely more heavily on WEPs, with consumption frequency varying based on demographic characteristics related to vulnerability such as food insecurity, assets and off-farm incomes. Access conditions including amount of farmland owned, proximity to harvest areas and permission requirements were also shown to impact the amount of WEPs consumed by households. Protecting and promoting sustainable use of WEPs could increase the current contribution of these valuable resources to household food security, especially if policies can be tailored for the groups that depend on them the most.

Keywords: Food policy; Social-ecological system; Subsistence agriculture; Sustainable livelihoods; Tharaka; East Africa

2.2 Introduction

Food insecurity and malnutrition affect much of the world's population (Godfray, Beddington et al. 2010). Approximately 2 billion people, representing every country on earth, are estimated to suffer from micronutrient deficiencies that make them more susceptible to disease, and that can be a significant obstacle to economic growth (FAO 2012). Looking forward, there are some 100

million underweight children worldwide that will be unable to achieve their full economic, health and human potential as a result of malnutrition (FAO 2012). These food security issues are especially severe in the largely import-dependent countries of Sub-Saharan Africa (FAO 2011). In this region, the 2006-2008 food price shocks combined with drought resulted in a famine that affected an estimated 12 million people, killing between 50,000 and 100,000 people in Kenya, Ethiopia, Djibouti and Somalia, where the famine was most severe (Moseley 2012). Furthermore, projected crop yield declines due to climate change are expected to be particularly severe in Sub-Saharan Africa due to already high levels of environmental degradation (CIDA 2004), and reliance on low levels of technology and manual farming (Brown and Funk 2008; Müller et al 2011). The Intergovernmental Panel on Climate Change (IPCC) (Easterling 2007) predicted 50 per cent yield reductions in rain-fed agriculture by 2020, which will be particularly significant for smallholder and subsistence farmers (Minaxi, Acharya et al. 2011).

Many of the interventions and policies designed to mitigate the potential negative impacts of climate change on food production are beginning to emphasize resilience - a combination of flexibility in the face of disturbance and the capacity to adapt to change (Speranza 2010). Recent climate change assessments have identified low-levels of adaptive capacity as one of the main drivers of vulnerability in Africa, largely due to the prevalence of extreme poverty, extreme weather (primarily drought), low levels of yield-enhancing technologies and general lack of infrastructure (Easterling 2007; Müller et al. 2011). While a number of studies have sought to address the importance of adaptive capacity in farming systems (Adger and Vincent 2005; Below, Mutabazi et al. 2011), particularly as seen through national socio-economic and government indicators (Brooks, Neil Adger et al. 2005) and in response to natural disasters (Yohe and Tol 2002), few have considered the role of existing coping strategies within local socio-ecological systems.

2.2.1 Wild edible plants as a coping strategy

Rural communities that lack resilience and are highly sensitive to environmental perturbations tend to rely on a range of coping strategies to minimize system vulnerability (Davies 1993). These “portfolios of options” can include straight-forward measures like reducing food intake or

selling livestock for income, and more complex, long term actions such as migration (*Ibid)*. Wild edible plants[3](WEPs), as distinct from non-timber forest products (NTFPs), have been identified as a particularly important coping strategy for households in rural Africa for several reasons (see Figure 2.1):

1. The resources are locally available and based on traditional ecological knowledge (Pardo-De-Santayana, Tardío et al. 2005; Jman Redzic 2006; Arenas and Scarpa 2007);
2. WEPs are a low input, low cost option for increasing nutrition and reducing the need to spend limited cash resources (Shackleton and Shackleton 2004; Jama, Mohamed et al. 2008);
3. WEPs provide greater benefits to vulnerable populations (poorer households, women, and children) (Grivetti and Ogle 2000; Fentahun and Hager 2009), who are often disproportionately affected by climatic events (Eriksen and O'brein 2007);
4. The contribution and availability of WEPs during times of drought or conflict-driven famine (Gordon and Enfors 2008; Muller and Almedom 2008; Strauch, Muller et al. 2009); and
5. WEPs have been shown to tolerate water stress better than their domesticated relatives (Humphry, Clegg et al. 1993; Addis, Urga et al. 2005), possessing an "innate resilience to rapid climate change, which is often lacking in exotic species" (Fentahun and Hager 2009:208).

Considering the importance of WEPs to household food security, it is essential that the socio-ecological systems that make gathering these natural resources possible be appropriately protected, managed and valued to avoid overexploitation and degradation (Feyssa, Njoka et al. 2011). Better understanding of ethnobotanical knowledge and WEP users is necessary to inform agricultural development, natural resource management and food security policies that could facilitate more sustainable access to these resources, and even increase their positive impact on community resilience (Mavengahama et al. 2013, Termote et al 2010). Studies have shown that inappropriate regulation of WEPs can take several forms, from unmitigated open access which can result in unsustainable harvest levels and degradation (Stewart 2003), to poorly targeted restrictions that exclude populations relying on WEPs as a major nutrition source (Falconer 1990), or push them to purchase alternative foods at the market using scarce cash resources (Sandemose 2009). To date, the relative exclusion of WEPs from agriculture-related scientific research, development and policy has likely had a detrimental effect on rural household nutrition

[3] The Food and Agriculture Organization of the United Nations defines non-cultivated plants as: *"*plants that grow spontaneously in self-maintaining populations in natural or semi-natural ecosystems and can exist independently of direct human action*"* (Heywood 1999). For the purposes of this study all plants that are gathered (not cultivated) are considered wild, including species harvested in agricultural areas, uncultivated or forestland. While NTFPs are defined by habitat, the forest, and can include edible and non-edible products. WEPs are limited to only those plants that can be eaten (c.f.Termote 2011).

as WEP production, consumption and diversity has declined (Dansi, Adjatin et al. 2008). This is a time sensitive issue, requiring the identification and protection of local indigenous knowledge systems that inform the collection and use of WEPs (Tabuti, Dhillion et al. 2004).

2.2.2. Research objective

Despite recognition that WEPs are an important component of the diets of at least one billion people worldwide (Burlingame 2000), significant questions remain regarding which demographic groups rely on these resources and where they are obtained in times of low food availability and financial stress. Ethnobotanical studies have investigated the various household factors that affect knowledge and use of wild foods, such as income level, proximity to local markets and the age, sex and education level of the head of household (Somnasang and Moreno-Black 2000; Byg and Balslev 2001; Reyes-García, Vadez et al. 2005). The issue has also been approached from a resource management perspective, where conservation restrictions, land tenure, community organizations and environmental conditions have been correlated with changes in WEP consumption (Ladio and Lozada 2003; Paumgarten 2005; Devineau, Aurouet et al. 2008). Farm size is a particularly interesting variable, since more private land provides greater unabated access to WEPs for the owners who can harvest these resources while farming (Price 1997), but may not be inclined to do so since households with greater wealth and assets often avoid WEPs due to the social stigma of eating the "food of the poorest" (Kepe 2008:543). These previous studies provide the starting point for our research into the factors affecting access to WEPs and their contribution to household food security in semi-arid Kenya.

My research differs from previous studies in that I seek to incorporate vulnerability proxies, such as household assets, self-reported food insecurity and off-farm employment opportunities, while also considering the reasons that WEPs are eaten, consumption frequency and harvest locations. Ultimately, we have undertaken to delineate the demographic groups and harvest locations that could be targeted by policy makers, development practitioners and extension programs to sustain WEP harvest as part of a resilient system. The results of this study can be used to limit actions and policies that reduce WEP availability, which Bharucha and Pretty (2010) suggest will increase the contribution these resources make to household food security and mitigating gaps

between food supply and demand.

2.3 Methods

2.3.1. Study area

This project was conducted as part of a multi-disciplinary research partnership between the Kenya Agricultural Research Institute (KARI) and McGill University[4]. The main objective of this larger project is to enhance food and nutritional security of rural households in semi-arid Kenya by understanding and encouraging the adoption of techniques that enhance the socio-ecological resilience of smallholder farming systems.

In order to better understand the factors affecting use and access to WEPs in semi-arid Kenya, we utilized a case study research design (Yin 2009), focusing on two farming communities in southern Tharaka Constituency (Figure 2.2): Nyukani (0° 17' S, 37° 56' E) and Gantundu (0° 15' S, 37° 52' E), where food insecurity is prevalent with crops failing, on average, once every three seasons (Kenya 2012). Tharaka, one of two Constituencies in Tharaka-Nithi County, is located in the semi-arid region of Eastern Province, Kenya. Both villages are dominated by a mixed livelihood system of livestock, some formal sector income and marginal/subsistence farming of maize, millet, sorghum, cowpeas, pigeon peas, cassava, and green grams (mung peas) as well as cash crops like tea, coffee, horticulture, and cotton. The average annual rainfall fluctuates between 200mm-800mm, and falls mostly during the long rains (October-December) and the short rains in April. Elevation varies considerably, from 690 m. to over 1400 m. a.s.l. at the top of Kijege Hill (Wisner 1977). These communities were selected based on criteria that included: 1) the prevalence and intra-community variation of WEP consumption; 2) the diversity of livelihood strategies; and 3) their proximity to harvest sites covering a spectrum of access conditions (Personal communication, Patrick Maundu, June 11, 2012).

[4] "Innovating for Resilient Farming Systems in Semi-Arid Kenya," funded by the Canadian Food Security Research Fund (CFSRF) (106515) through the Canadian International Development Agency (CIDA) and the International Development Research Centre (IDRC).

The two case study sites were chosen to encompass a variety of public, private and community managed lands, in order to appropriately represent diverse local opinions. The first village, Gantundu, is larger with 108 households, situated in the Nkarini sub-location. Nyukani is comprised of 54 household in the sub-location of Chiakariga. Nyukani is less than a kilometre from a bustling market town, Chiakariga, and sits at the foot of a 3,303 hectare protected forest. Kijege Hilltop Reserve has been managed by the Kenyan Forestry Service for conservation objectives, watershed protection and soil preservation since 1959 (IUCN and UNEP 2010). Settlement on this hilltop has been restricted since colonial times, leaving the forest essentially intact (Smucker and Change 2002).

Gantundu, is located approximately 10 km away from Nyukani, and the nearest protected area (Figure 1.4). Despite being more isolated from local trade infrastructure, Gantundu has had significantly more intervention from non-governmental organizations (NGOs), government extension agents and development projects like the 'work for food' program, in addition to on-site agricultural trials for the KARI-McGill project. When statistics from household surveys were compared, Gantundu had significantly higher household assets and less food insecurity, perhaps due to greater average education level for the household head and more of the major breadwinners working primarily off-farm. The age of the household head, number of children, household size, total farm size and off-farm employment in general were not significantly different between the two sites (Table 2.1).

2.3.2. Data collection

The mixed methods used to minimize the limitations and biases inherent within each type of data collection and to develop more accurate results through the triangulation of different data sources (Creswell 2003) are detailed in Figure 1.5. The contemporary nature of this project made case study research appropriate, allowing for the inclusion of diverse evidence from observation, documentation and interviews (Yin 2009). Data collection was approached from different perspectives, initially employing a variety of participatory activities, interviews and group discussions followed by a quantitative household survey and botanical sample collection. Spatial information was then integrated into all aspects of the study through a combination of GIS

analysis and participatory mapping activities, further discussed in the following sections.

2.3.2.1. Species identification (what)

Although our main objective was not to conduct an ethnobotanical survey of the area, information about the local names and uses of various species was obtained. Botanical samples for each of the available WEPs mentioned by survey respondents and identified during participatory activities were collected with help from participants and field assistants. The purpose of identifying each species was two-fold: 1) to ensure that the local names used in the two study sites referred to the same species; and 2) to augment general scientific and cultural understanding of WEP consumption in the study area. Plant samples were collected and pressed according to the methods described by Martin (2012) and Alexiades and Sheldon (1996), then identified on-site, when possible, aided by the reference text from Maundu et al (1999). The samples were then dried and reviewed at the East Africa Herbarium, National Museums of Kenya (NMK) by Patrick Maundu of the Kenya at the Kenya Resource Center for Indigenous Knowledge (KENRIK) to ensure correct identification (Appendix I).

2.3.2.2. When, where, why and how much?

Primary data from household surveys were collected by KARI-trained enumerators with the assistance of local field assistants. The survey conducted in Kitharaka was designed according to the guidelines for quantitative data collection in developing countries (UN 2008), and evolved through input from project team members, experts in the field and local participants during pre-testing. The survey included a statement of informed consent, followed by questions on demographics, family structure, household food security, land tenure and access to natural areas. Information on the harvest and consumption of WEPs from the home, farm, and other privately owned or public lands over a calendar year was collected, including the reasons for harvesting, preparation techniques and the identification of distinct collectors and consumers of each plant (see Dansi, Adjatin et al. 2008). At the conclusion of each survey, a semi-structured interview was conducted with the respondent to clarify any inconsistencies in the survey and gain a better understanding of local opinions and concerns regarding WEPs, cultural considerations, and the

implications of changes in climate, land tenure and access to common property resources (Appendix II). Thirty households were randomly selected from a list obtained from the village elders in each study site, with a total of 108 households in Gantundu and 54 in Nyukani, respectively. The population included a mix of male and female headed households from diverse age groups, occupations and locations within the community.

Participatory activities were conducted with the assistance of local facilitators (Sutherland, Irungu et al. 1999; Campbell 2001; Kuhnlein, Smitasiri et al. 2006; Günther and Vogl 2010). These meetings took place over the duration of the field season (June 8 – September 12, 2012), providing an opportunity for community input on the research design and results dissemination. These activities also served to gather the background information necessary to contextualize the data collected through surveys, interviews and subsequent focus group sessions. At the start of the season, a community meeting was held that discussed the goals and requirements of the project. After the initial presentation, an informal focus group discussion was conducted to determine the WEPs known to the community, their importance to food security and cultural traditions and the degree to which each species was appreciated.

Later, the communities of Gantundu and Nyukani, participated in seasonal mapping activities to describe the changes in their food security, economic status and WEP availability (c.f. Fentahun and Hager 2009). During these sessions, dried maize was used to represent relative abundance of various assets and resources, and then graphed using the seasons described by community members (Fig. 2.3). In each study site, the focus groups were divided into two sub-groups, all of which had slightly different seasonal calendars and different perceptions of annual variation in WEP availability as well as household food security and farm productivity. The WEPs were divided into a few groups by type and harvest location to simplify the exercise, as going through each species' seasonal availability individually would have taken many more hours.

2.3.3. Data analysis

2.3.3.1. Qualitative data analysis

The constant comparison technique was employed to analyze the variety of data items obtained during participatory activities, focus group discussion and household interviews. First described by Glasser and Strauss (1967), this 4-step process requires the researcher to compare incidents by creating broad categories and later refine those groups with more concrete rules until a theory can be created to address the research question (Grove 1988). Coding was used to identify repeating ideas and themes, as well as to understand the broader theoretical narratives both for the various groups of participants and the population as a whole (Auerbach and Silverstein 2003). This process is especially well suited to evaluating factors, variables and categories to understand the knowledge generated through case study research (Patton 1980).

2.3.3.2. Quantitative data analysis

The data collected during the household surveys were entered into spreadsheets and converted for descriptive statistical analysis using STATA (2011). After determining central tendencies of key variables, ordinary least squared (OLS) regression techniques were used to determine which household, farm and access factors had a significant impact on consumption of WEPs. The data were analyzed from the household, harvest site and individual data point levels to draw out differences based on characteristics from each group. The consumption frequency was transformed using a log function to create a more normal distribution. Several studies have employed similar questionnaires, obtaining statistical data while also focusing on "the nature and importance of forest products and activities in meeting household needs, and not just numbers involved" (Byron and Arnold 1999:791).

The factors that impact harvest and use of WEPs were divided into two categories:

1. System sensitivity/vulnerability - the likelihood of suffering consequences from environmental or social changes (Kelly and Adger 2000; Eriksen, Brown et al. 2005). These included household food insecurity and assets, number of children, off-farm employment, as well as age, education, residency and marital status of the household head.

2. Adaptive/coping capacity - the ability to overcome system instability by working within existing infrastructure and alternative livelihood strategies. This term also refers to framework evolution over time, although not directly observed in this case study (Eriksen, Brown et al. 2005; Nelson, Kokic et al. 2010). Three main areas were considered in this case: 1) Local ecological knowledge (LEK) (Somnasang and Moreno-Black 2000); 2) Access using proximity to harvest areas and farm size as proxies (Pardo-De-Santayana, Tardío et al. 2005; Arenas and Scarpa 2007); and 3) Regulation in terms of harvest restrictions on public land and permission requirements for private holdings (Widayati, Jones et al. 2010).

These factors were used as independent variables to analyze household level WEP consumption, as well as changes in individual species collection rates from each specific harvest area. WEP species diversity was also considered by recording each of the plants individually, with their respective collection site, consumption frequency and reasons for harvest.

2.3.3.3. Geospatial analysis

The GPS points for each harvest location were mapped using ArcGIS (ESRI 2010; Scott and Janikas 2010) with base layers from Africover (URL:www.africover.org; (FAO 1997)). Metadata for each point included the household characteristics found to impact WEP harvest and consumption in previous studies and during OLS regression analysis of the case study data. The Moran's I and Getis-Ord Gi*[5] statistics were used to test for spatial autocorrelation, or hotspots, of WEP consumption (c.f.Kelly-Hope, Hemingway et al. 2009). Later, geographically weighted regression was employed using ArcGIS spatial analyst to determine if harvest location had a significant impact on WEP consumption frequency if other environmental factors and household conditions are also considered (c.f. Foody 2004; Pineda Jaimes, Bosque Sendra et al. 2010).

2.3.4. Assumptions and limitations

In total, sixty household surveys were conducted, which gave a large range of responses and a sample of the socio-economic diversity within the case study sites in Tharaka. In addition to

[5] Moran's I compares each point with its neighbours to see if the values are more similar (or dissimilar) than random numbers. Getis-Ord Gi* is a hotspot analysis statistic that identifies clusters where the points have higher or lower values than predicted by random chance. Both statistics use a z score measure of standard deviation to determine significance (ESRI 2007a, ESRI 2007b).

these home visits, the community had several opportunities to attend group meetings and engage in activities where their unique knowledge could be shared, debated and included as an important component of this study.

The participatory activities were successful for gathering additional insight as well as background information; however it is likely that some perspectives and opinions were overlooked (Pain 2004; Beverly, Uto et al. 2008), and that recall bias may have skewed some of the data collected (Delang 2006). Generalizing the information gathered during this study requires considerable reflection. Community projects often focus on local issues in rich detail, and require interpretation before they can be generalized to the regional or national level (Abbot, Chambers; et al. 1998).

Much of the importance of WEPs lies in the timing of collection and quality of the products as a means of differentiating between WEPs consumed by choice and those eaten by necessity (Byron and Arnold 1999). We were unable to measure these factors directly, This important distinction was somewhat addressed by the survey questions about motivation, but could have been more definitively conceptualized in order to draw strong conclusions about the true dependence on forest resources. Clephas (2004) also cautions that understanding of alternative rural development strategies, like promoting WEPs and maintaining access to forest resources, requires scientists and practitioners to avoid imposing predisposed ideas of 'indigenous' or 'traditional' actives and ensure that local communities have access to scientific knowledge as a complement to their own LEK.

2.4 Results and Discussion

2.4.1 Motivations for WEP consumption: Descriptive and significant statistics

A general understanding about preferences for certain wild fruits and vegetables, harvest demographics and reasons for consumption was gained following the initial community meeting and focus group free-listing sessions (see examples in Table 2.2).

Motivation for WEP consumption were revisited during the household survey where respondents could describe their reasons using one or all of the available options. From the descriptive statistics, some clear trends by WEP-type emerged (Fig. 2.4):

- Vegetables are often consumed due to hunger, medicinal needs and perceived vitamin benefits
- Fruits tend to be eaten for "fun" or their taste.

From these figures, we can see that a taste and fun are major motivations for gathering WEPs, but also that a significant portion are consumed as a coping mechanism. Motivations like vitamins and hunger suggest that the respondent is having difficulty obtaining adequate nutrition, and is utilizing alternative livelihood strategies to overcome food insecurity for themselves and their household members.

These results were separated by harvest area distinction, and then analyzed for significance (Table 2.3) (c.f. Kristensen and Balslev 2003). These results show that some areas, such as farms, neighbours' farms, and riverbanks, are visited for WEPs when hunger or vitamins are the main motivation. Other areas, such as the home or riverbanks, are often WEP collection sites for those seeking fruits that taste good or are eaten for fun.

2.4.2. Seasonal variation in food security, WEP harvest

As with crops, WEPs reach maturity at different times during the year. Seasonal mapping shows the abundance and consumption for WEPs, for example the low consumption of fruits from farm areas between January and March, despite high abundance (Fig. 2.5). This might be explained by the low rates of food insecurity during that season and high cash reserves that come from crop harvest incomes gained at that time and discussed during seasonal mapping activities.

Fluctuating food availability and cash reserves are a common phenomenon in tropical environments where rainfall is unpredictable, Chambers et al (1981) explain that food becomes less available, more expensive and less varied as the end of the dry season draws nearer, which is especially detrimental to poorer populations that lack the production capabilities (large farms, investment capital and alternative incomes) to avoid food shortages. Other researchers have

found similar seasonal trends in Kenya, finding that household calorie consumption is significantly higher between December and March, (Kennedy and Cogill 1988), while identifying October to December as the hungry season when food must often be purchased until crops can be harvested (Ferguson 1986). WEPs have long been associated with hungry seasons, even earning the name 'famine foods' in a number of publications that tracked increasing consumption of these wild foods with annual food shortages prior to crop harvest (Bell 1995), with specific examples in Kenya (Maundu, Ngugi et al. 1999).

Similar data were also collected during the household surveys and plotted by month (Fig. 2.6). Based on our analysis, there was no statistically significant correlation between household food insecurity and consumption frequency by month. Households that identified themselves as food insecure during specific months did not show an increased WEP consumption during those months, but did tend to consume WEPs with greater frequency overall (see below). From these descriptive statistics, it seems that consumption reaches higher levels during the start of the rainy seasons (April and October) when crops have not yet matured and stores from the previous harvest are often exhausted. Consumption is lowest during September, December and January, which participants attributed mainly to greater species availability during the rainy season (see also Powell et al 2011). Other studies have shown that species abundance and diversity directly affect WEP consumption (Arenas and Scarpa 2007), and that the availability of most WEPs varies by season (Kuhnlein and Receveur 1996).

Figure 2.6 shows that farm-collected WEPs are consumed more frequently than those harvested in any other area throughout the calendar year. This is consistent with several other studies, which identify farms and their non-cultivated edge areas as a major source of WEPs, especially weedy leafy vegetables and tree fruits (Price 1997; Cruz-Garcia and Price 2012).

The number of food insecure households reported in the survey also fluctuated, peaking in September and to a lesser extent in November, which concurs to some extent with the literature cited above, but raises questions about why food insecurity is lower in October. Reliance on public access areas like riverbanks, forests and hilltops was described as greater during the short rains of April, and nearly non-existent at the onset of the long rains and at the end of the main

cultivation season (see Figure 8). This might be due to the amount of time required to prepare the field for planting (September) and then again to harvest, dry and transport the crops for sale (December/January). Ferguson (1986) explains that labour requirements are at their highest during the long rains (October-December), particularly for women who are also charged with collecting WEPs.

The results of our quantitative household survey revealed interesting findings in the species used each month in the two study sites. There were significant differences in the diversity of WEPs named by survey respondents. Species diversity overall was significantly higher in Nyukani ($p<0.0013$), in the homestead ($p<0.0443$) and in the farms ($p<0.0198$) when compared to Gantundu. As discussed in Section 2.1, there are several major differences between the two case study sites, with Nyukani having lower off-farm employment and assets and higher rates of food insecurity. These household characteristics were associated with changes in WEP consumption.

Rural poverty and under-nutrition rates, which have been shown in this and other studies to correlate to increased consumption of WEPs (Lewu and Mavengahama 2010), are often higher near biodiversity hotspots and conservation areas (McNeely and Scherr 2001; Naughton-Treves, Holland et al. 2005), such as the Kijege Reserve adjacent to the village of Nyukani. Protected areas have long been associated with biodiversity conservation, identified as an objective by the 2005 Kenyan Forest Act (FAOLEX), while the areas adjacent to reserves tend to increase the plant and animal species richness of surrounding areas (Chapman and Chapman 2001). High species diversity and abundance has a large positive impact on consumption rates of WEPs as availability increases (Tabuti, Dhillion et al. 2004; Pardo-De-Santayana, Tardío et al. 2005). Furthermore, mid to high elevations (1,000-2,000m), such as those in Nyukani (http://www.hypemaps.com/airc.php), have been shown to contain the greatest number of WEP species as opposed to the lower altitude of the harvest sites in Gantundu (Samant and Dhar 1997).

2.4.3. Environmental and geospatial influences

Despite the predictions that species diversity of WEPs might be higher in Nyukani due to the

proximity of a conservation area and higher altitude, environmental conditions and spatial factors were not accurate predictors of consumption frequency. Geographic information systems (GIS) analysis did not identify significant correlations in WEP consumption frequency after the harvest locations were coded using global positioning system (GPS) points. Location and the environmental characteristics of specific harvest areas were overall less significant than the metadata that included the household characteristics linked to changes in WEP harvest and consumption during OLS analysis.

Overall no statistically significant autocorrelation was detected using Moran's index in Nyukani ($p<0.453$) or Gantundu ($p<0.474$). Both sites were also analyzed to determine the effect of the system sensitivity factors discussed above with similar results observed in both locations. In Nyukani, a hotspot of increased WEP consumption was found using Getis-Ord Gi Hot-Spot analysis (Fig 2.7A). However, when household factors were considered by doing a hotspot analysis of the geographically weighted regression (Fig 2.7B), essentially controlling for previously identified significant characteristics, that effect was much less apparent (Fig 2.7C)

These results suggest that the majority of variation in WEP consumption can be predicted by household characteristics (Table 2.4) and the access conditions (Table 2.5) of specific harvest areas. Devineau, Aurouet et al (2008) come to a similar conclusion following their GIS analysis of the availability and consumption of wild yams. They find that the use of this food resource does not correlate directly with the species distribution, but rather suggest that WEP consumption is related to factors outside of resource availability such as cultural traditions and unpredictable climate that increases vulnerability.

2.4.4. Household factors that influence reliance on WEPs

Many different household variables have been shown to impact the consumption frequency and species diversity of WEPs (Somnasang and Moreno-Black 2000; Byg and Balslev 2001; Reyes-García, Vadez et al. 2005). In our study, these variables, including some additional conditions, were tested through the household survey. One of the strongest correlations was the value of assets, [determined by combining the average price (in Kenyan shillings) of household

possessions like cell phones, bicycles and ploughs], and much decreased consumption from all harvest areas (Table 4). Off-farm employment of the primary earner was also associated with lower WEP consumption in home and farm areas. Both of these trends were expected, since several other studies have suggested that wealthier households, especially those with access to cash income from formal sector employment, rely significantly less on WEPs than poorer households (Cavendish 2000; Arnold and Perez 2001; Musaba and Sheehama 2009, Pandit and Thapa 2003; Ticktin 2004; Mithofer, Waibel et al. 2006; FAO 2011).

The results of the household survey showed a strong relationship between self-reported food insecurity and increased WEP consumption from the home and farm. As discussed above, WEP consumption often increases during hungry seasons and times of food crisis, but these results show a more general, year-round association of food insecure families using WEPs as a coping mechanism. Other studies have found similar relationships, where wild foods are used by chronically food insecure households on a daily basis to supplement nutrition, increase food volume and stave off hunger (Harris and Mohammed 2003), especially for vulnerable groups like AIDS-affected families, widows and the landless (Campbell 1990; Grivetti and Ogle 2000; Kaschula 2008; Fentahun and Hager 2009; FAO 2011).

Total farm size was positively correlated to consumption of WEPs from the home and farm, suggesting that families with larger farms are able to gather more WEPs from those areas. This may be due to generally higher plant species diversity in larger farms (Kindt, Simons et al. 2004), or possibly the amount of time spent on the farm due to greater labour demands related to increased acreage (Clay and Johnson 1992). This is important because WEPs are often collected during other activities rather than during visits to harvest areas expressly for the collection of wild foods (Campbell and Luckert 2002; Delang 2006).

2.4.5. Influence of distance on adaptive/coping capacity

Several studies have indicated that the availability of wild edible plants motivates their use, with the most popular species being those growing in the vicinity of the village (Pardo-De-Santayana, Tardío et al. 2005; Arenas and Scarpa 2007). We considered self-reported travel time (in

minutes) for the WEPs harvested in non-farm areas and neighbouring private farms in order to accurately represent the labour costs associated with each (Campbell, Luckert et al. 1997; Espinosa, Shepherd et al. 2011). Longer travel times were found to significantly correlate with a decrease in consumption frequency and species diversity in hilltops, forests and privately owned farms (Table 5). Travel time and distance have been shown to affect individual decisions to gather WEPs in other studies (Ladio and Lozada 2000), in relation to optimal foraging theory which formalizes the cost-benefit analysis of expending energy (calories) to collect natural resources and how that affects harvester decision-making (Keegan 1986).

WEPs collected from riverbanks showed no relationship to distance, neither in species diversity nor consumption frequency. During participatory mapping sessions, community members discussed the common practice of collecting in these areas while bringing livestock to graze, thus completing the task without exerting additional effort. WEP harvest during other activities (see Campbell and Luckert 2002; Delang 2006), may explain the lack of distance effect for riverbank harvest sites.

2.4.6. Permission requirements and access restrictions

One of the common themes that emerged during focus group discussions, interviews and casual conversations was the variation in WEP access policies on private and public lands. From data gathered during the household survey, trends emerged concerning permission requirements in different harvest areas (Fig. 2.8). WEPs harvested from sites that required permission were consumed approximately half as frequently as those that do not (t-test; $p<0.001$). However, when the sample was reduced by excluding the respondents' homes and farms, there was no significant effect of permission on WEP consumption frequency ($p<0.70$).

Although no statistically significant trends emerged for WEP consumption frequency and species diversity when permission requirements were considered, there may still be an effect since the household survey only included WEPs collected, and not those that the respondent might have liked to harvest if conditions were better. (see Widayti et al. 2010).

2.5 Implications for rural socio-ecological resilience in semi-arid Kenya

The homogeneous geographic distribution of WEP consumption frequency in our two case study sites (Fig. 2.7C) suggests that household conditions and resource accessibility were the main factors affecting WEP consumption frequency and species diversity. We relate these two categories to one another in a combined system (Fig. 2.9) describing how WEPs can be used to increase community resilience by manipulating household conditions and harvest practices. Our results reveal several factors that impact the frequency and diversity of WEPs consumed by rural Kenyans, both in terms of the need for these resources and the capacity to access them.

Household characteristics related to increased reliance on WEPs can be considered one measure of vulnerability or system sensitivity, which is how food insecurity, lack of off-farm income and low assets have been identified previously (Mithofer, Waibel et al. 2006). Ladio and Lozada 2003; Paumgarten 2005; Devineau, Aurouet et al. 2008). In addition to identifying WEP user group demographics, other researchers have found WEP consumption trends and NTFP harvest activities related to access conditions and management regimes (Berks, Colding et al. 2000; Pardo-De-Santayana, Tardío et al. 2005; Widayati, Jones et al. 2010). Few reports consider both system sensitivity and coping capacity in the context of WEPs contribution to socio-ecological system resilience. Our theoretical model (Fig. 2.9) suggests that increased resilience can be achieved by reducing system sensitivity (promoting off-farm employment, reducing food insecurity and augmenting household asset value) while also increasing access to adaptive measures.

In Kenya, the nutritional benefits of WEPs and traditional foods are a common topic of scientific study (Muthoni and Nyamongo 2010, Ogoye-Ndegwa 2003), but the importance of access to common areas where these products are harvested is often overlooked (Cousins 1999) and harvest restrictions in protected areas can shut out users who rely on WEPs (Falconer 1990). Lifting access restrictions in areas where WEPs are harvested primarily for food and micronutrient properties could benefit users that rely on them to combat malnutrition. This has been suggested in other studies, which demonstrate the nutritional benefits of WEP consumption for vulnerable groups and during times of food insecurity (Kengni, Mbofung et al. 2004;

Mithöfer and Waibel 2004; Dovie, Shackleton et al. 2007), especially for communities where open access to NTFP resources is available (Dovie, Witkowski et al. 2005).

In terms of harvest policies and extension activities, system sensitivity factors could be used to identify groups that consume WEPs more frequently, helping non-governmental organizations (NGOs) and governments target relevant projects more effectively. This is becoming more important as limited resources restrict food security initiatives in rural areas, despite increased need for these programs in the face of a changing climate and increasingly vulnerable smallholder farms (Speranza 2010). In some cases, inappropriately targeted interventions have increased income inequality (Harrigan 2003), or overlooked supposed beneficiaries, subsistence farmers and poorer populations, when deciding on program participants (Belay and Abebaw 2004).

2.6 Conclusion

This study sought to determine which household conditions are correlated with vulnerability and reliance on WEPs as a coping strategy during times of food insecurity, while also investigating the role of access restrictions on adaptive capacity and the ability to obtain these important food resources. Following our study in two villages in rural Kenya, it was found that reliance on WEPs was greater in households that reported food insecurity, lacked off-farm income and had lower levels of assets. Access to WEPs was also a major factor in consumption frequency, with smaller farm sizes and increased distance to harvest areas correlated significantly to lower levels of WEP use. These variables are specific enough that they can be used to determine the demographic groups that rely heavily on WEPs, and the access conditions that are likely to increase the ability of vulnerable groups to employ WEPs as a coping strategy to increase system resilience.

This research is unique in that we have combined vulnerability and adaptive capacity measures for each household to create a more complete accounting of the factors that influence WEP consumption frequency and the diversity of species consumed. These data can improve understanding of how common areas, marginal lands and protected forests contribute to rural

livelihoods on a daily basis and as emergency safety nets during hungry seasons. Specific, easy to test conditions like off-farm income and self-reported food insecurity could make identifying user groups relatively simple for future projects and extension activities. The effects of farm size, distance to harvest areas and ownership conditions on WEP access have been clearly identified in this study, which can inform future extraction regulations and land tenure reforms.

This study represents an important first step in taking a more holistic view of the important subsistence value of NTFPs, such as WEPs, and the myriad factors that influence households' reliance on natural resources and their ability to obtain such products. As land tenure becomes increasingly formalized in Kenya, access to common property resources is decreasing (Migot-Adholla, Hazell et al. 1991; Rutten 1997) and forest laws are making entry into protected areas more difficult for fragmented and impoverished rural communities that traditionally gained benefits from these areas (Laird, McLain et al. 2010). WEP resource use in the future is dependent upon long-sighted policies that better consider the needs of user groups in scientific research, development policy and extension activities (Feyssa, Njoka et al. 2011). This becomes especially significant as climate change increases the pressure on institutions to foster socio-ecological resilience (Folke, Carpenter et al. 2002; Ericksen 2008). If government and community regulations fail to consider the significance of WEPs to food security, the food production potential of their habitats is ignored and household nutrition suffers (Dansi, Adjatin et al. 2008, Dovie et al 2007), with potentially dire consequences in semi-arid Kenya where food insecurity and failed crops are common (KFSSG 2011).

2.7 Figures and Tables

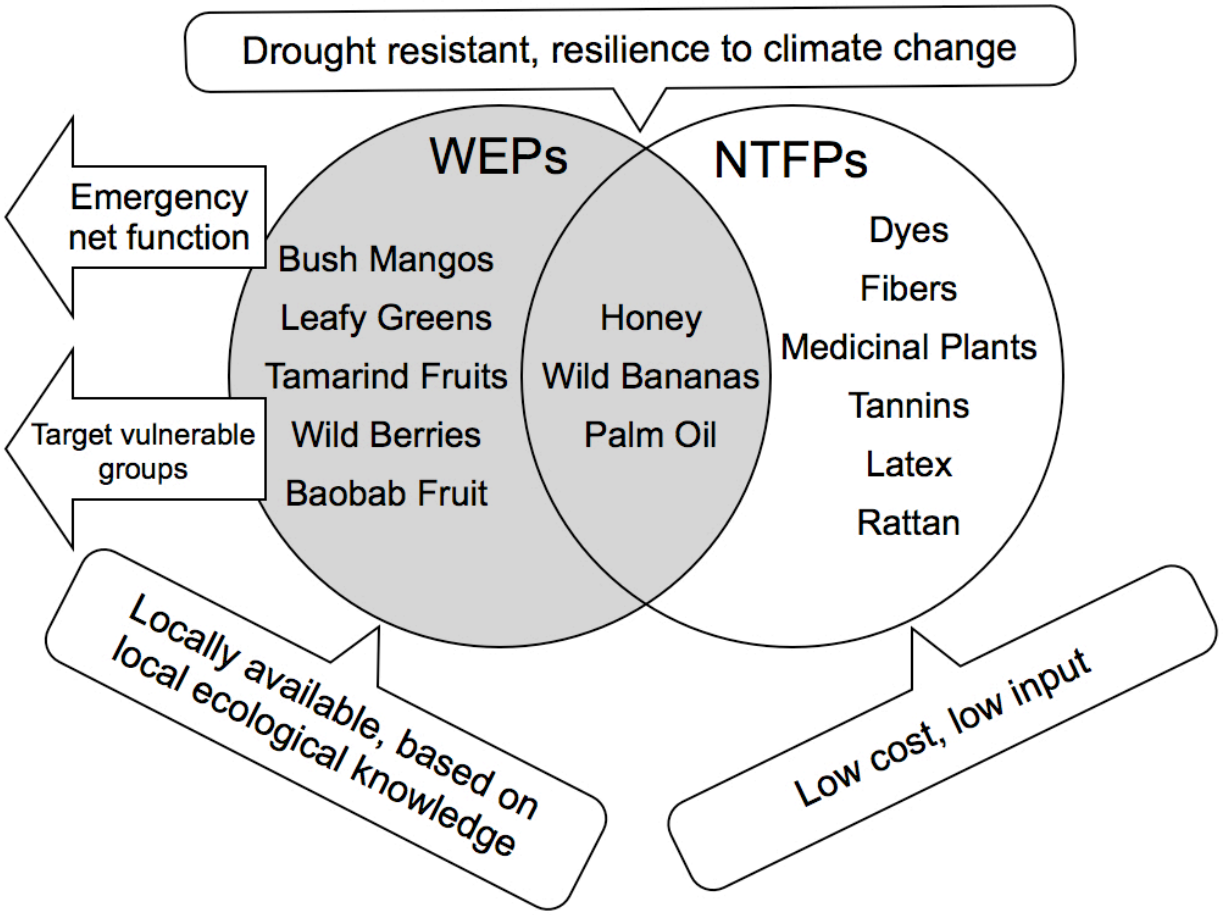


Figure 2.1. Venn Diagram comparing examples of Wild Edible Plants (WEPs) and Non-Timber Forest Products (NTFPs). The Food and Agriculture Organization of the United Nations defines non-cultivated plants as: *"*plants that grow spontaneously in self-maintaining populations in natural or semi-natural ecosystems and can exist independently of direct human action*"* (Heywood 1999). For the purposes of this study all plants that are gathered (not cultivated) are considered wild, including species harvested in agricultural areas, uncultivated or forest land (c.f.Termote 2011). See further references in text.

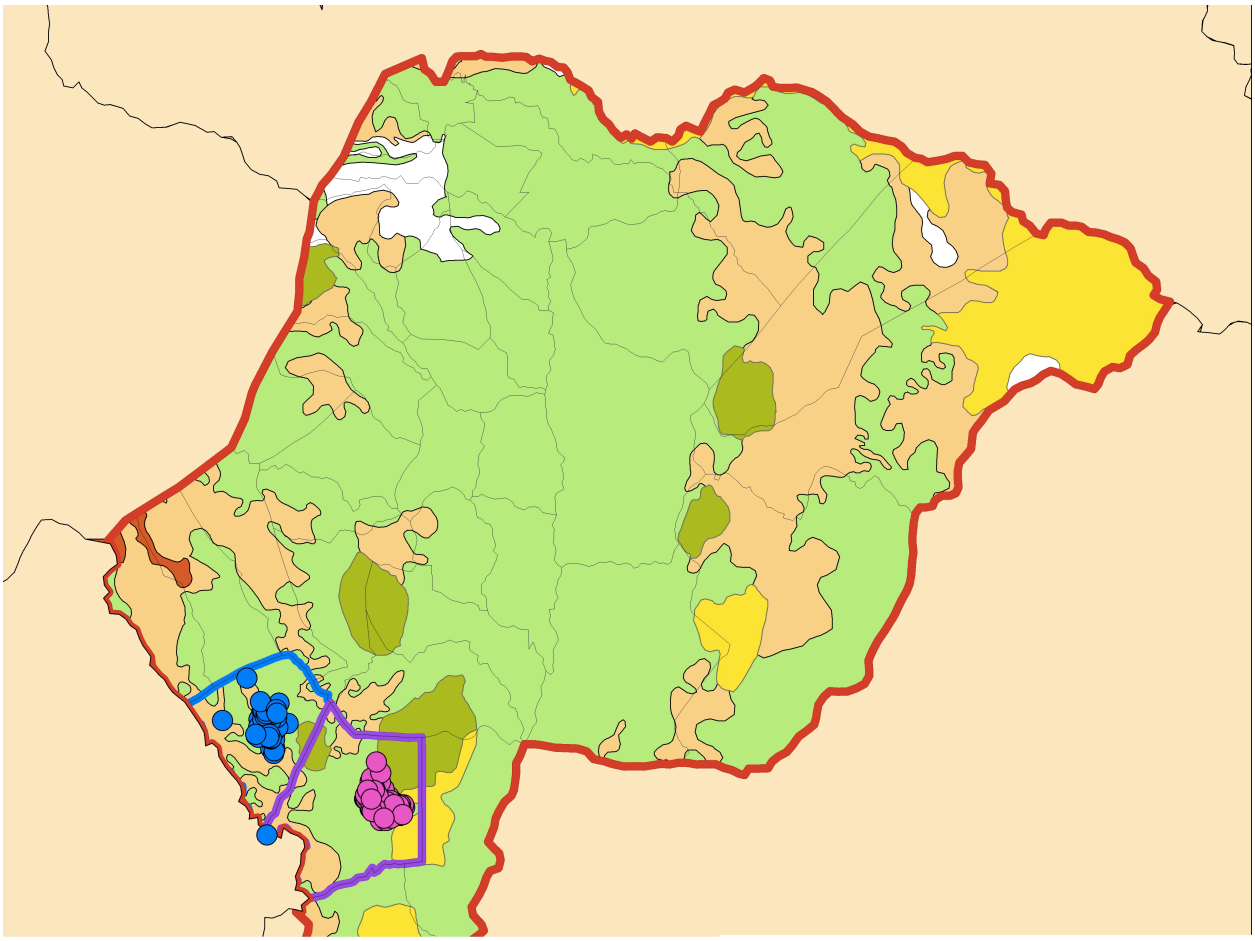


Figure 2.2. Study locations in Tharaka Constituency, Eastern Province, Kenya

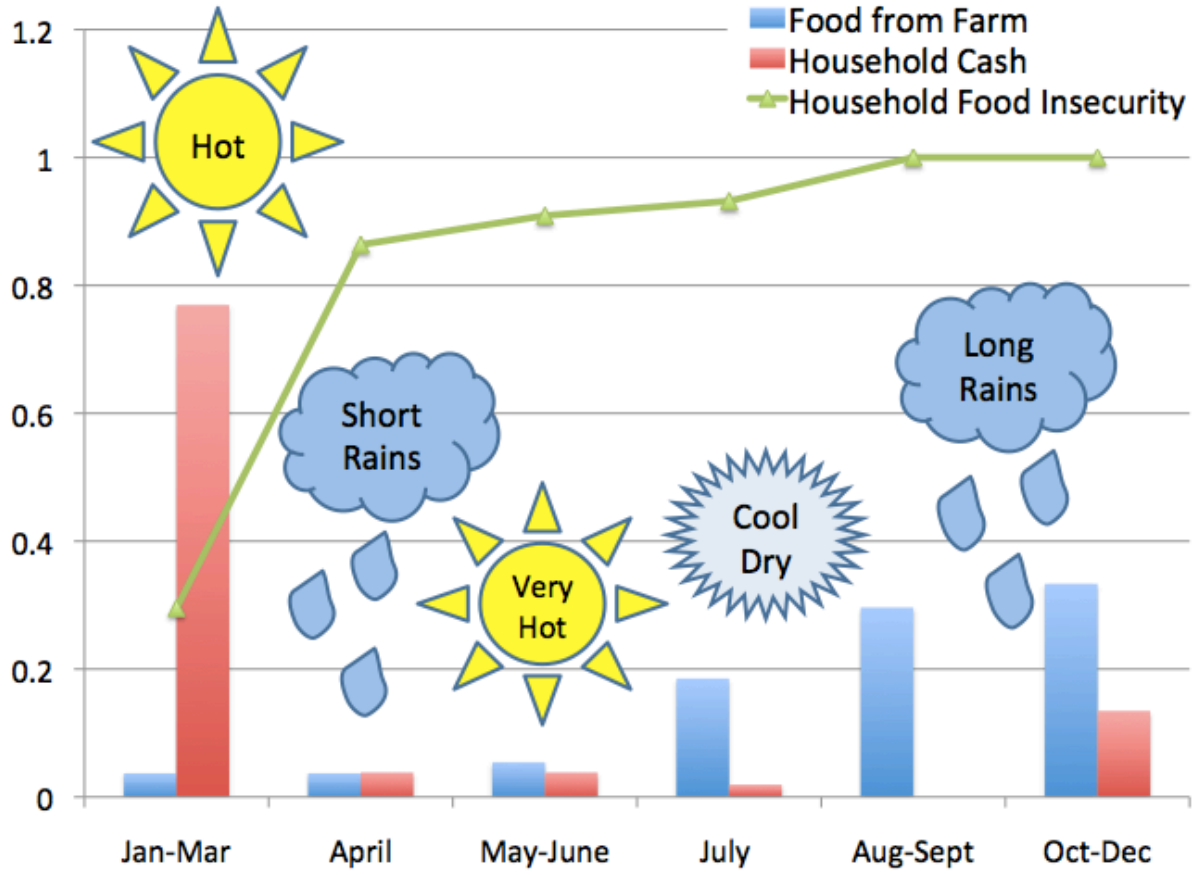


Figure 2.3. Results of seasonal mapping activity in Nyukani, HH food security was inverted to allow later comparisons with survey results. The original mapping used the term food security. Five seasons are delineated by participants, with food insecurity peaking right before the harvests following the long rains between October and December. Food available from the farms is highest directly after the harvest, and then transformed into greater cash resources in the following season (January-March) as the crops are sold for profit. (Data Collected 08/02/12).

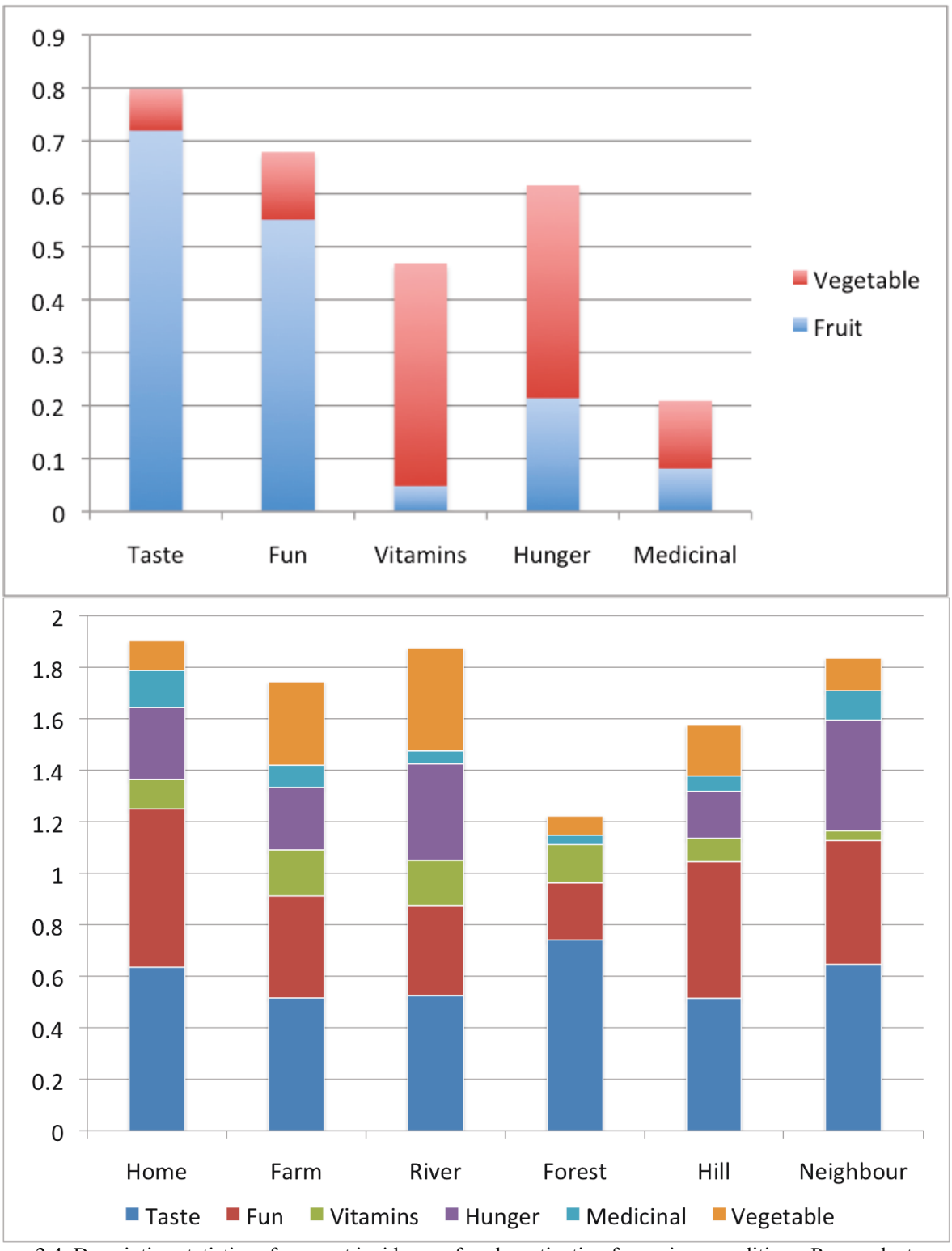
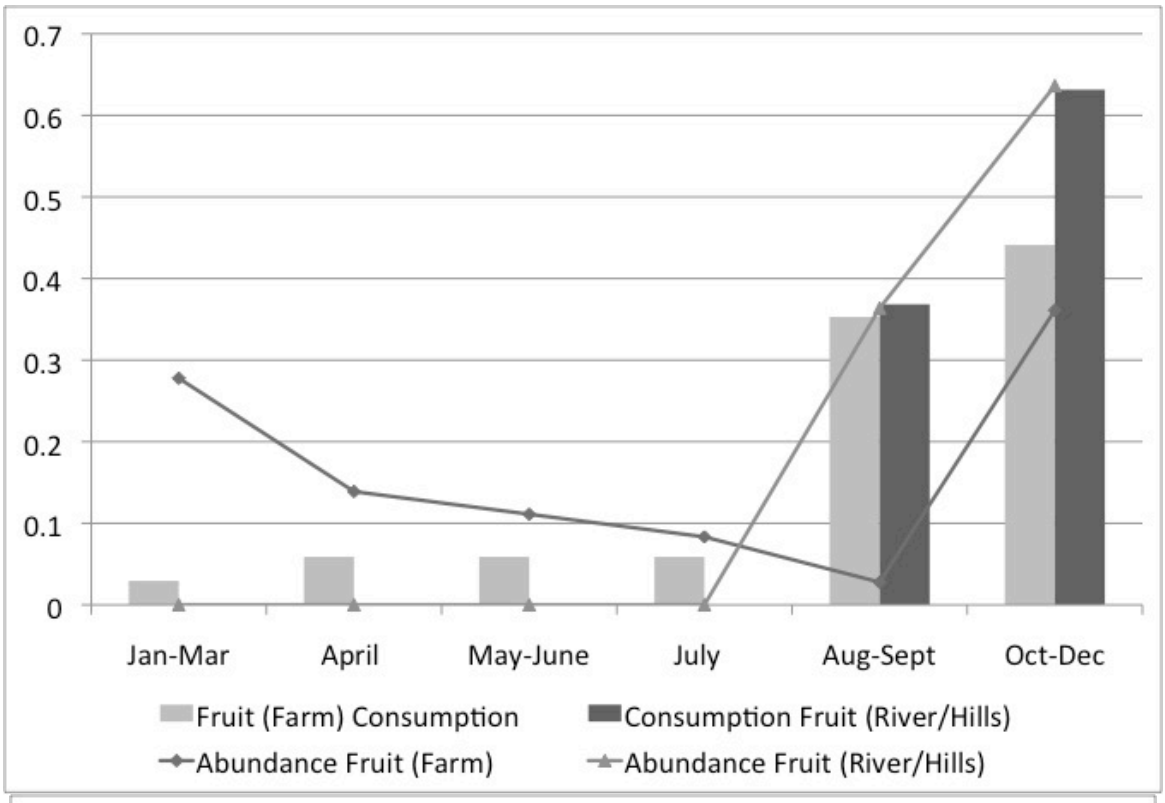


Figure 2.4. Descriptive statistics of per cent incidence of each motivation for various conditions. Respondents could choose multiple motivations for each plant, resulting in sum percentages of over 100%. From the top graph, it is obvious that vegetables are often consumed for their nutritional value or during times of hunger. Fruits are consumed more for 'fun' or taste. The bottom graph shows some trends of consumption motivation based on harvest location that will be explored in statistical analyses (Table 2.3)



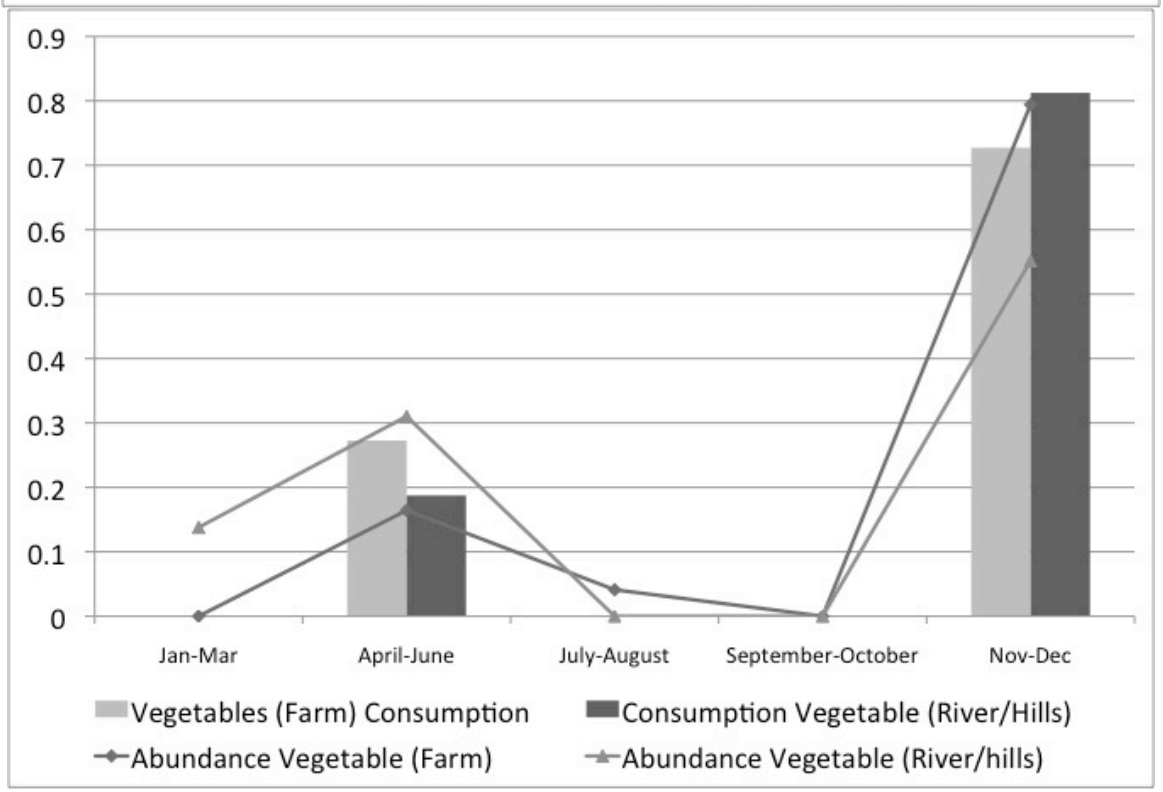


Figure 2.5. Seasonal mapping results Nyukani (Data Collected 08/02/12), show changes in collection and abundance of WEPs by harvest area distinction. Participants used dried maize to represent relative conditions. Results suggest that consumption is a function of perceived availability but also may be related to other factors, since abundance and consumption are not always linked.

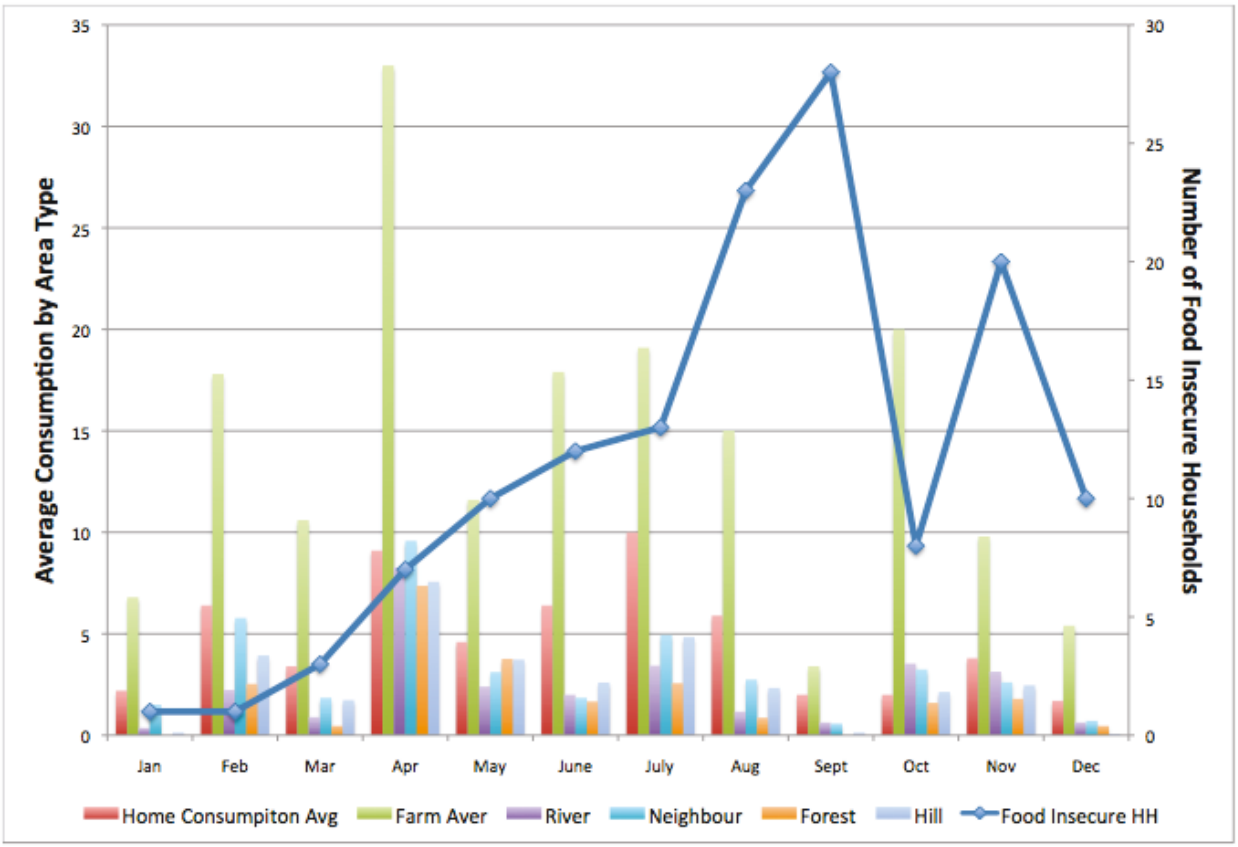


Figure 2.6. Average consumption frequency in homes, farms and other harvest areas over the calendar year, with food insecure households. This data was calculated from the household surveys, which shows that respondents consume WEPs from their own farms most frequently, and that monthly consumption averages are not directly linked with food insecurity in the population overall.

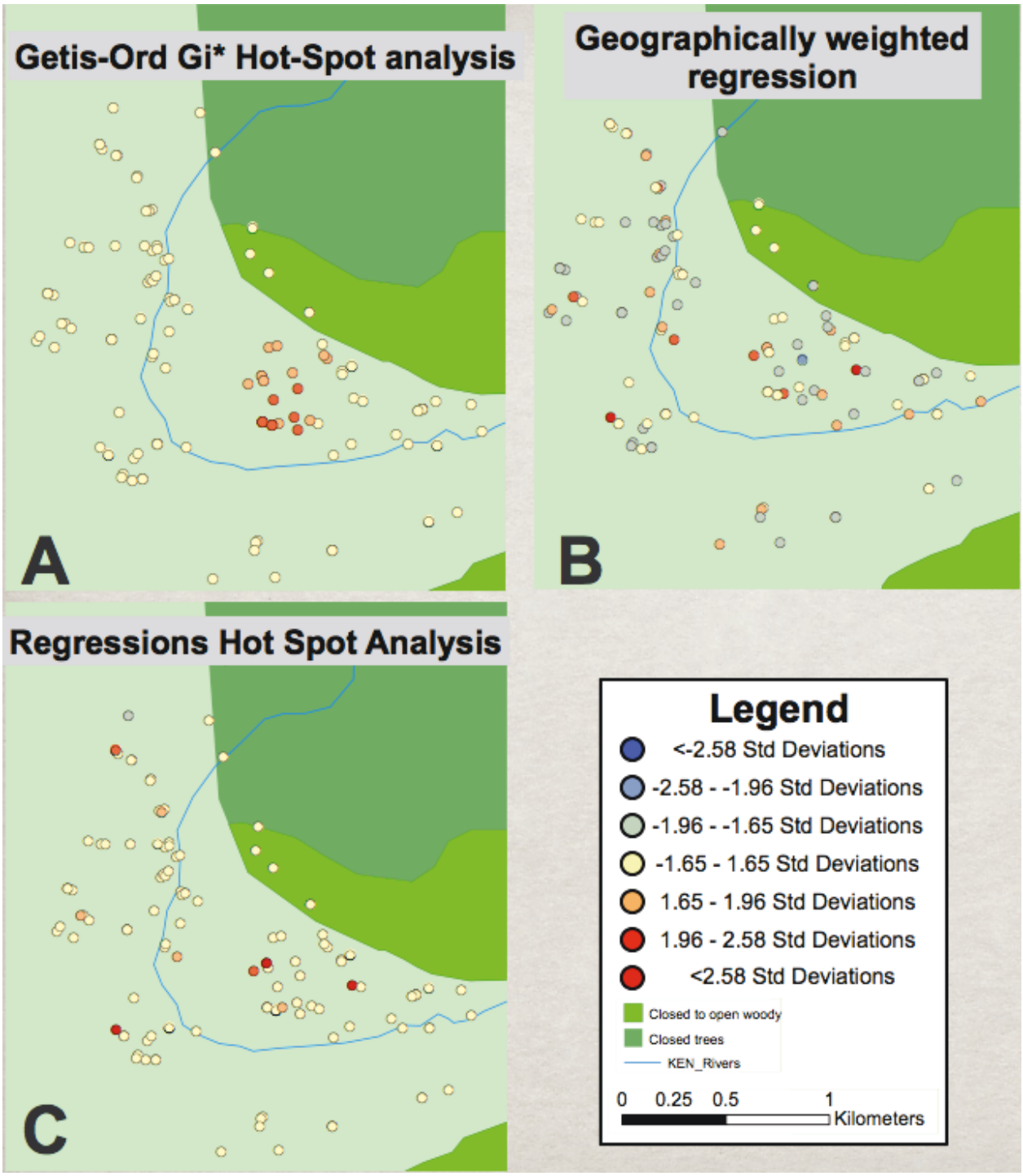


Figure 2.7. GIS map created using ArcGIS showing a random distribution of statistical outliers in a geographically weighted regression (B) and no statistically significant spatial autocorrelation of those outliers (C).

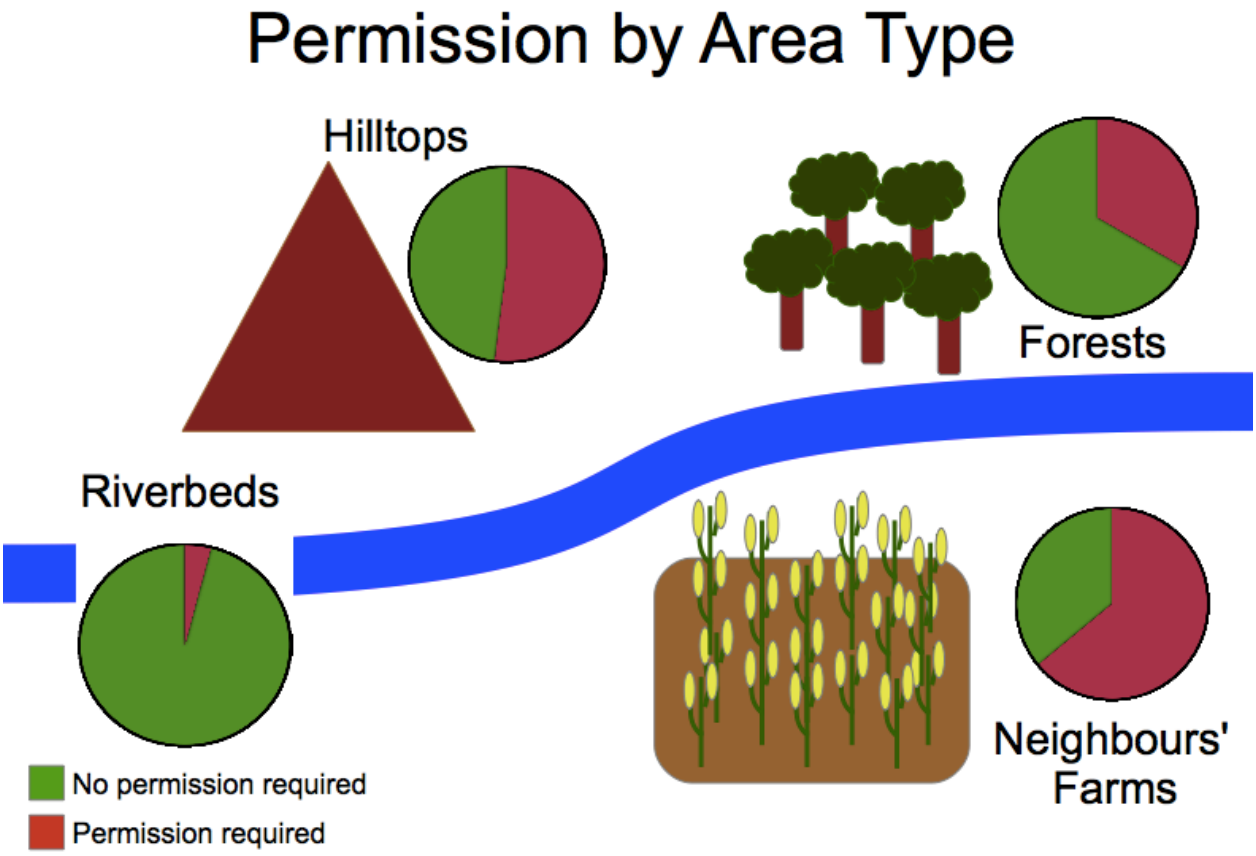


Figure 2.8. Permission requirements by harvest area. Hilltops owned by the government, private farms and forests located on private land require permission for WEP harvesters, while riverbeds generally do not. Despite the fact that riverbeds are often adjacent to private or government property, they are considered open to the public for WEP harvest.

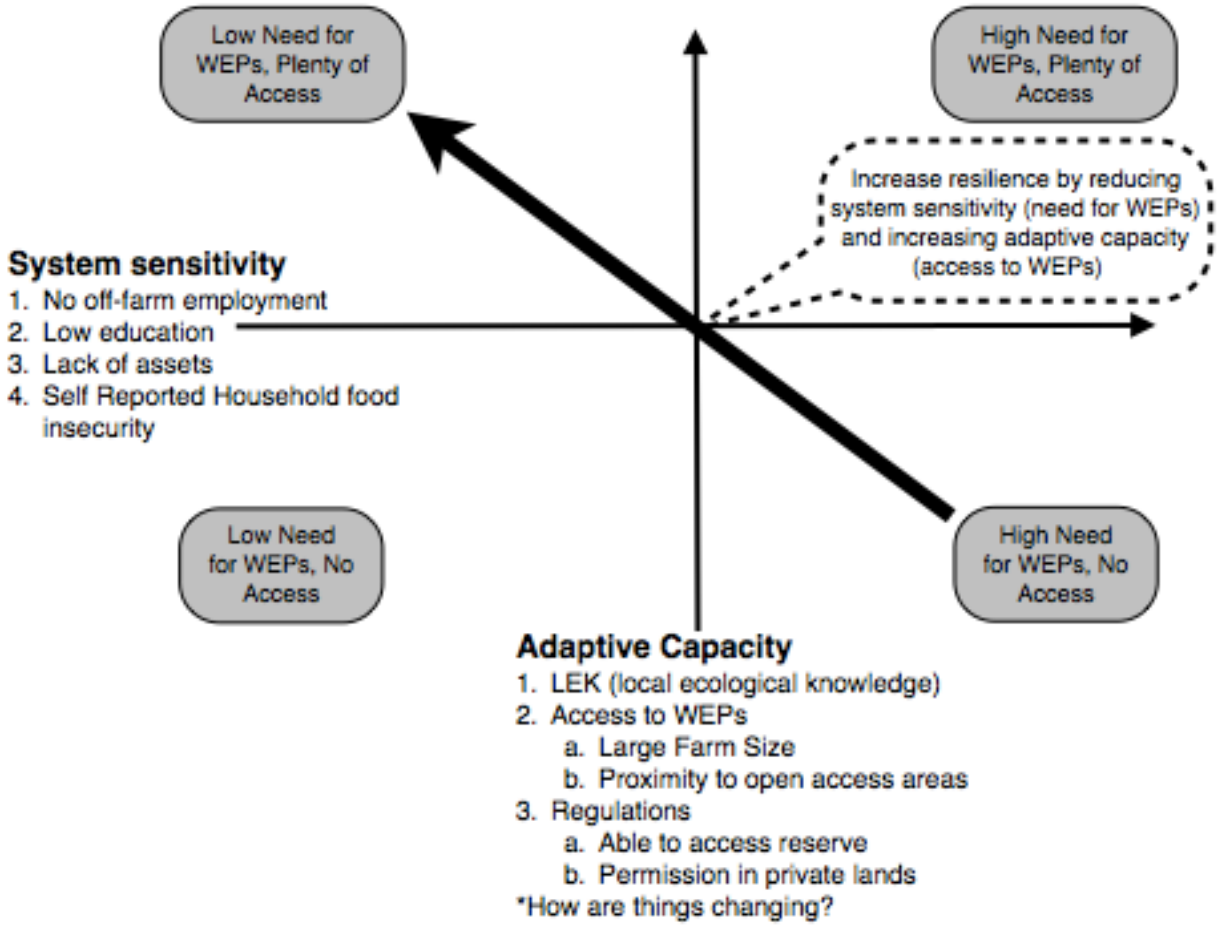


Figure 2.9. Combined system showing how adaptive capacity and system sensitivity affects WEP contribution to community resilience.

Table 2.1. T-test for descriptive statistics between case study sites Gantundu and Nyukani. Gantundu had significantly higher household assets and less food insecurity, greater average education level for the household head and more of the major breadwinners working primarily off-farm. The age of the household head, number of children, household size, total farm size and off-farm employment in general were not significantly different between the two sites

Indicator	**Gantundu**	**Nyukani**
	Mean	Mean
Total children (<15 years)	1.63	1.87
Household size	4.27	4.97
Asset value (Ksh)	15750	4083***
Education level of household head [A]	1.37	.87**
Head of Household works off-farm [B]	0.4	0***
Percentage of household members working off-farm	0.29	0.28
Age head of household (in years)	49.53	46.96
Head of household away [C]	0.4	0.03**
Food insecure (1 = yes; 0 = no)	0.6	0.9**
Time to market (in minutes)	85.27	35.34***
Total farm size (hectares)	4.29	3.56

*$P <= .05$; ** $P <= .01$;*** $P <= .001$

[A] = Education Level (00=None) (01=Primary) (02=Secondary) (03=Higher Ed.) (04=Adult Ed)

[B] = Off - Farm dummy variable (00=No off-farm employment) (01=Primarily employed off-farm)

[C] = Lives Away dummy variable (00=Lives at home) (01=Primarily resides away)

Table 2.2. Some free-listing and preference ranking results from Gantundu, Kenya (Data Collected 06-26-12).

Local Name	Preference	Eaten when:			Season			Collected by			Eaten by:		
	(0=Dislike; 1=Like; 2=Prefer to crops)	Crops fail	No cash	For fun	Rains	Post-rain	Dry	Kids	Women	Men	Kids	Elders	Pregnant women
Muthunka	2	X	X	-	X	X	X	-	X	-	-	-	X
Mparia	1	X	X	-	X	-	-	-	X	-	-	-	-
Nkengejia	-	X	X	-	X	X	-	-	X	-	-	-	-
Terere	2	X	X	-	X	-	-	-	X	-	-	-	X
Ngonko	0	X	X	-	X	-	-	-	X	-	-	-	X
Nthawana	2	X	X	-	DATA NOT COLLECTED			X	-	-	-	-	-
Uthithi	1	X	-	X					-	X	-	-	X
Mbuu	1	-	-	-					-	-	X	X	X
Mboobua	1	-	X	X				X	-	-	X	X	-
Ndoroma	1	-	X	-				X	-	-	-	-	X
Matoo	1	-	-	X					-	-	X	X	-
Uramba	2	X	-	-					-	X	-	-	-

Table 2.3. Student's t-test performed for each area type and motivation shows These results show that some areas, such as farms, neighbours' farms, and riverbanks, are visited for WEPs when hunger or vitamins are the main motivation. Other areas, such as the home or riverbanks, are often WEP collection sites for those seeking fruits that taste good or are eaten for fun.

Location	Fun	Taste	Hunger	Vitamin	Medicinal	Vegetable
Home	+++	*	0	0	++	---
Farm	--	--	0	+++	0	+++
Other (in general)	0	0	0	--	0	+
Hill	0	0	0	0	0	0
Forest	--	++	---	0	0	-
River	0	0	+	0	0	+
Neighbours' Land	0	*	+++	++	0	--

Greater Incidence Compared to Other Areas:*<=.1; + <=.05; ++<=.01, +++<=.001;
Lesser Incidence Compared to Other Areas: -*<=.1; - <=.05; --<=.01, ---<=.001

Table 2.4. Ordinary Least Squares (OLS) regression of WEP consumption and species diversity with independent household variables. Asset value and off-farm employment were significantly negatively correlated with WEP consumption, while food insecurity, non-traditional families and total farm size were associated with greater consumption frequency. The diversity of WEPs consumed was less for households where the head was more educated and asset values were higher.

Independent Variables	**Home/Farm Consumption**	**Other Area Consumption**	**Home and Farm Spp. Diversity**	**Other Spp. Diversity**
Food Insecure[A]	0.854**	0.762	0.931	0.250
Non-Traditional Family[A,B]	0.126**	-1.224	-0.527	-1.439
Household Head Education[C]	-0.130	0.136	-1.091**	-0.149
Value of Assets (Ksh)	-0.000243**	-0.000137***	-0.0000212	-0.00015***
Age Head of Household (years)	0.00455	-0.0200	-0.004091	-0.004016
Head of Household Away[A]	0.572	-0.111	1.016	-0.409
Primary off-farm work[A]	-0.381+	1.1636**	-1.572	0.507
Total Kids (<15 years)	0.045	-0.051	-0.0465	-0.250
Female Respondent[A]	0.208	0.088	-0.0784	0.942
Total Farm Size (ha)	0.083**	0.130	0.241	0.129
Constant	4.091*** (0.521)	4.493*** (1.105)	8.128*** (1.895)	5.896*** (1.198)
R2	0.4885	0.3772	0.1927	0.3476
Observations	51	51	51	51

A Dummy variables (1=condition fulfilled; 0=Condition not fulfilled)
B Non-traditional family = Single male alone or single female headed household
C Education level (00=None) (01=Primary) (02=Secondary) (03=Higher Ed.) (04=Adult Ed)
+P<=.1; *P<= .05; ** P <= .01;*** P <= .001. Standard Error in parentheses.

Table 2.5. OLS regression using WEP consumption or species diversity as dependent variables and distance as the independent variable, separated by harvest area type. Coefficients are shown (+/-), next to P-values.

Area Type	Effect on WEP Frequency	Effect on WEP Spp.
River	(+) 0.834	(+) 0.553
Neighbours' Lands	(-) 0.060	(-) 0.008
Forest	(-) 0.145	(-) 0.025
Hilltop	(-) 0.012	(-) 0.000

2.8 Acknowledgements

This research was supported by the McGill University and KARI. We would also like to acknowledge the field assistants, translators and especially the anonymous participants for donating their valuable time and expertise to our study. This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, and with the financial support of the Government of Canada provided through the Canadian International Development Agency (CIDA).

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Preface to Chapter 3

Access restrictions and regulations are known to have a significant impact on WEP harvest. In order to understand the community level factors affecting access to WEPs in the study area, the legal framework and implementation forest laws in reserves was investigated. Since WEPs are also collected in marginal areas and privately owned land, the permission requirements, management regimes and extension programmes targeted at those areas were also considered. Chapter 3 builds on the household level data collected in Chapter 2 with the intention of better understanding the regulatory context for WEP use in our study area, and identifying how WEP access and use might be better supported to improve food security outcomes in semi-arid Kenya.

Chapter 3. Institutional factors affecting the contribution of wild edible plants (WEPs) to sustainable food security outcomes in semi-arid Kenya: A multiple case study.

3.1 Abstract

Pervasive food insecurity and poverty in much of the world drives vulnerable populations to harvest natural resources as a means of generating income and meeting other household needs. Wild edible plants (WEPs) are a particularly common and effective coping strategy used to increase socio-ecological resilience in Sub-Saharan Africa where agricultural systems are often sensitive to environmental perturbations and instability. WEPs are collected across the landscape, from agricultural areas to government-managed hilltops with varying degrees of success and legality. This multiple case study research, conducted in Eastern Province, Kenya, investigates the formal forest regulations and land tenure rights, as well as local enforcement and understanding of those rules, in order to understand their impact on the ability of vulnerable populations to use WEPs as a coping strategy. The results suggest that widespread confusion, trust issues and a strong focus on the commercialisation of wild foods are limiting the possible contribution of WEPs to food security and increased socio-ecological resilience. We identify a number of policy changes and extension programmes that could better support local communities relying on WEPs for subsistence purposes to improve their adaptive capacity.

Keywords: East Africa, Tharaka, Land tenure, Community forest management (CFM), Non-timber forest product (NTFP) commercialization; Sustainable development

3.2. Introduction

Ensuring adequate human nutrition is a significant challenge facing governments internationally, despite global efforts to increase agriculture production, improve food distribution and identify appropriate policy interventions (FAO 2012). This challenge is highly complex, requiring consideration of "food availability, food accessibility and food choice, which in turn may be influenced by geography, demography, disposable income, socioeconomic status, urbanization, globalization, marketing, religion, culture and consumer attitudes" (Kearney 2010:2802). Combined, these factors influence the ability of individuals, communities and nations to fulfill daily nutritional requirements, creating an unstable framework that negatively affects society.

Historically, increased global food demand could be addressed by agricultural extensification; however, this has become less of an option over the past 50 years. Population growth, urban sprawl, demand for the production of other natural resources, and existing agricultural areas are just some of the reasons that competition for farmland has been increasing (Smith, Gregory et al. 2010). Also of concern are the environmental consequences of intensifying and increasing the land occupied by traditional agricultural production such as loss of habitat for biodiversity conservation, nutrient runoff, sedimentation of waterways, pesticide poisoning of humans and non-target species (Zhang, Ricketts et al. 2007) and increased carbon emissions (Godfray, Crute et al. 2010). Intensive agriculture consumes large amounts of scarce resources, such as freshwater (Strzepek and Boehlert 2010) and petroleum products (Woods, Williams et al. 2010), while the rising cost of these inputs is predicted to limit future crop choices and production yields. Changing climate conditions are also likely to impact agriculture, especially in areas that currently have marginal food production, as extreme weather events and temperatures combine with rising sea levels to dramatically change the landscape (Jaggard, Qi et al. 2010).

The Millennium Ecosystem Assessment (UN 2005) detailed global trends in balancing provisioning, regulating and cultural ecosystem services. This global investigation found that gains in provisioning services, such as food and timber, were generally associated with environmental degradation and loss of other ecosystem services, like erosion and water quality controls. These conclusions have encouraged scientists to call for resilient food production systems that can produce a variety of ecosystem services (Bennett and Balvanera 2007). Since the management of the majority of productive land worldwide is connected in some way with agriculture, it is often farmers that have the responsibility and the opportunity to successfully implement resilient systems (Tilman, Cassman et al. 2002). Resilient systems combine reduced vulnerability to perturbations, both environmental and otherwise, and the capacity to respond to broader changes with renewal and reorganization (Folke, Carpenter et al. 2002). Foley and colleagues (2005) suggest a compromise between natural areas and intensive agricultural regimes, while Ellis (2011) inspires humans as a whole to take charge of the anthropogenic modifications that have shaped this period of our existence, which he names the Anthropocene. These ‘middle-ground’ biomes, often called agri-ecological systems, must also consider community development objectives by including locals in decision-making processes, sharing

knowledge and building relationships (King 2008).

For many years, non-timber forest products (NTFPs) have been promoted as one solution to increasing incomes from production while maintaining environmental integrity and achieving conservation goals (Neumann 2000). Unfortunately, meta-analysis has suggested that this may be more complicated than originally expected. Kusters et al (2006) compiled 55 cases and found that positive livelihood changes, such as increased income and household nutritional status, were associated with lower environmental outcomes such as lower species diversity and abundance or increased soil erosion. This finding has been repeated in other studies, (e.g., Ros-Tonen and Wiersum 2005), but should be interpreted with caution.

While commercial applications and export-level extraction of NTFPs may not be a viable method of integrating conservation and development objectives, the possibility of balancing ecosystem services while supporting food production and community needs remains an important area for development interventions. Less-intensive combined systems have been shown to have a positive impact on the socio-economic conditions of local populations, while avoiding serious negative impacts on biodiversity conservation objectives (Belcher, Ruíz-Pérez et al. 2005). Subsistence-level NTFP harvest is the predominate condition worldwide, yet has often been excluded from ecosystem service assessments and economic valuation of forests (Delang 2006). Of the NTFPs used at the household level, wild edible plants (WEPs) are some of the most frequently gathered (Tewari 2000), representing an important provisioning service of the local agri-ecological system that does not critically undermine other supporting and regulating services since collection is often low volume and intended for use directly by the household (Van Jaarsveld, Biggs et al. 2005).

3.2.1. Wild edible plants increase resilience when properly managed

Wild edible plants[6] (WEPs) play an important role in food production and maintaining

[6] The Food and Agriculture Organization of the United Nations defines non-cultivated plants as: "plants that grow spontaneously in self-maintaining populations in natural or semi-natural ecosystems and can exist independently of direct human action" (Heywood 1999). For the purposes of this study all plants that are gathered (not cultivated) are

ecosystem services, especially in Sub-Saharan Africa (Grivetti and Ogle 2000; Bharucha and Pretty 2010). These wild food resources supplement energy and micronutrients, improve the taste of staple foods and diversify food sources (Arnold and Perez 2001). This is especially true in poorer households and in rural areas where they can help to reduce spending of limited cash resources on energy, shelter, food and medical needs (Shackleton and Shackleton 2004). Many WEPs can be gathered without monetary cost and do not require expensive inputs, machinery or processing, meaning initial investment in production is not a barrier to successful outcomes (Jama, Mohamed et al. 2008). In addition to the baseline contribution of WEPs to household food security, they are also an important coping mechanism during periods of food insecurity brought on by drought, political unrest and unstable commodity markets due to their year-round availability (Fentahun and Hager 2009) and relatively high tolerance to water stress (Addis, Urga et al. 2005).

There are, however, barriers to successfully combining environmental protection and WEPs, particularly when regulating harvest sustainability. Poor policy design, lack of enforcement and community misunderstandings can result in harvest declines and ecosystem degradation (Falconer 1990; Brooks and Tshering 2010). While there are many examples where inappropriate formal policy interventions have resulted in negative social-ecological outcomes (see, for example, Stewart 2003), there are also examples of success (see Robinson and Lokina 2011). Informal policy also affects the collection and use of WEPs, and can be important in ensuring successful regulation (see, for example, Wynberg and Laird 2007). Although WEPs are an important dietary resource in rural areas, their contribution to food security is often under-appreciated by policy-makers, leading to formal policies on access, extraction and sale that can lack understanding of local conditions (Shackleton and Shackleton 2004).

3.2.2. The importance of resilience-focused policy and institutions

Institutions are central to balancing social and ecological issues and resources if food security in

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considered wild, including species harvested in agricultural areas, uncultivated or forest land. While NTFPs are defined by habitat, the forest, and can include edible and non-edible products. WEPs are limited to only those plants that can be eaten (c.f.Termote 2011) – See Figure 1.1

the face of global environmental change is to be managed as an integrated system (Ericksen 2008). According to Folke et al (2002), resilience can be fostered through policies that encourage openness, learning and building adaptive capacity, while also promoting management flexibility and cooperation. As local ecological knowledge (LEK) declines, scientific research, development policy and extension activities will have a greater role to play in maintaining WEP diversity, production and consumption (Feyssa, Njoka et al. 2011). When government and community regulations fail to consider the significance of their WEPs to food security, the food production potential of their habitats is ignored and household nutrition suffers (Dansi et al 2008).

Focusing on the food insecure semi-arid region of Kenya, I will analyze WEP harvests from various types of property and the impact this has on individual, household and community access to wild foods as a coping strategy for increasing socio-ecological resilience. The arid and semi-arid lands (ASALs) of Kenya are a particularly vulnerable region, as variable climate and heavy reliance on rain-fed agriculture leave some ten million residents susceptible to environmental and social disturbances (Kamotho 2007), especially as climate change reduces the capacity of such livelihood systems to ensure food security (Minaxi, Acharya et al. 2011). The importance of WEPs in the ASALs of East Africa is well documented (Grivetti and Ogle 2000; Asfaw and Tadesse 2001; Harris and Mohammed 2003), as is the trend of decreasing use, knowledge and protection of such resources (Smucker and Wisner 2008). It is therefore imperative that the current management regimes regulating WEP harvest are well understood, in order to maintain access to these important resources in the face of environmental change. Ultimately Kenya's subsistence and smallholder farming communities need to be better able to make use of appropriate coping strategies and build socio-ecological resilience for sustainable food security.

3.3. Institutional factors affecting WEP regulation in semi-arid Kenya

3.3.1. Government control of forests

Many international development organizations and donors have strongly supported large-scale land transfer by African governments from tribes, clans and community groups to individuals or

public institutions (Monbiot 1994). Traditional common property regimes have become scarce as privatization, land titles and formal rights are promoted, leaving approximately two per cent of all forests in Sub-Saharan Africa to community control and nearly all of what remains under government management (Agrawal 2007). In Kenya, the vast majority of forests have been converted to publicly owned conservation areas[7], while 90 per cent of other wooded lands are also government controlled (FAO 2010) (see Fig. 3.1).

While government control of forests and wooded land in Kenya may have conservation benefits, such as reducing deforestation by local actors, there are many other threats to these ecosystems. Commercial agents working with government contracts are known to circumvent regulations, often gaining permission to increase cultivated areas, expand pastures and extract large quantities of natural resources such as timber (Kaimowitz 2003). Furthermore, public forest management often reduces local community access to resources such as WEPs, which tends to have disproportionate negative effects on more vulnerable populations and poorer households within the community (FAO 2011). According to Robinson and Lokina (2011), arbitrary access prohibition in designated reserves can also inadvertently cause severe environmental degradation in adjacent natural areas that were previously managed sustainably.

3.3.2. Legal framework: Summary of the Kenya's Forests Act (2005)

Although the sustainable harvest of WEPs is contingent on a wide variety of location-specific factors, general recommendations on how to regulate common property resources have emerged from meta-data analysis and large-scale comparative studies (see for example, Ostrom 1990). Generally speaking, rules that regulate shared resource use, monitor compliance and punish illegal actors are associated with more successful conservation and development outcomes for communal resources (Ostrom, Burger et al. 1999). Drawing on the work of Kohler and Schmithfisen (2002),we review the aspects of Kenya's Forests Act that relate specifically to the

[7] According to Sec. 20 of Kenya's Forest Act (2005), all forests aside from those owned by private actors or local authorities are property of the state. Some of those State Forests are set aside as National Parks and Reserves, or gazetted, and managed strictly for biodiversity conservation. The majority (80per cent) of State Forests (Sec. 34.1) allow utilization, silvicultural operations and infrastructural development, provided a management plan has been submitted and other requirements have been met (Matiru 2000).

harvest of WEPs for household consumption (Table 3.1).

Aspect 1: Definitions – The Forests Act includes definitions of forests, consumptive use, sustainable use and management, and a thorough explanation of forest produce which includes various WEPs (Part 1- Preliminary):

> "forest produce" includes bark, bat droppings, beeswax, canes, charcoal, creepers, earth, fibrewood, frankincense, fruit galls, grass, gum, honey, leaves, flower, limestone, moss, murram, myrrh, peat, plants, reeds, resin, rushes, rubber, sap, seeds, spices, stones, timber, trees, water, waxwithies and such other things as may be declared by the Minister to be forest produce for the purpose of this Act"

'Forest community' is, however, defined in a confusing manner where traditional user groups and registered conservation associations are combined into one category.

Aspect 2: Traditional Use Rights - The Forests Act specifically states that infringement on traditional use rights is not permitted (Sec.21):

> "Nothing in this Act shall be deemed to prevent any member of a forest community from taking, subject to such conditions as may be prescribed, such forest produce as it has been the custom of that community to take from such forest otherwise than for the purpose of sale".

However, permits are required for entry into State Reserves and the State can take over forest management in cases where it (Sec. 25): "supports an important industry and is a source of livelihood for the surrounding forest communities"

Aspect 3: Objectives - In Section 6, the functions of the Forest Board are described, including (h): to "establish and review policies and rules for marketing of trade in forest produce," and (o) to "approve the provision of credit facilities and technical training for community based forest industries, and the provision of incentives to persons who exploit wood and non-wood forest products sustainably." This confers jurisdiction to the forest service over NTFPs, including WEPs, for commercial use. Although multiple-use forest management is not specifically mentioned as an objective, the Act does reference the myriad potential benefits from forests,

such as ecosystem services, conservation of biodiversity, income generation, research and cultural values (Sec. 17).

Aspect 4: Community Participation - There are many references to community groups and associations throughout the Act, and an entire part (IV) is devoted to explaining the application process, rights and functions of these groups. The responsibility of the Kenya Forestry Service to promote community-based projects is clearly stated (Sec. 17f), as are the requirements of the community charged with managing a forest (Sec. 46). The application process is somewhat involved, requiring a formal petition, charter and proposals that detail: (i) use of forest resources; (ii) methods of conservation of biodiversity; (iii) methods of monitoring and protecting wildlife and plant populations and enforcing such protection (Sec. 45e).

3.3.3. Communal land and the privatization trend

The vast majority of traditional agricultural systems in Africa rely on land abundance in order to employ shifting cultivation regimes that included long fallow periods, clearing new land and labour as the main input (Sjaastad and Bromley 1997). Population growth has dramatically increased the pressure on limited arable land resources, while agricultural intensification has resulted in continuous cultivation for commercialization using more technologically advanced inputs. These factors have combined to drive changes in indigenous land management regimes towards privatization and formal recognition of land rights. Formal government policies have followed a similar pattern, with colonial governments in Kenya passing reforms to secure inalienable individual rights beginning in the 1950s, a trend that has continued through independence and to the present day (Migot-Adholla, Hazell et al. 1991).

Kenya has a land classification for “communally-owned private” tenure, which was created to cover remaining traditional systems for grazing livestock and sharing natural resources. Unfortunately, the usage of many of these areas has been socially and environmentally unsustainable, resulting in a backlash against such regimes and further driving the move toward individual private ownership (see, for example, Rutten 1997). Privatization is often promoted as a panacea for overcoming poverty, with supporters suggesting that land titles open the door to

credit, secure land tenure and allow more stable trade (De Soto 2000, as cited by Obeng-Odoom). However, registering private land comes with its own issues, as high costs of demarcation and titling and disagreements about ownership can lead to long-lasting conflicts (Deininger, Ali et al. 2008).

3.4 Methods

3.4.1. Study area

I conducted this research as part of a multi-disciplinary research partnership between the Kenya Agricultural Research Institute (KARI) and McGill University[8]. The study area was located in southern Tharaka Constituency, where food insecurity is prevalent with crops failing, on average, once every three seasons (Kenya 2012). Two farming communities, Nyukani (0° 17' S, 37° 56' E) and Gantundu (0° 15' S, 37° 52' E), were chosen as case study sites (Fig. 2.2), both dominated by a mixed livelihood system of livestock, some formal sector income and marginal/subsistence farming of millet, maize, sorghum, cowpeas, pigeon peas, green grams (mung beans) cassava, and cash crops like cotton and horticulture. The average annual rainfall fluctuates between 200mm-800mm, and falls mostly during the long rains (October-December) and the short rains in April. Elevation varies considerably, from 690 m. to over 1400 m. a.s.l. at the top of Kijege Hill (Wisner 1977). These communities were selected based on the prevalence and intra-community variation of WEP consumption, diversity of livelihood strategies and proximity to harvest sites covering a spectrum of resource access conditions, (Personal communication, Patrick Maundu, June 11, 2012), as demonstrated by the average annual consumption frequencies across several types of harvest areas (Fig. 3.2).

Nyukani is comprised of 54 household in the sub-location of Chiakariga while Gantundu is a larger village of 108 households in the sub-location of Nkarini . Nyukani is located less than a kilometer from a bustling market town, Chiakariga, and sits at the foot of a 3,303 hectare protected forest, Kijegee Hilltop Reserve. This reserve has been managed by the Kenyan

[8] "Innovating for Resilient Farming Systems in Semi-Arid Kenya," funded by the Canadian Food Security Research Fund (CFSRF) (106515) through the Canadian International Development Agency (CIDA) and the International Development Research Centre (IDRC).

Forestry Service for conservation objectives, watershed protection and soil preservation since 1959 (IUCN and UNEP 2010). Settlement on this hilltop has been restricted since colonial times, leaving the forest essentially intact (Smucker and Change 2002).

Gantundu is located approximately 10 km away from Nyukani, and the nearest protected area (Fig. 1.4). Despite being more isolated from local trade infrastructure, Gantundu has had significantly more intervention from non-governmental organizations (NGOs), government extension agents and development projects like the 'work for food' program, in addition to on site agricultural trials for the KARI-McGill project. When statistics from household surveys were compared, Gantundu had significantly higher household assets and reported less food insecurity, perhaps due to greater average education levels for the household head and more off-farm employment. The household head's age, number of children, household size, total farm size and off-farm employment in general were not significantly different between the two sites (Table 2.1).

3.4.2. Research methodology

The contemporary nature of this project, where context and research are difficult to separate and experimental manipulations are impractical, made using a case study research approach the logical choice, allowing for the inclusion of diverse evidence from observation, documentation and interviews (Yin 2009). Baxter and Jack (2008) explain how this framework is particularly useful when investigating the context and research question simultaneously, using a variety of data sources and multiple perspectives. Issues of validity and trustworthiness in our results were addressed through data triangulation, specifically using different data sources and methods to answer the same questions, which aids in obtaining results convergence and verification (Thurmond 2004). Whittemore and Chase et al. (2001) outline a number of other measures of validity in qualitative research, which were considered throughout the research process, with special focus on length of engagement in the field, consideration for disenfranchised groups and member checking at the conclusion of interviews and the study as a whole. Despite our best efforts, it is likely that some perspectives and opinions were overlooked in our case study (Pain 2004; Beverly, Uto et al. 2008), and that recall bias may have skewed some of the data collected

(Delang 2006). Nevertheless, the understanding that comes from intense scrutiny of cases has been shown to be critical for solving 'real world' problems like persistent food insecurity (Flyvbjerg 2006).

3.4.3. Data collection

Community perspectives and experiences were elicited through semi-structured interviews (Keller, Mndiga et al. 2005; Gordon and Enfors 2008) and participatory research activities (Herlihy 2003; Fentahun and Hager 2009; Maroyi 2011; Termote 2011). Insight from higher-level actors, such as community elders and government representatives, was incorporated using key informant interviews similar to those conducted by Pandit and Thapa (2003) (Table 3.2). A legal analysis of the 2005 Forest Act was also conducted to provide the regulatory context in Kenya, which was accessed using the Food and Agriculture Organization (FAO) legal database (FAOLEX), drawing on the work of Kohler and Schmithfisen (2002).

The semi-structured household interviews were conducted between June and August 2012 by KARI-trained enumerators with the support of local field assistants. Thirty households were selected randomly from a list of all residents from the sub-chief of the village, resulting in a total of sixty household surveys that included a mix of male- and female-headed households from diverse age groups, occupations and locations within the community. The questionnaires were initially written in English, and then translated by interviewers into the local dialect of Kitharaka. The same translators were employed for the duration of the project, and trained together to ensure accuracy and standardization of response interpretation. The survey and interview questions were pretested in early June 2012, resulting in improved clarity.

Each session began with an oral statement of informed consent that was recorded electronically, followed by a brief household survey designed according to the guidelines for quantitative data collection in developing countries (UN 2008). The household survey included questions on demographics, family structure, household food security, land tenure and access to natural areas. Information on the harvest and consumption of WEPs from the home, farm, and other privately owned or public lands was collected for the entire year, with particular focus on the access

restrictions and permission requirements for each harvest area. A short semi-structure interview was conducted following the survey with the same respondent. The prompts focused on eliciting local opinions and concerns regarding WEPs, cultural considerations, and the manifestations and implications of changes in climate, land tenure and access to common property resources (Appendix III). The interview also provided participants an opportunity to clarify their initial responses and member-check the data collected.

Key informant interviews with government officials were conducted in English, also following a semi-structured format that encouraged the participant to speak freely about land tenure, extension activities, regulatory policy, WEP harvest and a variety of related topics. These sessions were digitally recorded and transcribed for analysis. The translators employed during household visits assisted in facilitating the interviews of elders from each village in the local language to better understand the history and current situation in both study sites.

Various participatory research activities were conducted to gain a better understanding of the communities, the various categories of land tenure in the study areas, and the impact that these distinctions have on WEP harvest. Maps are easily understood by people from different backgrounds and help communicate information immediately with a sense of authority, making participatory mapping an appropriate technique for working with disadvantaged, diverse populations (Alcorn 2000). These activities were extremely useful to our research because they brought together various groups within the community and encouraged people to speak.

Local facilitators, translators and field assistants were instrumental in organizing and executing these meetings, (see Sutherland, Irungu et al. 1999; Campbell 2001; Kuhnlein, Smitasiri et al. 2006; Günther and Vogl 2010). Another benefit of bringing the local participants together multiple times was ensuring continuous community input on the research design and results dissemination throughout the field season. Table 3 details the distribution of interview participants, key informants and focus group attendees by study site and activity.

3.4.4. Data analysis

The constant comparison technique was employed to analyse the qualitative data. First described by Glaser and Strauss (1967), this four-step process requires the researcher to compare incidents by creating broad categories and later refine those groups with more concrete rules until a theory can be created to address the research question (Grove 1988). Coding was then used to identify repeating ideas and themes, as well as to understand the broader theoretical narratives for the various groups of participants and the population as a whole (Auerbach and Silverstein 2003). This process is especially well suited for the evaluation of factors, variables and categories to understand the knowledge generated using the case study methodology (Patton 1980).

In the following sections, I present and discuss our results based on the responses of participants using the following notation: 1) the words "generally", "the majority" and "many" indicate the characteristic response of a majority of the respondents (50 % or more); 2) the words "some" and "a number of" indicate response from 25%- 49%; 3) "a few" indicates responses below 20%; 4)) "all" and "one" were also used occasionally. In order to capture the rich perspectives of our participants, we present illustrative quotes.

3.5. Results and Discussion

3.5.1 State-owned resources: interpretation and application of the Forest Law

Representatives from the Kenya Forest Service and Ministry of Agriculture were interviewed individually to assess their interpretation of the policies and explore the resulting impacts on community access to WEPs for subsistence use. Based on these interviews, two key themes emerged that affect the collection of WEPs: 1) Various interpretations of the rules for gathering WEPs; and 2) Differences in the penalties for unauthorized WEP harvest.

3.5.1.1. Various interpretations of the rules for gathering WEPs

The data that were coded to this theme highlighted a great deal of confusion amongst

government employees regarding traditional use rights, community forest management and regulations related to WEP harvest, which trickled down to community members as well.

> Forester #1 explained: "We encourage it. We call them Non-Tree Products...the law does not allow anybody to collect material from the forest without a permit, a government document...If you want to go collect wild fruits it is good that you get licensed. Even if it's just for household. You have to get licensed. Because our law says you cannot enter there without a permit for any activity. Even collecting the very wild fruits, you have to be licensed."
>
> Contradicting this account, a district officer from the Ministry of Agriculture stated: "If you go to the forests now, even the hills, although you realize that they are owned by the government, whatever wild fruits are there you don't even have to consult anybody. As long as you are not cutting down the tree." He clarified that "generally it does not affect the tree. You just pick what you want and leave the tree there."
>
> He went on to clarify that it is all right "because you are not taking the tree, only the fruit or the leaves." He stated that "The economic value is the most important consideration, and since most wild fruits don't have much values there is no problem." This differs from other respondents (Forester #1 and #2) who based their interpretation of gathering WEPs according to the Forest Act rules related to large-scale NTFP collection for income generation.
>
> Forester #2 made a distinction between WEP users who hold grazing permits for their animals: "So maybe whoever is getting into the forest for grazing he might be helping himself to the wild fruits that are there, which are also conserved...it is inevitable...but it's not for trading" and those who do not: "It's not allowed, especially for commercial...You need to notify the forester in charge of the area, or the guard...You know that maybe there are those medicinal plants, herbs and people usually go for them, and those are illegal activities now unless you are permitted to do that."

After discussing the regulations for harvesting WEPs with enforcement officers and extension agents, we asked the community about their interpretation of WEP collection in the government-controlled forests. The majority of participants understood the prohibitions against entering the forest and harvesting wild foods. Each of the following illustrative quotes is identified using the household survey number of the respondent.

> 36. "They are against people who are cutting down trees, firewood and collecting WEPs without permission."

However, when surveyed about actual harvest locations, only 48 per cent of those collecting WEPs in the hilltops said that permission was required for entry into the hilltop reserve. A few respondents believed that restrictions have recently been eased, and entry into the forest is now less difficult than in the past, especially where WEPs are concerned:

> 45. "Today the foresters are not so strict on people going into the hills. The rules have

changed from the government - in the early days you could not get permission at all to collect firewood, cut trees or collect building materials. Now you can."

53. "There are less restrictions now on WEP collection - this depends on the government in power, and the new constitution which calls for freedom of movement so the foresters no longer beat people like used to happen before."

55. "The restrictions from his youth seem more strict than today, at least now they can enter the hills with a permit and get materials such as trees, poles, grass and WEPs."

Of the 60 survey participants, 45 % explicitly referenced a permit that is required for collecting WEPs. Some went so far as to explain the procedure for obtaining this permit and the cost, which varied from free to 400Ksh ($4.60 CAD).

"Must get permission from the forester, even just for WEPs. The permit is a printed paper, free but difficult to obtain because the office is often closed. There is an unlimited number available, but it's only good for 1 day."
"Get permit from forester at Chiakariga - specific according to the activity you want to do. He doesn't get a permit for collecting WEPs due to cost - 400 Ksh to collect fruits."

These responses are interesting because, according to the foresters we interviewed, no such permitting process for subsistence activities exists in the semi-arid regions of Kenya. These foresters referenced the time required for creating community forest associations (CFAs) and a lack of community interest in WEP collection as the main reasons that no permitting procedures had been developed for subsistence collection.

Forester #2 said: "What we are waiting now is permission to go to the next step to go to the community forest associations, CFAs...in drylands, we haven't been having a lot of income to the government ...there is that mentality of disregarding the marginal areas. The priority might be on the high priority areas because that is where they are generating a lot of revenue."

Ministry of Agriculture Officer #2 explained that: "People don't know the importance of them (WEPs). You know is nasty some how, you know they are trained to eat it when they are tender, they don't consider as a good vegetable for their consumption. They eat but very little, very rarely."

Forester #1 stated: "We have not started because the interest is not there...you see madam is that the farmers they can be able to get it (WEPs) from your farmland...Maybe in the future because the trees are diminishing from the farmland. Maybe in the future there will be a demand."

The confusion surrounding formal regulations is fairly common, perhaps due to the numerous types of forest management and the high number of stakeholders involved (Lescuyer 2003). Unclear property rights might also cause confusion in policy implementation, and often results in increased environmental degradation caused by illegal extraction activities (White and Martin

2002). The laws themselves are also often somewhat contradictory and do not lend themselves to easy application, which has resulted in disagreements about the legality of many forest activities (Colchester 2006).

Furthermore, a lack of information and outreach to communities has plagued forest agencies in many developing area contexts. These issues range from incomplete records of land ownership, to inaccurately transcribed documents and even laws cobbled together from several different administrations, time periods and languages (Witness 2001; Rosenbaum 2004). Laws need to be simple and easy to understand, across all networks or users and enforcement agents, otherwise they run the risk of becoming unenforceable, irrelevant and create loopholes for illegal activities (Contreras-Hermosilla 2002).

3.5.1.2. Differences in the penalties for unauthorized WEP harvest

The data supporting this theme revealed confusion regarding the consequences of collecting WEPs in State-managed forests. Some officials reported significant fines and jail time, while others were more lenient:

> Forester #1:"If somebody is caught it seems they have committed an offense, we take them to the police station and then the person is charged with illegal entry into the forest...there are several penalties stated as per each of the Acts. The minimum is 10,000 Ksh or three months jail. Or both the fine and sentence...If I catch you with wild fruits you are in possession of forest produce. In this case the fine, is under Section 52, the fine is 50,000 Ksh or six months in jail. Now, also, if you are caught having cut, now you are in possession of that already, but by picking them you have already cut the produce.. the fine is the same...you have three counts you have 150,000 Ksh and in the courts you are fined."
>
> Forester #2: "You would be charged with trespass, being in the forest illegally...I don't think there would be any other charges, because there is nothing particularly addressing the fruits. Maybe we would be talking of the trespass, it would not be saying that you were harming that tree because maybe you were collecting the fruits on the ground or the top of the tree...being in the forest without a license or a permit of the owner as the case may be is liable on conviction of not less that 50,000Ksh or imprisonment of a term of not less than one year or both such fine and imprisonment."

These fines are significant, between $115 and $1,728 (CAD), particularly considering that 67 % of the population in Kenya survives on less than $2 a day, and GDP per capita is only $808 (World Bank 2012). These large fines were described as presenting a hardship for the

community:

“The amount is so large that you cannot afford to pay and must go to jail.”

Forester #1:“Once you are fined there, then you will get finished.”

The community members reported an awareness of the serious consequences if caught collecting WEPs in the forests. Respondents mentioned fines ranging from 1,000 Ksh to 50,000 Ksh, and up to seven years in jail. There were a number of references made to bribing one’s way out of the situation.

A few participants also reported that no permit will be requested if the only activity observed is WEP harvest:

33. “One needs to sneak in for WEP collection, but if caught can explain and will not suffer consequences.”
43. “No permit required, forester won’t even ask if they are only collecting WEPs.”

These results support the view of Forester #2 who noted a “lack of information by the community members. They don't have, they might not be knowing what are the consequences if they commit an offense. Of what is prohibited and what is not prohibited. You find that some of them are ignorant of the situation or the rules concerning the forest.”

However, the majority of our participants reported some degree of trouble for anyone caught inside the forests. Many noted that enforcement agents would assume that some other illegal activity was occurring if one was caught in the forest and claimed to be harvesting WEPs:

2. “The forest officers won’t listen if they catch you inside whether you are doing something good or bad and you’ll get in trouble either way.”
5. “The government restricts WEP harvest in reserves because people pretend they are going for vegetables but really go to collect firewood.”
27. “People pretend to harvest WEPs but actually go to collect firewood or grass for cattle.”

The general lack of coherence in policy interpretation concerning WEP collection by the foresters from the Forest Service and the extension agents from the Ministry of Agriculture has resulted in confusion regarding WEP harvest regulations, permitting and penalties for illegal entry into government-controlled forests and collection of forest produce. Based on feedback received at community-wide focus groups in Gantundu and Nyukani, it appeared that the local community members were generally unaware of their traditional use rights under The Forests Acts. Despite the education campaigns and sensitization reported by a the officials interviewed, community participants did not fully understand community forest associations (CFAs).

Inconsistency in the interpretation and enforcement of forest laws is not unusual. Several studies have found similar trends around the world, a situation that often favours the local elites and officials who have the capacity to understand and circumvent the laws to their advantage (Delville, Toulmin et al. 2000). The harvest of WEPs as a means to increase resilience is primarily undertaken by poorer, more vulnerable populations (Shackleton and Shackleton 2004), the very groups that suffer as the application of penalties for illegal forest activities tends to concentrate on small scale community actors (Colchester 2006). Despite protections for community rights and development in many forest laws, including Kenya's Forests Act (2005), enforcement agents often ignore those provisions in favor of applying regulations that give preferential access to larger industrial agents while ignoring community rights (Ibid). Such biases might be caused by overt prejudices and bias, or simply a product of the isolation of forest adjacent communities, as discussed by Rosenbaum (2004), who stated that "officials governing the forest may feel little obligation to the people living there".

Improving understanding of Kenya's Forests Act will increase the probability that a given household will participate in a CFA. This participation can have a positive impact on environmental indicators like tree cultivation, and offer benefits to members by allowing them to extract specific forest produce for household and commercial use (Ogada 2012). As discussed by Mayers and Vermeulen (2002), access to information on forest resources, rights and effective routes to recourse is an integral part of pro-poor development policy. The reported lack of clarity regarding these issues in our study area is a barrier to freedom of choice for the communities involved and may make it more difficult for locals to take part in decision-making.

3.5.2. Common property resources in Tharaka

In the past, community owned and managed land was widespread in Kenya, but such regimes are less common today, mostly associated with national parks and reserves like Narok, Amboseli and Samburu (Kameri-Mbote 2005). In the villages of Nyukani and Gantundu, the only reported community-controlled lands housed institutions like schools or marketplaces. According to the oral history recorded from village elders in each study site, the sub-division of clan lands happened relatively recently. A female elder from Nyukani shared the origins of her community:

> "People came from a place called Mboa a long time ago, around 1944, some kept going and settled in Mt. Kenya or Nambenny. The land in this area is mostly inherited from the forefathers, most have land from their family."

In Gantundu, an elder detailed the arrival of many of the current residents that migrated to the area after land tenure reforms and the break-up of clan holdings:

> "Originally this area was home to the Kamarao clan, and the land was owned by them. I come from the Ndegi clan. My parents came here for farmland from another place and originally rented a small plot from the clan in Chiakariga. I came to the village of Gantundu during the 1990 demarcation. Today, many different clans make up the village, and everyone has their land. Some people come now and buy land from the original owners, the clan members. Very few people don't have land."
>
> A Ministry of Agriculture officer referenced the sub-division of land, explaining that all land in this area is: "either still owned by those same families or has been bought from other clan members or outsiders that came to own the land...There is no real shared land anymore...they are all owned."

Local community participants reported a similar story during participatory mapping sessions, with no community lands identified in either village. Riverbeds were often mentioned as common harvest sites for WEPs, especially during the dry season when vegetables are not available in most other locations. In Gantundu (Fig. 3.3), the group explained through translators that '*in the past it was easy to get vegetables in the hills and streams, but now one must ask permission of the owners.'*

The Nyukani mapping session produced a similar sketch using ephemeral mapping (Fig. 3.4), which also showed no open access areas. Following demarcation by clan leaders and local government officials in 2010, formal boundaries are being enforced for individual farms and owners can accuse trespassers and report them to the police. In Nyukani, there was some confusion regarding ownership of the riverbeds. The large rivers are owned by the government and access is restricted, but the majority of waterways are seasonal, and are considered private property. Two non-formally protected hills are also available to the community for grazing and picking WEPs, but only along the hill base, which is marginal land at best. Outsiders are required to obtain permission to pick WEPs on riverbeds and hills.

The non-protected hilltops were only mentioned as utilized harvest areas by one survey respondent in Nyukani and two in Gantundu, suggesting they do not play a large role in WEP

harvest for the community. The prohibition of outsiders is a common theme in common property resource management, since the viability of these regimes often relies on cooperation and understanding within the user groups (Singleton and Taylor 1992). The community management of these small hilltops is closer to shared resource management than strict private property designation, and could guide the creation of effective village governance of other collective use areas, similar to those advocated in the literature (Kellert, Mehta et al. 2000; Pellikka, Lötjönen et al. 2009).

3.5.3. Private property rights and access to WEPs

Private land holdings were clearly defined by Ministry of Agriculture Officer #1: "When you own the land, you own everything on it...for example trees, soil, rocks and minerals, crops."

Both government and community respondents were in agreement when asked to clarify the rights to restrict WEP harvest and the ownership of forest produce on one's property:

> The same Officer #1 explained: "That would depend on the owner of the farm. There are owners who are generous and allow people to pick the wild fruits and go. There are others who say if you enter their farms you will be in trouble. So long as it belongs to you, now everybody coming there will not be able to take it. So for you to pick a wild fruit there it depends, some owners are very generous and allow people to pick wild fruits, even encourage peoples."

3. Must ask permission now from owners of private land, who even refuse to grant it. They don't like disturbances in their homes.
29. Land ownership has created boundaries - since the people own the land they want to secure it and there is no freedom to enter without permission.
34. One might even report you to the Chiefs office if you are caught on their farm without permission, caused by the boundaries creating ownership.

A variety of explanations were given for the reluctance of land owners to allow WEP harvest on their farms, beginning with concerns about soil fertility and crop health:

8. Private property owners will restrict access to WEPs because they fear reduced soil fertility due to WEP harvest.
14. They believe that people collecting WEPs on the farm can cause soil compaction and make the land less fertile.
33. People don't want others to enter for fear of destroying young cultivated plots.

Some participants described jealous and mean-spirited behaviour, calling their neighbours

selfish, while others referred to the potential market value of WEPs:

4. They won't let others use their WEPs because they are being mean and jealous. It's often not because they want to use the WEPs themselves.
23. Don't want others to get WEPs from their farms, want to keep them for themselves.
54. Some people hate their neighbours and so don't want them in their homes.

Ministry of Agriculture Officer #1 agreed: "If I am a farmer and own a piece of land and there is a wild fruit there and I know that that fruit or vegetable has a certain value in the market, I won't just let others come and pick. If I have no idea about the commercial value then maybe it is ok."

A fear of ulterior motives for collecting WEPs was also described as a reason to restrict access, similar to the issue raised in relation to the government controlled forests.

37. Owners fear you may destroy the fence and everyone will enter the farm without permission. Owners don't want their farms to be stepped on and create paths in the there, worry that people may be going to graze animals while pretending to collect WEPs.
39. Owners think that when you cross the boundaries you might be cutting down his trees, breaking the fences or even stealing other (more valuable) fruits from the farm

Other researchers have also discussed the challenges that arise for community management of NTFPs like WEPs when there is a lack of trust among participants, especially when there have been few interactions with local gatekeepers and occasional negative outcomes (Everett 2001) such as those discussed by our research participants. Policy makers and practitioners often expect the community members to act as one, single-minded and stagnant group in their management of common resources using unanimously agreed upon rules of access (Turner 1999). This is often not the case, however, as the regulations governing access to natural resources on common and private lands are apt to change, politically and spatially, due to lack of formal management regimes and weak local institutions (Ibid). Communities that depend on forest resources are not often uniform entities with singular intentions (Adhikari and Adhikari 2005), and this was the case in our study where the villages had members from over ten clans, and were comprised of individuals representing a wide range of religious affiliations and economic levels with their own distinct opinions about WEP harvest on private property.

Ostrom (1990) also cites poorly defined tenure rules as an impediment to sustainable management of common property resources, such as the marginal lands and riverbeds where access is prohibited due to community concerns about theft, degradation and boundary changing. Permanent land ownership and titling are a relatively new phenomenon in Kenya, resulting in

uncertainty about boundary demarcation, exploitation of new land registration protocols and informal channels by opportunistic actors, and higher risks and transaction costs for outsiders attempting to buy property in formerly traditionally managed systems (Atwood 1990). The combination of lack of trust and mutual understanding, both within the community and between community members and enforcement personnel, community heterogeneity and poorly defined rules makes WEP harvest difficult in the public forests, private farms and marginal lands in our study areas, with negative implications for household food security and community resilience.

3.5.4. Government extension activities and commercialization of WEPs

Commercial trade in NTFPs is rarely a viable option for balancing development and conservation objectives (Kusters 2006). Large-scale WEP extraction for income generation is not necessarily the way to maximize the benefits for communities while maintaining the integrity of the ecosystems under their management. Despite this, WEP-related extension activities in Kenya are almost entirely focused on value-added export production. The fruit most commonly referenced as a commodity by extension agents, foresters and community members, muthithi (*Tamarindus indica*), can be used to make juice, jams and candies that can then be sold in the village or regional markets. Other fruits are included in plans for commercialization, such as muura (*Sclerocarya birrea*), which is known in South Africa as marula and used to make beer, while more recently packaged products like jam, oil, fruit juice and wine have been introduced (Mander, Cribbins et al. 2002).

While the Kenya Forest Service in Chiakariga was not actively working with communities to manage State forests for subsistence WEP collection, they are promoting commercialization of these resources by encouraging farmers to plant tamarind and marula trees on their land, and to establish CFAs that aim to profit from the sale of the final products.

> Forester #1: "We have a project here called, a community based forest project that is encouraging the farmers to get into enterprises like those with fruits. Like to make the juice or make conservation of the same and also to start now establishing the trees...So we are actually working for the wild fruits, we go to what is now actually in demand and where farmers can get an income like the tamarinds they are sold. There is someone who collects them and takes it to Mombasa...we would establish those trees, form kind of plantations and then we could call the farmers to come and collect the things."

> Ministry of Agriculture Officer #2. "Mostly the government is insisting that the people look after their ordinary (wild) fruits for the areas which are dry areas. And once they have them, they can be trained how to preserve them as the other (domesticated) fruits."
>
> Forester #2: There are those viable things like muthithi (tamarind), this is something which is we can harness it or domesticate it so it can be managed by the village farmers so that they can reap higher yields from it and also see how they can join a network, like the farmer field school network, so that they would be able to do marketing of the produce...We also have the marula, the marula, is a viable investment taking into consideration that marula wine comes from it and its processed especially in S. Africa. If it's something that can also be domesticated and be well managed, then it could be a viable project. Because apart from maybe feeding on the fruits, those fruits they can also be processed, they can also be the jam for the bread they can also come from marula.

The Ministry of Agriculture is also working to promote the harvest and processing of tamarind for income generation.

> Ministry of Agriculture Officer #3: "So we actually taught them how to make the juices, the jam and candies, but they didn't go for the candies, so they went for the jam and juice...They also collaborate with the catholic diocese of Meru who do some marketing promotion for them...they are the first customers themselves and then they sell it to the other people members of their networks, when they have visitors they take them to their group and the can buy there."

Local entrepreneurs are also involved, with one man in Chiakariga collecting kilograms of tamarind fruit to sell in bulk to a juice processing facility in Mombasa.

The focus on commercial value of WEPs is taking away from the major subsistence role of these products within the communities, ignoring the myriad nutritional benefits of these resources in lieu of economic gains. Studies in Southeast Asia have demonstrated that poorer households are often forced to sell high value WEPs like mushrooms and vegetables in order to be able to buy staple foods (Yen, Duc et al. 1994). In addition to the economically driven inequalities that result from WEP commercialization, considering NTFPs primarily as an income-generating resource can lead private landowners to refuse entry to harvesters who formerly were permitted on the property. Such changes in resource access have been demonstrated elsewhere [e.g., the restriction of njansang (*Ricinodendron heudelotii*) harvest in Cameroon to only nuclear lineage and household members (Peach Brown and Lassoie 2010), and local children's loss of access to fruits which are instead sold for income generation (Brown and Lapuyade 2001). This situation can be especially detrimental to poorer households without land, and more vulnerable

demographic groups, like widows and children, who are generally more dependent on WEP resources (Paumgarten and Shackleton 2009) yet the first to lose access when resources collection sites are privatized and formally managed (Sick 2008).

WEP collection in the forest is also being affected by the concentration on economic valuation, where subsistence harvest is regulated like a commercial activity. This occurs despite no formal pricing for the required licenses according to our Kenya Forest Service participants. According to these key informants, subsistence collection is not differentiated from larger harvests meant for processing and export, and the same licenses and permits are required whether the harvester is taking a few leaves for the family dinner or a hundred kilograms of fruit to make juice. The resulting disparity in access and benefit sharing has been demonstrated in a number of studies where local elites are the only ones that can afford initial investments in certification (Pierce, Shanley et al. 2003; Pierce, Shanley et al. 2008), fees to join CFAs (Pokharel and Nurse 2004) and the price of access permits (Malla, Neupane et al. 2003), and thus tend to receive the majority of benefits from NTFP development projects (Thoms 2008). Importantly, these elites are not generally reliant on WEPs as a coping strategy to increase household resilience, as they tend to have alternative assets and sources of income that decrease their vulnerability (Block and Webb 2001; Iiyama, Kariuki et al. 2008). The contribution of coping strategies like WEPs to increased socio-ecological resilience and household food security becomes more significant when their harvest benefits poorer populations in addition to the local elites (Ericksen 2008).

3.6. Summarizing the history, challenges and opportunities for resilience-focused policy and institutions

Figure 3.5 presents a summary of the evolution of forest policy and land tenure in Kenya over time and the impact of those changes on WEP access. The issues identified in this study, and corroborated in the literature, are presented as actions (arrows) with associated WEP harvest outcomes (boxes). One of the most obvious issues that arose for both private lands and publicly controlled forests was the communication breakdown and high levels of confusion and mistrust related to the rules for harvesting WEPs. The interpretation of the formal rules varied

considerably in relation to permission requirements, permits and penalties for illegal entry. The spectrum of responses ranged from defining the government reserves as open access areas where anyone can collect WEPs, to considering these forests as closed systems where harvesters face severe penalties if caught. Several respondents described a fear that WEP collection would be misconstrued as illegal firewood collection or charcoal burning in the forests, and attempted theft and boundary changing on their neighbours' farms.

The focus on commercialization of WEPs and other NTFPs also had substantial effects on harvest policies, community perceptions and enforcement activities for private landowners and State forests alike. Conflating harvest of WEPs for subsistence and income generation in government-managed forests was associated with greater access inequality and negative impacts on the contribution of WEPs to socio-ecological resilience for vulnerable populations. There were also consequences on private lands, where the perception of high economic value for WEPs led to loss of harvest access for community members. Some policy recommendations are presented below, and also integrated into Figure 3.5 (dotted lines) along with the possible outcomes of such interventions.

3.6.1. Distinguishing between commercial and subsistence NTFP harvest

Based on our results, there is a need to address the inconsistent interpretation of the 2005 Forest Law to clarify traditional use and subsistence-level collection of forest produce. WEPs may need to be considered as a separate category in the Act, enabling the creation of a permit structure that is not based on market price. This would lend itself to more effective regulation, since the vast majority of WEPs were not considered to be economically valuable by the study participants. Furthermore, making a distinction between small-scale WEP harvest and the significant extract that often occurs with processing NTFPs for commercial use and export would open the door for simplified CFA formation requirements when collecting WEPs for subsistence.

The Forests Act stipulates a number of expensive pre-requisites for creating a CFA, including professionally designed management plans and methods for monitoring and conserving biodiversity in the entire forest. These formal plans are an important precaution for commercial

collection, which even under non-destructive harvest conditions can have significant ecological impact (Peters 1994). However, WEPs collected for household use may not require such formal management controls, since extraction is generally low-level with limited impacts on the target species or ecosystem as a whole (Laird, McLain et al. 2010). This is an area that requires more research.

In order for WEPs to contribute to food security and act as a coping strategy for increased resilience, policy interventions need to better consider user groups when implementing restrictions that will almost certainly have a detrimental impact on local livelihoods and food security (Mbuvi and Boon 2009). Equitable access, especially for the more vulnerable groups within communities, is imperative if forest-based livelihood interventions like WEP harvest are to be considered a positive development activity across demographic groups (Sunderlin, Angelsen et al. 2003; Mahanty, Gronow et al. 2009). There is also some evidence that WEP users are more inclined to conserve forests, due to their interest in continuing to benefit from these resources in the future, which further contributes to the sustainability of such resource management regimes (Delang 2006). This is another area requiring further research.

3.6.2. Creating a culture of mutual trust and communication

A major finding of our study was the reported lack of trust and communication between the community and government officials, and between neighbours concerning entry to private lands and the sharing of food resources. Our participants described being somewhat fearful of their neighbours or the Forestry Service refusing to believe that subsistence WEP collection was their singular motivation for being in the forest or on a private farm. The tendency to jump to conclusions of anti-social behaviour like theft, boundary changes and illegal forest product extraction, could be mitigated by encouraging greater community dialogue (Turner 1999). This discourse might even allow user groups to agree on community open access areas, like seasonal streams and unprotected hilltops, that are currently operating under vague management regimes.

Bringing together the Forest Service officials and the local community would be an excellent step in reducing the confusion surrounding forest access regulations and penalties for subsistence

activities. Such a process could also provide an opportunity for foresters and farmers to interact, dispelling some of the negative opinions held by both parties. Despite the claims by forest officers that the villages surrounding Kijege reserve had been sensitized on access restrictions and CFA creation procedures, it was apparent during our household interviews and focus group discussions that there were significant gaps in local knowledge related to the 2005 Forests Act and its enforcement.

Social capital, or the existing sum of social relationships in a society, varies greatly within and between groups of people and can have significant impacts on community development and resource management (PiazzaGeorgi 2002). Our respondents briefly touched upon these differentiations when referring to local elites and their capacity to circumvent regulations and invest capital to derive greater benefits from forest resources like WEPs (Thoms 2008). However, other types of social capital are involved in determining which groups can access WEPs and the benefits they can derive from these resources, such as linkages that create rules and conventions as well as relationships between actors that help develop networks (Barr 2000). Bonding social capital, evident in connected and cohesive community groups, and bridging social capital that supports inter-community connections and cooperation between communities and institutions are also important components of successful local forest management (Hyakumura and Inoue 2006).

Resilience from WEP harvest is only possible when vulnerable populations are able to access resources as a coping strategy; otherwise they are just another mechanism for local elites to benefit to the detriment of disadvantaged populations (Delville, Toulmin et al. 2000). Confusion about existing forest laws, poor communication and inconsistent enforcement is disproportionately harmful to poorer populations attempting to benefit from forest resources and will continue to increase inequality unless pro-poor policies are instituted (Mayers and Vermeulen 2002). Social capital plays a role in this situation, as socially subordinate populations often depend more on natural resources despite encountering greater barriers to access such products (Wiersum and Shackleton 2005). Increasing social capital, through strengthening social organizations and group ties, has been suggested as a means of increasing socio-ecological system resilience (Ladio and Lozada 2009) and is important for sustainable development and

biodiversity conservation as a whole (Pretty 2003).

3.6.3. Moving beyond value addition and income generation

In addition to the issues surrounding access conditions and harvest rights, government extension activities and attitudes were almost entirely focused on WEPs as inputs for value addition, export and income generation. The main product, muthithi (*Tamarindus indica*), has a very low demand, which is reflected in the prices paid for semi-processed fruits (3Ksh/Kilogram) by the major buyers on the coast of Kenya, and the lack of a local market for the product. International trade in tamarind is limited due to complex health standards, difficulties finding exporters, and competition from Indian and Mexican producers (Betser 1999).

The combination of low profits and inequitable benefits distribution suggest that a change in WEP extension activities to focus on simpler preparation and preservation of WEPs for household use would aid food security objectives. According to the Ministry of Agriculture officers we interviewed, projects were underway to promote vegetable gardens with leafy greens like kale and cabbage, and this could include wild varieties like nterere (*Amaranthus dubius*) and muthunka (*Launaea cornuta*) that are already found in and around farms. Programs also exist to promote the use of cowpea (*Vigna unguiculata*) leaves through educating community members about their nutritional properties, cooking techniques and methods of drying to preserve it for later use. These activities could also be modified to include wild vegetables, something in which extension agents have expressed interest.

In an era of decreasing funding and increasing environmental uncertainty, accurate targeting of funding and extension activities is ever more important (Ansoms and McKay 2010). It is therefore time to focus on resilience-focused policy interventions that have a high likelihood of ensuring that benefits from forest ecosystems go to those who need them most, subsistence collectors of NTFPs that lack alternative livelihood options and additional income (Shackleton, Shackleton et al. 2009). Broad analyses suggest that "the very same characteristics that make them important and attractive to the poor in the first place also limit the potential for further income increases," (Angelsen and Wunder 2003) which makes promoting subsistence use of

WEPs all the more attractive as a means of increasing food security and resilience without relying on unlikely income generation-related gains (Campbell and Luckert 2002).

3.7. Conclusion

This study investigated the various access regimes associated with the harvest of WEPs in two communities in semi-arid Kenya, and the effect that changing institutional conditions have had on the ability of vulnerable populations to use WEPs as a coping strategy to increase socio-ecological resilience. The results suggest that there are serious communication and interpretation breakdowns regarding the application of national forest policy described in The Forests Act (2005), where subsistence collectors are disadvantaged due to strict enforcement that targets small-scale harvesters and substantial barriers to CFA creation for community groups. The focus on commercialization of WEPs by foresters, agricultural extension agents and private landowners also contributes to negative impacts on poorer households, such as loss of access to WEP resources on public and private lands and reduced benefits when local elites are better prepared take advantage of value-addition activities and markets. Furthermore, concentrating on WEPs for income generation minimizes the subsistence value of these products, limiting the education and outreach programs that might otherwise benefit local users and contributes to a belief that WEP harvesters have ulterior motives for entering collection areas.

The results obtained through this research contribute to a greater understanding of the resource access conditions that exist in rural semi-arid Kenya and inform sustainable food security policy as the traditional land tenure systems transition to private ownership, state managed forests and community owned resources. Future policy analyses should consider how Kenya`s Forests Act could be amended to better support national and international food security objectives. In particular, policy and research efforts to better support the sustainable use of WEPs for subsistence purposes will likely result in improved household food security and increased socio-ecological resilience in the rural communities of arid and semi-arid Kenya.

3.8. Figures and Tables

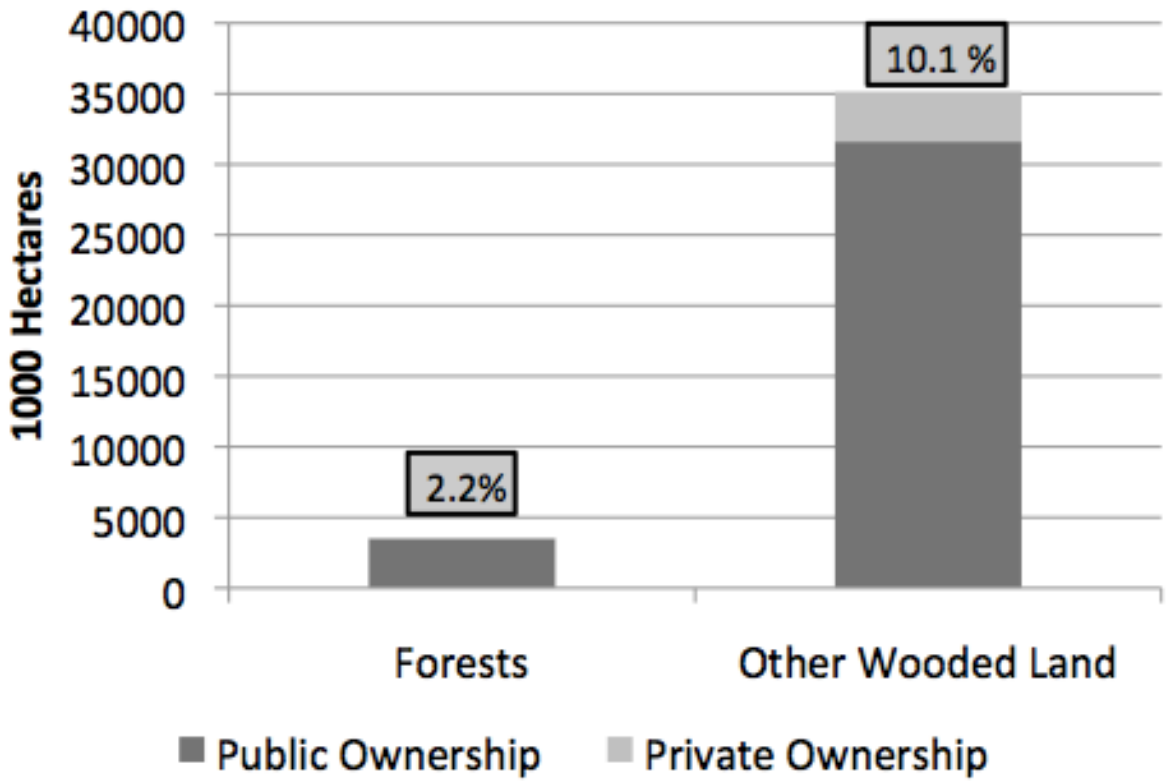

Figure 3.1. Ownership of forests and other wooded lands in Kenya. Only 2% of forests and 10% of all wooded land in Kenya is not government owned (FAO 2010).

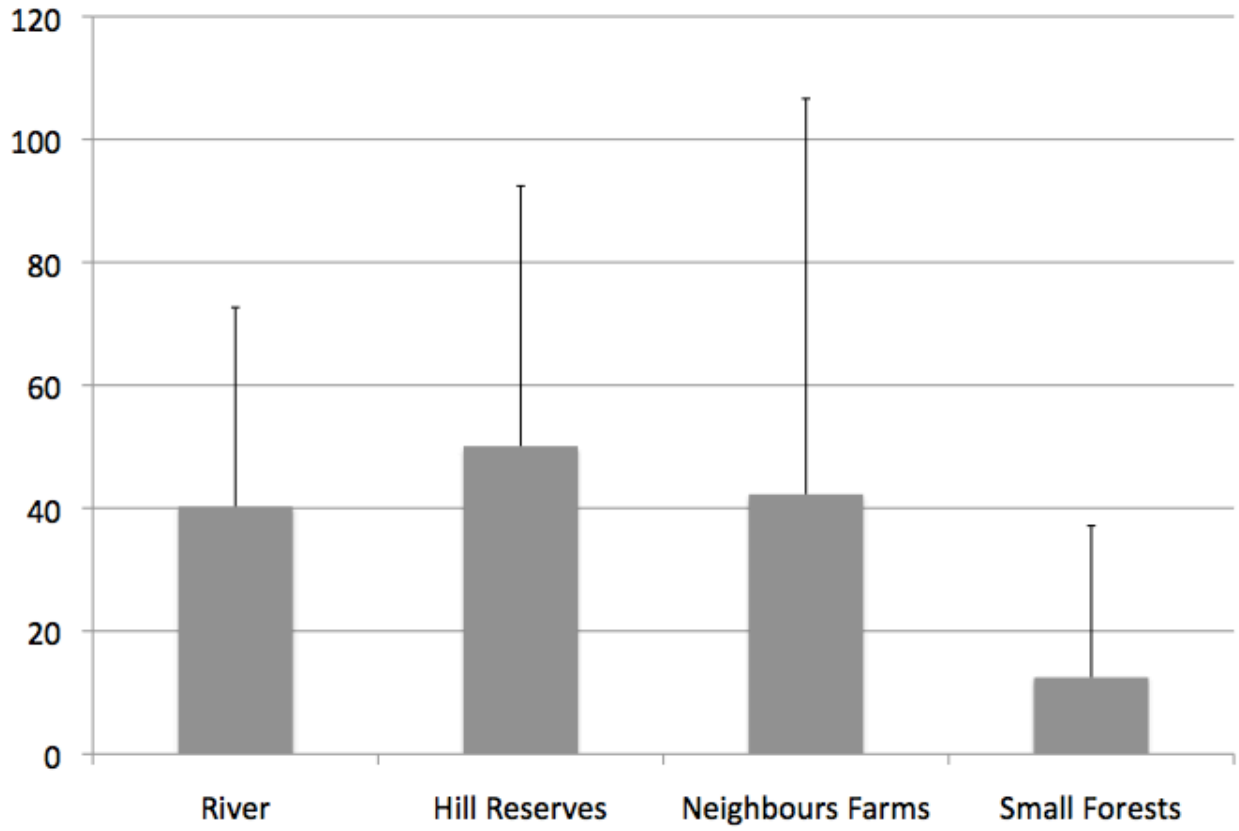

Figure 3.2. Average annual WEP consumption frequency by harvest area, with standard deviation bars. From these figures, it is obvious that government hilltop reserves and privately owned farms are important WEP sources despite prohibitions on entry.

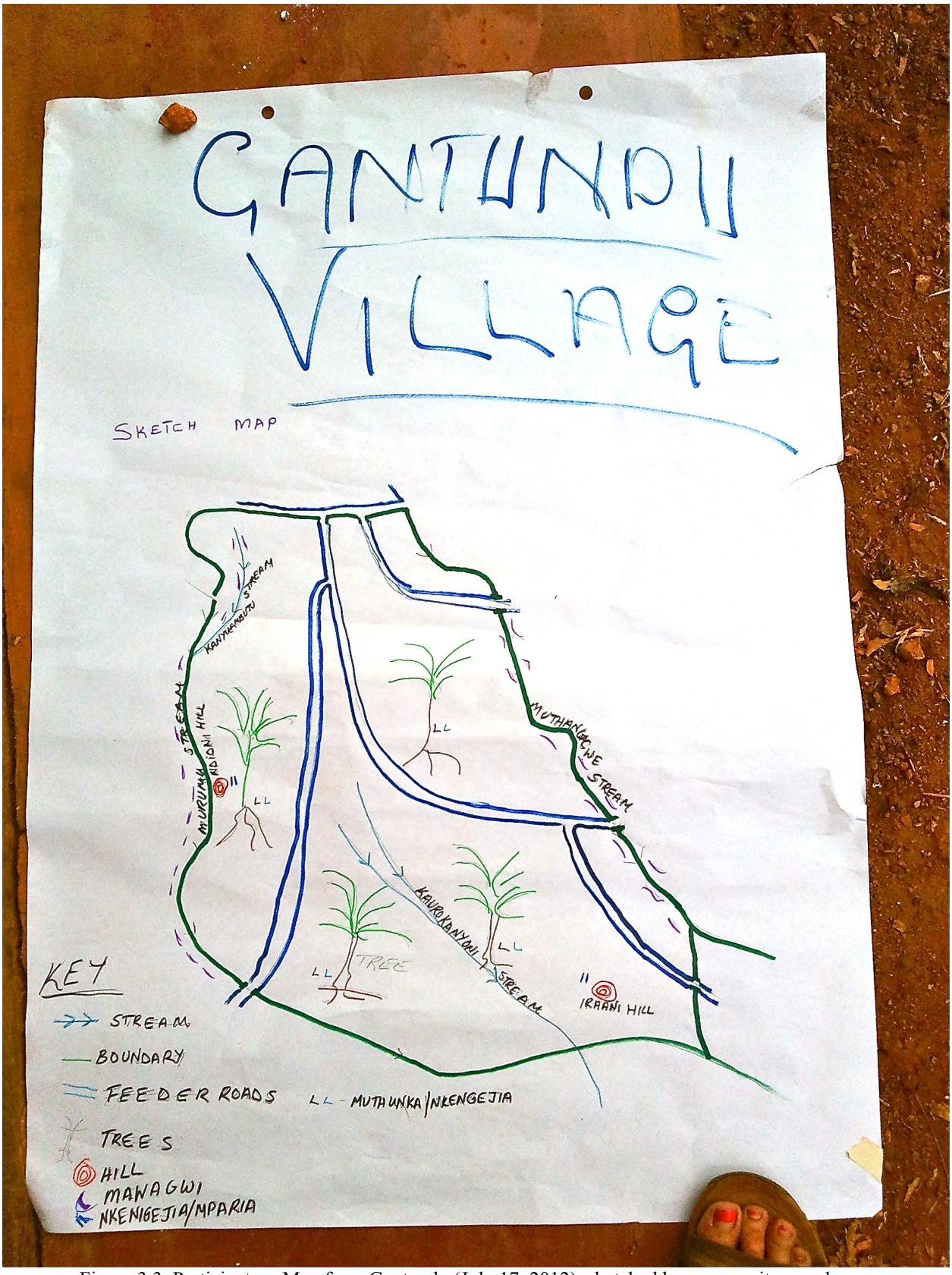

Figure 3.3. Participatory Map from Gantundu (July 17, 2012), sketched by community members.

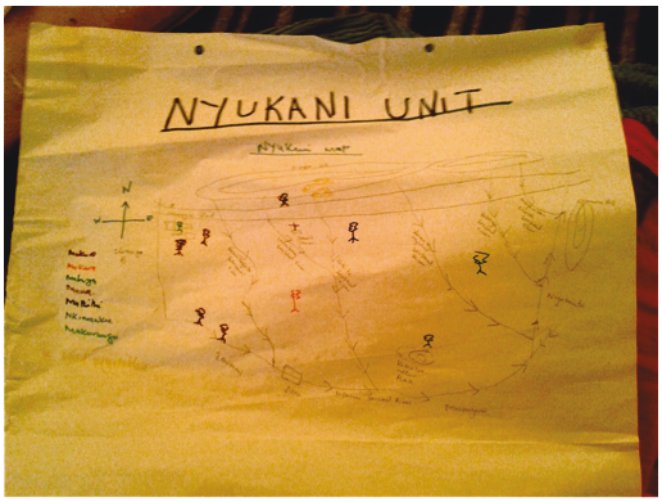

Figure 3.4. Ephemeral mapping in Nyukani (left), sketched by community members (right) - Data Collected August 12, 2012.

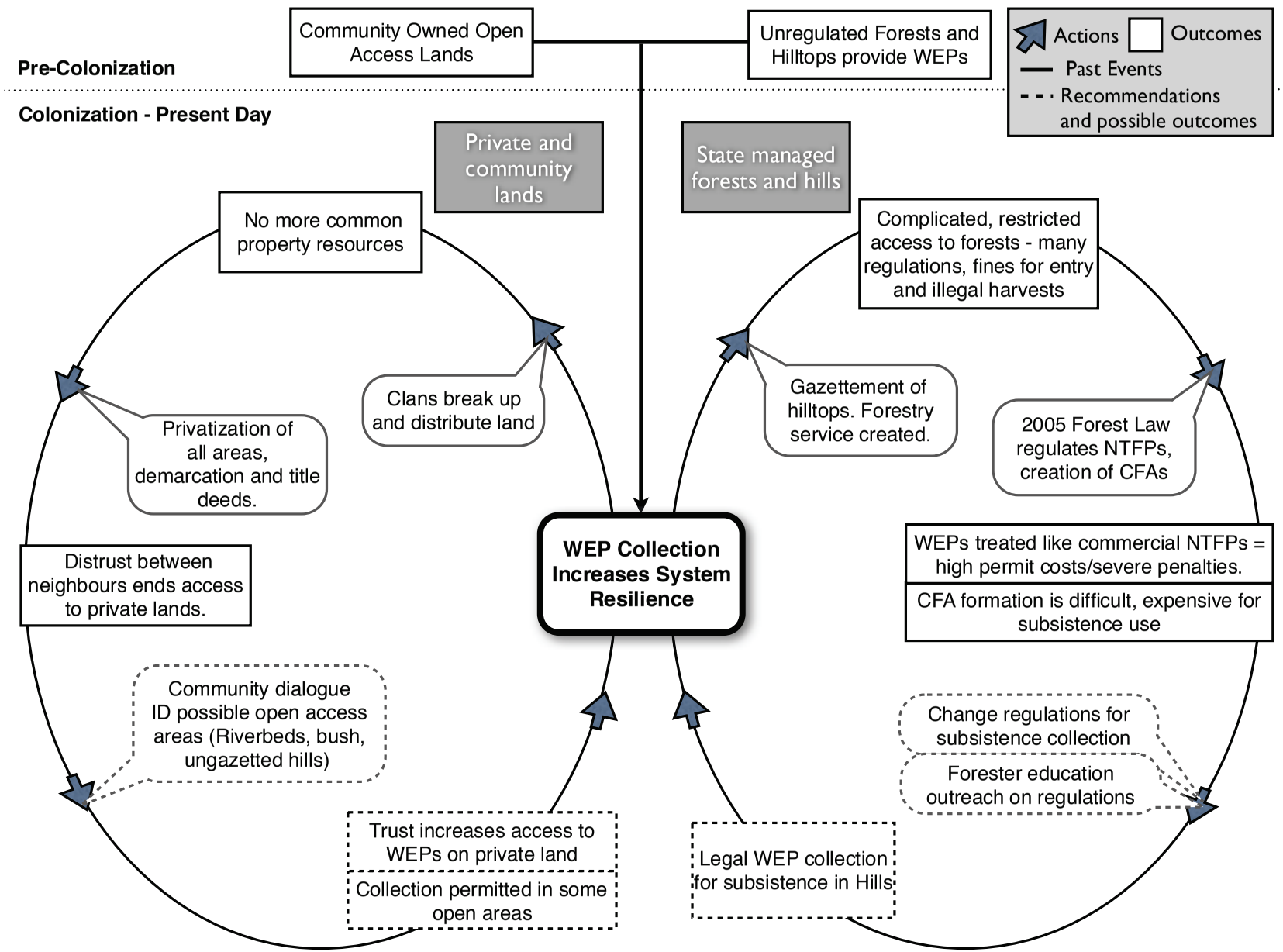

Figure 3.5 - Historical summary of actions and outcomes related to WEP harvest in forests, community, and privately managed lands. Includes possible policy interventions and outcomes.

Table 3.1 - Conditions for sustainable management of common pool resources and associated evaluation criteria for forest laws (Ostrom 1990, Ostrom, Burger *et al*. 1999; Larson, Barry *et al*. 2010)

Management conditions for common pool resources	Congruence between rules and local conditions. Understanding that translates across various enforcement levels.	Clear boundaries and tenure rights that agree with local beliefs	Collective-choice arrangements allowing for the participation of most of the appropriators in the decision making process, stakeholder involvement in policy creation
Evaluation criteria for formal forest policies	1. Are forest products, resources and/or produce (including WEPs) clearly defined?	2. Are traditional use rights and community access to NTFPs and WEPs protected? 3. Does the law identify multiple uses as a priority for forest management? Specifically identify jurisdiction over NTFPs like WEPs?	4. Is the community included in decisions regarding the use of forested land? Are there specific frameworks set up for villages to create, manage and derive benefits from the forests?

Table 3.2 - Breakdown of interview participants and focus group attendees by study site and activity

	Nyukani	Gantundu
Total Households	54	108
Elders Interviewed	1	1
Households Interviewed	30	30
Seasonal Mapping Participants	26	12
Preference Ranking Participants	36	35
Participatory Mapping Participants	26	25
Key Informant Interviews	4 Ministry of Agriculture 2 Forestry Service (From district and local offices)	

3.9. Acknowledgements

This research was supported by the McGill University and KARI. We would also like to acknowledge the field assistants, translators and especially the anonymous participants for donating their valuable time and expertise to our study. This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, and with the financial support of the Government of Canada provided through the Canadian International Development Agency (CIDA).

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Chapter 4. Conclusions and Future Directions

This thesis aimed to provide a better understanding of the household characteristics, access conditions and regulatory policies that affect access to WEPs and their contribution to household food security and resilience in the semi-arid midlands of Kenya. The research was designed to provide household and community level conclusions to better inform the strategies of government, other institutions and local actors to achieve shared goals of improved food security by managing WEP harvest sustainably and equitably to improve household nutrition.

This study has identified a variety of household characteristics and access conditions that are associated with greater reliance on WEPs as a means of increasing resilience in the face of environmental change and food insecurity. The research combined several variables from each category to form a more complete picture of the motivations individuals have for using WEPs, and what causes change in access to these resource, harvest location and consumption frequency. Mixed methods were used to collect rich and varied data from the numerous actors involved in regulating the collection of WEPs on the community and household scales. The combination of qualitative and quantitative techniques was instrumental in obtaining different perspectives within the study sites and contributed to the reliability and trustworthiness of the results (Creswell 2003), while participatory activities provided the opportunity to further involve local stakeholders in data collection, analysis and dissemination activities (Medley and Kalibo 2005).

The results have revealed demographic groups that may depend more on WEPs for food security and how access conditions can affect their harvesting practices. This study also offers some insight as to how those conditions came to be, historically, legally and through implementation, as well as commentary from participants about the viability of the current situation and prospects for a future of sustainable subsistence WEP harvest.

Households that tended to rely on WEPs were likely to self-report food insecurity, lack off-farm income and have lower levels of assets. Across all demographic groups, access to harvest areas was a determinant of consumption frequency, with smaller farm sizes and increased distance to other sites negatively affecting WEP collection rates. These variables are specific enough that

they can be used to more effectively target groups that rely heavily on WEPs, and the access conditions that are likely to increase the ability of vulnerable populations to employ WEPs as a coping strategy to increase system resilience.

An overview of the evolution of natural resource access and restrictions in Kenya provided context to analyze data collected on how WEP harvest regulations are currently interpreted by foresters, agriculture extension workers and private landowners, and the effect that these policies have on the use of WEPs. The main issues identified during data analysis were communication breakdowns, confusion and mistrust between officials and community members as well as between community members within the villages. The disproportionate policy attention paid to WEPs as a commodity for commercial export, income generation and value addition was also a common theme, suggesting that rules governing access to WEPs were designed with commercial applications in mind. As a result, extension activities have all but ignored the direct, subsistence contribution of WEPs to household food security.

This study is unique in that we have combined vulnerability and adaptive capacity measures for each household, and included community access regulations to create a more complete accounting of the factors that influence WEP consumption frequency and the diversity of species consumed. This is useful data that can be used to improve understanding of how common areas, marginal lands and protected forests contribute to rural livelihoods on a daily basis and as emergency safety nets during hungry seasons. Specific, easy to test conditions like off-farm income and self-reported food insecurity could make identifying user groups relatively simple for future development projects and extension activities. The effects of farm size, distance to harvest areas and ownership conditions on WEP access have been clearly identified in this study, which can be applied to future extraction regulations and land tenure reforms.

4.1 Future Directions

This thesis revealed that WEPs in the study area were used mainly at a subsistence- level by vulnerable populations without access to alternative incomes as a coping mechanism in times of food insecurity. Other research has shown that most household-level NTFPs collectors do not

extract resources to the point of environmental degradation, and that subsistence users often have limited access to the capital and organization required to create collectives like those required by the Kenyan Forests Act (Laird, McLain et al. 2010). Limited risks and vulnerable user groups have led to calls for the deregulation of WEPs collected for household use, as the risks of environmental degradation from unsustainable harvests have been over stated, resulting in unnecessary consequences for local livelihoods and food security (Mbuvi and Boon 2009). This is an area that requires further research in the context of arid and semi-arid Kenya.

Our findings confirm the findings of other studies, that WEPs are used more often by food insecure households without access to off-farm incomes and other assets as coping strategies (Cavendish 2000; Arnold and Perez 2001; Pandit and Thapa 2003; Ticktin 2004; Mithofer, Waibel et al. 2006; FAO 2011). Distance to harvest area also played a significant role, as increasing distance decreased both WEP species diversity and consumption frequency overall, similar to the findings of Pardo-De-Santayana, Tardío et al. (2005) and Arenas and Scarpa (2007). Many of the WEPs in this study were collect in the homes and farms of the respondent and their neighbours, as well as in marginal areas such riverbeds. This is an emerging area for further research as much of the existing discussion about WEPs is grounded in theories of NTFP collection and sharing forest resources, while those WEPs from agricultural areas have been largely neglected by scientists and policy makers (Bharucha and Pretty 2010; Cruz-Garcia and Price 2012).

Nearly every study referenced in this paper calls for additional research into the nutritional composition and sustainable harvest levels for WEPs, which is also warranted in this study. There is a need to better understand the benefits of specific resources as well as the levels at which they can each be exploited without causing ecosystem degradation and decreased species health and abundance (Peters 1994). The results obtained in Chapter 3 suggest the need to revise the existing regulatory framework concerning subsistence-level harvesting of WEPs in protected areas, as well as community discussion of the many issues identified concerning WEP collection within the villages. This case would be an excellent candidate for access analysis (Ribot and Peluso 2003) and further study of the social, ecological and institutional points of entry as advocated by Kepe (2008). Further research using social network analysis would also improve

understanding of the issues surrounding access to WEPs, both in terms of entering private lands, knowledge sharing and community safety nets (Godoy et al 2005) and as related to creating effective CFAs and equitably sharing benefits from State forests (Djamhuri 2008).

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Appendix I. Local and Scientific Species Names

Fruit Tree Name	Fruit Name	Family Name	Genus species
Chiamaguna	Mbuu	Tiliaceae	Grewia villosa spp.
Gintujia	Ntugia	Euphorbiaceae	Tragia impedita (prain)
Kirigurigu	-	Cataceae	Opuntia ficus-indica
Mubata mukundo	Batamukundo	Vitaceae	Cyphostemma adenocaule
Mubiru	Mbiru	Rubiaceae	Vangueria madagascariensis
Mubobua	Mbobua	Balanitaceae	Balanites aegyptiaca
Mubuu	Mbuu (Sphere shaped variety)	Tiliaceae	Grewia villosa
Mubuyu	Buyu	Rhamnaceae	Ziziphus mucronata
Muchicha	Machicha	Amarantheacea	Amaranthus dubius
Mucimoro	Macimoro	Verbenaceae	Lantana camara
Mucuura	Ncuura	Sapindaceae	Deinbollia kilimaudscherica
Mudura	Ndura	Tiliaceae	Grewia similis
Mugumo	Ngumo	Moracea	Ficus spp.
Mujee	Njee	Euphorbiaceae	Bridelia taitensis
Mujuria	Njuria	Malvaceae	Sterculia africana
Mukawa, Mukagwa	Nkawa, Nkagwa	Apocynaceae	Carissa edulis
Mukenia	Nkenia	Verbenaceae	Lantana trifolia
Mukoro	Makoro	Ebenaceae	Diospyros mespiliformis
Mukumangao	Nkumangao	Loganiaceae	Strychonos madagascariensis
Mukunduthi	Nkunduthi (oval shaped variety)	Olacaceae	Ximenia americana
Mukuru	Makuru	Annonaceae	Uvaria scheffleri
Mukurungu	Nkurungu	Rubiaceae	Meyna tetraphylla
Mukururu	Makururu	Euphorbiaceae	Flueggea virosa
Mukuura	Makuura	Caesalpiniaceae	Piliostigma thonningii
Mukuyu	Makuyu	Moracea	Ficus sur
Mungo (Moongo)	Maongo	Apocynaceae	Saba comorensis
Mupuuru	Mpuuru	Verbenaceae	Vitex payos
Muragwa	Ndagwa, Ndawa	Tiliaceae	Grewia bicolor
Muramba	Uramba	Bombacaceae	Adansonia digitata
Murenda	Ndenda	Tiliaceae	Grewia spp.
Muroroma	Ndoroma	Olacaceae	Ximenia americana
Muruguyu	Nduguyu, Ncomo	Palmae	Hyphanene compressa

Fruit Tree Name	Fruit Name	Family Name	Genus species
Muthana	Nthana	Capparidaceae	Maerua decumbens
Mutherema	Ntherema	Anacardiaceae	Lannea rivae
Muthigora	Nthigora	Combretaceae	Combretum aculeatum
Muthigu	Mithigu	Bignoniaceae	Kigelia pinnata
Muthithi	Uthithi	Caesalpiniaceae	Tamarindus indica
Muthwana	Nthwana	Rhamnaceae	Berchemia discolor
Mutoo	Matoo	Malvaceae	Azanza garckeana
Mutuunka	Ntuunka	Rubiaceae	Tennantian sennii
Muura	Maura	Anacardiaceae	Sclerocarya birrea
Muyumu	Irumu	Minosaceae	Acacia senegal
Ngatu	-	Cyperaceae	Cyperus blysmoides

Local Vegetable Name	Family	Genus species
Magendenakuru	Fabaceae	Senna didimobotrya
Mathorokwe	Papilionaceae	Vigna membranaceae
Mathuma-mbiti	Icacinaceae	Pyrenacantha kaurabassana
Mathunju	Fabaceae	spp.
Maturankunu (ruturankuru, kuturankunu)	Convolvulacease	Ipomoea mombassana
Mparia	Fabaceae	Clitoria ternatea
Muchicha	Amarantheacea	Amaranthus dubius
Mucungurira	Cucubirtaceae	spp.
Muthunka	Asteraceae	Lauaea cornuta
Ngonko	Polygonaceae	Oxygonum sinuatum
Nkengejia	Commelinaceae	Commelina bengalensis
Nkenia	Verbenaceae	Lantana trifolia
Nkunda, Nkuuda	Papilionaceae	Clitoria ternatea L.
Nterere	Amaranthaceae	Amaranthus dubius
Rugoya	Leguminosae	Indigofera lupatana
Rwoga	Amaranthaceae	Amaranthus graeciazans

Appendix II. Household Survey, Semi-Structured Interview Questions

Date _____ Survey Number _____ Village_____ Time to Market_____ Household Number _____

SECTION 01: HOUSEHOLD RESPONDENT AND TYPE

Household Members:

	First Name	Other Names	Relationship To Head of Household	Sex (M/F)	Birth Year	Education Level	Primary Occupation
Respondent							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Household Type:
1. Male headed, with a wife or wives;
2. Male headed, divorced, single or widowed;
3. Female headed, divorced, single or widowed

Where is the head of household?
1. Permanently at home
2. Temporarily away from home
3. Absent at least 6 months of the year
4. Other _____

SECTION 02: HOUSEHOLD ASSETS AND FOOD SECURITY

A- RESIDENCE & OTHER STRUCTURES

Q1. What is the type of dwelling? (as observed by enumerator) [__ __]
01.Mud hut with grass thatch roof; 02. Mud hut with asbestos/iron roof; 03 = Brick house with grass thatch roof; 04.Brick house with asbestos/iron roof;05.Block house with grass thatch roof; 06.Block house with asbestos/iron roof; 07.Pole and dagga with grass thatch; 08.Other (specify) _____

Q2. Does the house have electricity? 01. YES, 00. NO, 02. SOLAR [__ __]

Q3. Does the house have a latrine (either outside or inside the house)? 00.NO; 01.YES, inside; 02. YES, outside [__ __]

Q4. In addition to your primary residence, how many other residences do you have? [__ __]

B – HOUSEHOLD ASSETS

Household Asset	Total Number		Household Asset	Total Number
Plough			Tractor	
Cart			Radio	
Wheelbarrow			Mobile phones	
Bicycle			Television	
Car				

Q1. In the past 12 months, were there months in which you did not have enough food to meet your family's needs?01. Yes, 00. No [__ __]

Q2-14. If yes, which were the months (in the past 12 months) in which you did not have enough food to meet your family's needs?

Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__ __]

Q3 – If yes, what kinds of coping strategies did you use?

General Questions

1. How are people who eat wild fruits and vegetables viewed in general?

   a) Does this view depend on the plant or the person eating the plant?

2. Are you aware of any local traditions, customs or cultural practices associated with the harvest and use of wild foods?

SECTION 03: COLLECTION OF WILD PLANTS IN YOUR HOMESTEAD FOR CONSUMPTION

We want to collect information about wild uncultivated plants growing in your homestead that are eaten:

	Local Name	Part used (Code A)	Household use, sold or both?	What season is it available? (Code B)	Who harvests the plant? (Code C)	Is it difficult to harvest? **Why?** (Code D)	What changes have you seen since 2000 in plant consumption? (Code E)	What changes have you seen since 2000 in abundance? (Code E)	Comments
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

Code A	Code B	Code C	Code D	Code E
1. Whole Plant 2. Leaf 3. Root 4. Flower 5. Fruit 6. Bark	1. Year round 2. Before rainy season 3. During rainy season 4. After rainy season	01 = Everyone 02 = Women only 03 = Women and children 04 = Men only 05 = Other	01 = Too far 02 = Thorny 03 = Not abundant 04 = Tall tree, hard to climb 05 = Don't want them	1. Increased 2. Stayed the same 3. Decreased 4. Don't know 5. Other (Specify)

SECTION 04: FARMLAND

Questions:	**Land 1**	**Land 2**	**Land 3**	**Land 4**
How far is the land from the homestead (minutes)?				
Size of land (acres)?				
What is the tenure situation? (Code A)				
What is the current use of the land? (Code B)				
For how many years have you used this land?				

SECTION 05: COLLECTION OF WILD EDIBLE PLANTS ON AND AROUND THE FARM

	Local Name	Part used (Code C)	Household use, sold or both?	What season is it available? (Code D)	Who harvests the plant? (Code E)	Which land is it from? (# above)	Is it difficult to harvest? **Why?** (Code F)	What changes have you seen since 2000 in plant consumption? (Code G)	What changes have you seen since 2000 in abundance? (Code G)	Comments
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Code A (Tenure)	**Code B (Use)**	**Code C**	**Code D**	**Code E**	**Code F**	**Code G**
01. Hold a formal title to the land 02. Have customary but exclusive rights over the land 03. Rent the land from someone else 04. Borrow the land from someone else 06. Have use of land you consider your own but that has never been allocated to you	01. Grow crops 02. Pastures 03. Fallow land 04. Other (Specify)	1. Whole Plant 2. Leaf 3. Roots 4. Flower 5. Fruit 6. Bark	1. Year round 2. Before rains 3. During rains 4. After rainy season	01 = Everyone 02 = Women only 03 = Women, children 04 = Men only 05 = Other	01 = Too far 02 = Thorny 03 = Not many 04 = Tall tree 05 = Don't want them	01 = Increased 02 = Stayed the same 03 = Decreased 04 = Don't know 05 = Other (Specify)

SECTION 06: OTHER AREAS WHERE WILD EDIBLE PLANTS ARE FOUND

What are the other areas that wild fruits and vegetables are found? - These can be neighbours homesteads and farms,unowned property, community land, protected areas, government forests and other properties.

	Type of Natural Area (Code A)	How far from your household (minutes)?	Do you obtain wild foods from this area? **(Y/N)**	If not, why no:? (Code B)	Who owns this area? (Code C)	Do you need to ask permission to get wild foods here? **Y/N and who**?
1						
2						
3						
4						
5						
6						

SECTION 7: WILD EDIBLE PLANTS FOUND IN OTHER AREAS

	Local Name	Part used (Code D)	Household use, sold or both?	What season is it available? (Code E)	Who harvests the plant? (Code F)	Which area is it from? (# above)	Is it difficult to harvest? **Why?** (Code G)	What changes have you seen since 2000 in plant consumption? (Code H)	What changes in abundance? (Code H)	What changes in access restrictions? (Code H)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Code A	Code B	**Code C**	Code D	Code E	Code F	Code G	Code H
01 = Forest	01 = Too far	01= Government	1. Whole Plant	1. Year round	01 = Everyone	01 = Too far	01 = Increased
02 = Hills or hill top	02 = No access allowed	02 = Private owner (Who?)	2. Leaf	2. Before rainy season	02 = Women only	02 = Thorny	02 = Stayed the same
03 = Neighbours' farms	03 = Not abundant	03 = Community owned	3. Root	3. During rainy seascn	03 = Women and children	03 = Not abundant	03 = Decreased
04 = Rangeland	04 = Don't want them		4. Flower	4. After rainy season	04 = Men only	04 = Tall tree, hard to climb	04 = Don't know
05 = Wetland	05 = Don't have time		5. Fruit		05 = Other	05 = Don't want them	05 = Other (Specify)
06 = Streambed			6. Bark				

SECTION 8: PREPARATION AND CONSUMPTION OF WILD FRUITS AND VEGETABLES

From the Homestead	How prepared? (Code A)	When is this plant eaten? (Code B)	Who eats this plant? (Code C)	During what months is this plant eaten?	During those months, how many times a week is the plant eaten?	Why consume this plant? (Code D)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
From the Farm						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Code A	**Code B**	**Code C**	**Code D**
01 = Eaten Raw	1. As a snack	1. Everyone	1. Very tasty
02 = Cooked alone	2. When grazing animals	2. Children	2. For fun
03 = Cooked with Ugali	3. When en route	3. Women	3. Many vitamins/health benefits
04 = Cooked with Kitheri	4. As part of a meal	4. Elders	4. To prevent hunger
05 = Cooked with porridge	5. On special occasions	5. Others (specify)	5. Tradition
06 = Roasted	6. Other (specify)		6. Medicinal

From Other Areas	How prepared? (Code A)	When is this plant eaten? (Code B)	Who eats this plant? (Code C)	During what months is this plant eaten?	During those months, how many times a week is the plant eaten?	Why consume this plant? (Code D)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Code A	Code B	Code C	Code D
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04 = Cooked with Kitheri	04 = As part of a meal	04 = Elders	04 = To prevent hunger
05 = Cooked with porridge	05 = On special occasions	05 = Others (specify)	05 = Tradition
06 = Roasted	06 = Other (specify)		06 = Medicinal

Final Interview Questions:

3. Are there wild foods you remember eating as a child that are no longer harvested?

   a) Why do you think this has happened?

4. Have you noticed any changes in climate since you were a child?

   a) Do you think this is affecting the availability of wild fruits and vegetables?

5. Have you noticed any change in the places where wild fruits and vegetables are collected since you were a child?

   a) Why do you think this is?

6. Have you noticed any changes about the rules related to collecting wild fruits and vegetables on your neighbours' farms and pastures since you were a child?

   a) Why do you think this is?

7. Have you noticed any changes about the rules related to collecting wild fruits and vegetables in government reserves, hilltops and rivers since you were a child?

   a) Why do you think this is?